Getting Started with Selenium for Automated Website Testing

Selenium is designed to automate web browser interaction. It is primarily used to write scripts for actions users might take on your website, testing site functionality much faster than you could by hand. A short Selenium test might confirm that the browser can load a page at all, while a more complex test could automate an entire journey from log-in to a shopping cart.

This topic is intended to provide you with a quick overview of what Selenium does, and the basic components of a Selenium test script. For a complete reference guide and examples in most popular scripting languages, check out full documentation at SeleniumHQ.

See the following sections for more information:

- Selenium Architecture
- The Seven Basic Steps of Selenium Tests
- Example Use Case and Web Application
- Creating an Instance of the WebDriver Interface
- Navigating to a Web Page
- Locating an HTML Element on a Web Page
- Performing Actions on HTML Elements
- Anticipating Browser Response
- Running Tests and Recording Test Results
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Selenium Architecture

Selenium has a **client-server architecture**, and includes both client and server components.

**Selenium Client** includes:

- The **WebDriver** API, which you use to develop test scripts to interact with page and application elements
- The **RemoteWebDriver** class, which communicates with a remote Selenium server

**Selenium Server** includes:

- A server component, to receive requests from Selenium Client’s **RemoteWebDriver** class
- The **WebDriver** API, to run tests against web browsers on a server machine
- **Selenium Grid**, implemented by Selenium Server in command-line options for grid features, including a central hub and nodes for various environments and desired browser capabilities
The Seven Basic Steps of Selenium Tests

There are seven basic elements of a Selenium test script, which apply to any test case and any application under test (AUT):

1. Create a WebDriver instance.
2. Navigate to a Web page.
3. Locate an HTML element on the Web page.
4. Perform an action on an HTML element.
5. Anticipate the browser response to the action.
6. Run tests and record test results using a test framework.
7. Conclude the test.
Example Use Case and Web Application

The Login Use Case

Imagine that you want to test a very basic use case for any website or Web application, in which a user logs in and, upon successful authentication, receives a message. There are two basic processes in this use case, each of which we want to test:

- The **login** process, which involves the user entering a username and password in a form, and then clicking a **Submit** button.
- The **login response** process, in which the website displays the login response message.

The Foo Web Application

The Foo Web application, hosted at www.foo.com, implements the login process through a login form with HTML text inputs for username and password, and **Submit** and **Cancel** buttons. Depending on the success or failure of the login, Foo then displays a message. The aim of your Selenium test is to reproduce the action of a user who enters login information and clicks **Submit**, and then test whether the proper message is displayed.

HTML for the Login Web Page

This is the HTML code for the login form.

```html
<html>
<body>
...
<form action="loginAction" id="loginForm">
  <label>User name: &nbsp;</label>
  <input type="text" name="username"><br>
  <label>Password: &nbsp;</label>
  <input type="text" name="password"><br>
  <button type="submit" id="loginButton">Log In</button>
  <button type="reset" id="reset">Clear</button>
</form>
...
</body>
</html>
```

And this is the HTML for the successful login response method.

```html
<html>
<body>
...
<p class="message" id="loginResponse">Welcome to foo. You logged in successfully.</p>
...
</body>
</html>
```

Best Practices for Identifying Elements in HTML Code

When you write a Selenium test, you need to identify the elements that you want the test to interact with. In this code example, each of the elements you want to test is identified using either a name or id attribute, which follows HTML best coding practices.

- On the login web page, the username and password text input elements are identified uniquely by the values of their **name** attributes - `username` and `password`, respectively.
- The login form element is identified uniquely by the value of its **id** attribute, `loginForm`.
- The login response message paragraph has a generic **class** attribute, but is identified uniquely by the value of its **id** attribute, `loginResponse`. 
Creating an Instance of the WebDriver Interface

The WebDriver interface is the starting point for all uses of the Selenium WebDriver API. Instantiating the WebDriver interface is the first step in writing your Selenium test.

You create an instance of the WebDriver interface using a constructor for a specific web browser. The names of these constructors vary over web browsers, and invocations of constructors vary over programming languages.

Once you have created an instance of the WebDriver interface, you use this instance to invoke methods and to access other interfaces used in basic steps. You do so by assigning the instance to a variable when you create it, and by using that variable to invoke methods.

Example

This example instantiates the Firefox WebDriver, and assigns it a variable named driver.

```java
import org.openqa.selenium.WebDriver;
import org.openqa.selenium.firefox.FirefoxDriver;
WebDriver driver = new FirefoxDriver();
```

Local v. Remote WebDrivers

If you are running a Selenium test for a single type of browser on a local machine, you would use code similar to this example. However, if you are running your Selenium tests in the Sauce Labs browser cloud, you would want to instantiate the RemoteWebDriver, and you would set the browser/operating system combinations to use in your tests through Selenium's DesiredCapabilities, as shown from this example of a test written in Java. The scripts in Sauce Labs Demonstration Scripts include examples of how you would invoke RemoteWebDriver for various scripting languages.

```java
import org.openqa.selenium.WebDriver;
import org.openqa.selenium.remote.DesiredCapabilities;
import org.openqa.selenium.remote.RemoteWebDriver;
import java.net.URL;

public class SampleSauceTest {

    public static final String USERNAME = "YOUR_USERNAME'';
    public static final String ACCESS_KEY = "YOUR_ACCESS_KEY'';
    public static final String URL = "http://" + USERNAME + ":" + ACCESS_KEY + @ondemand.saucelabs.com:80/wd/hub";

    public static void main(String[] args) throws Exception {
        DesiredCapabilities caps = DesiredCapabilities.chrome();
        caps.setCapability("platform", "Windows XP");
        caps.setCapability("version", "43.0");

        WebDriver driver = new RemoteWebDriver(new URL(URL), caps);
    
```
Navigating to a Web Page

Once you've instantiated WebDriver, the next step is to navigate to the Web page you want to test. You do this by invoking the `get` method on the unique instance of the `WebDriver` interface, specifically on the `driver` variable. The `get` method takes the URL of the web page you want to test as an argument. It can be a string value, or an instance of a special type representing a URL or URI.

Example

This example invokes the `get` method on the `driver` variable to navigate to the web page at `www.foo.com`, passing a string argument value for its URL. You can find other examples in the SeleniumHQ documentation.

```java
driver.get("http://www.foo.com");
```
Locating an HTML Element on a Web Page

In order to interact with a web page, you first locate HTML elements on the web page, then perform actions on those elements, such as entering text (for text input elements) or clicking (for button elements). The documentation at SeleniumHQ contains extensive information on the different methods for locating HTML; this topic summarizes the most common methods.

Locator Expressions

You use a locator expression to locate a unique HTML element or a specific collection of HTML elements. A locator expression is a key: value pair containing a locator type and a locator value.

The locator type indicates which aspects of any HTML element on a web page are evaluated and compared to the locator value in order to locate an HTML element. An aspect of an HTML element indicated by a locator type can include:

- A specific attribute such as name or id
- The tag name of the element, such as form or button
- For hyperlink elements or anchor tags, the visible linked text, such as Foo in \(<a \text{ href}="\text{http://www.foo.com}" \text{>Foo</a}>\)
- Any aspects given by a CSS selector, such as ...
- Any aspects given by an XPath expression, such as //form[@id="loginForm"] or //button[@type='submit'].

Locator Methods on the by Class

The WebDriver API provides several locator methods to form locator expressions. Each locator method corresponds to a locator type, and forms a locator expression containing that type and a locator value passed as an argument when invoking the method.

In the WebDriver API for Java, locator methods are defined as static or class methods on the By class (whose name connotes that an HTML element is located by comparing an evaluated locator type to a locator value). For example, By.name("password") forms a locator expression whose locator type indicates the name attribute and whose locator value is the string "password".

Finder Methods and the WebElement Interface

To use locator expressions formed by locator methods, the WebDriver API provides two finder methods, findElement (singular) and findElements (plural), both of which take a locator expression as an argument value.

Typically, a locator method is invoked on the By class in the argument position of a finder method to form a locator expression as argument value in a single line of code - e.g. findElement (By.name("password")).

In the example below, the findElement and findElements finder methods are invoked on the unique instance of the WebDriver interface - e.g. on the variable driver, as in driver.findElement (By.name("password")).

The finder methods search the DOM (Document Object Model) tree for the web page, evaluating locator types for HTML elements, and comparing their values to the locator value.

The return value of the findElement (singular) method is an instance of the WebElement interface, which represents an element of any HTML type and which is used to perform actions on the element. The findElement (singular) method returns a WebElement for the first HTML element in the DOM tree for which the evaluated locator type matches the locator value. The findElements (plural) method returns a list of elements - in the WebDriver API for Java, a List of WebElement objects for all HTML elements on the web page for which the evaluated locator type matches.

Example: Locate HTML text input elements for username and password

This example invokes the findElement method on the driver variable, using the name attribute to locate the username and password text input elements, and (optionally) the id attribute to locate the form element.

```java
import org.openqa.selenium.By;
import org.openqa.selenium.WebElement;

WebElement usernameElement = driver.findElement(By.name("username"));
WebElement passwordElement = driver.findElement(By.name("password"));

Optional locate the HTML form element

WebElement formElement = driver.findElement(By.id("loginForm"));
```
Performing Actions on HTML Elements

Once you've identified the HTML elements you want your test to interact with, the next step is to interact with them. You perform an action on an HTML element by invoking an interaction method on an instance of the WebElement interface.

The WebElement interface declares basic interaction methods including:

- The sendKeys method, to enter text
- The clear method, to clear entered text
- The submit method, to submit a form

Example

This example first invokes the sendKeys method to enter text in the username and password elements, and then invokes the submit method to submit the login form.

Enter a user name and a password

```java
usernameElement.sendKeys("Alan Smithee");
passwordElement.sendKeys("twilightZone");
```

Submit the form

```java
passwordElement.submit(); // submit by text input element
or
formElement.submit(); // submit by form element
```
Anticipating Browser Response

When you click a Submit button, you know that you have to wait a second or two for the your action to reach the server, and for the server to respond, before you do anything else. If you’re trying to test the response, and what happens afterwards, then you need to build that waiting time into your test. Otherwise, the test might fail because the elements that are expected for the next step haven’t loaded into the browser you. The WebDriver API supports two basic techniques for anticipating browser response by waiting: implicit waits and explicit waits.

**Implicit Waits**

Implicit waits set a definite, fixed elapsed time that applies to all WebDriver interactions. Using implicit waits is not a best practice because web browser response times are not definitely predictable and fixed elapsed times are not applicable to all interactions. Using waits requires more technical sophistication, but is a Sauce Labs best practice.

**Explicit Waits**

Explicit waits wait until an expected condition occurs on the web page, or until a maximum wait time elapses. To use an explicit wait, you create an instance of the WebDriverWait class with a maximum wait time, and you invoke its until method with an expected condition.

The WebDriver API provides an ExpectedConditions class with methods for various standard types of expected condition. These methods return an instance of an expected condition class. You can pass an invocation of these standard expected-condition methods as argument values to until method. How this is done varies over programming languages, and is covered in depth in the Developing section of this documentation. The until method checks repeatedly, until the maximum wait time elapses, for a true boolean return value or a non-null object reference, as an indication that the expected condition has occurred.

**Example**

This example code illustrates how you could use either an explicit wait or an implicit wait to anticipate web browser response after submitting the login form.

**Explicit Wait**

```java
import org.openqa.selenium.support.ui.ExpectedConditions;
import org.openqa.selenium.support.ui.WebDriverWait;
WebDriverWait wait = new WebDriverWait(driver, 10);
WebElement messageElement = wait.until(ExpectedConditions.
presenceOfElementLocated(By.id("loginResponse")));
```

**Implicit Wait**

```java
driver.manage().timeouts().implicitlyWait(10, TimeUnit.SECONDS);
```
Running Tests and Recording Test Results

Running tests and recording test results is the ultimate purpose of your test script: you run tests in an automated test script in order to evaluate function and performance in the AUT, without requiring human interaction.

Test Frameworks

To run test and to record test results, you use methods of a test framework for your programming language. There are many available test frameworks, including the frameworks in the so-called XUnit family, which includes:

- JUnit for Java
- NUnit for C#
- unittest or pyunit for Python
- RUnit for Ruby

For some programming languages, test frameworks other than those in the XUnit family are common - for example, the RSpec framework for Ruby. The Sauce Labs Sample Test Framework repos on GitHub contain over 60 examples of test frameworks set up to work with Sauce Labs.

Assertions

Most test frameworks implement the basic concept of an assertion, a method representing whether or not a logical condition holds after interaction with an AUT. Test frameworks generally declare methods whose names begin with the term `assert` and end with a term for a logical condition, e.g. `assertEqual` in JUnit. Generally, when the logical condition represented by an `assert` method does not hold, an exception for the condition is thrown. There are various approaches to using exceptions in most test frameworks. The SeleniumHQ documentation has more detailed information on using both assertions and verifications in your tests.

Recording Test Results

Recording of test results can be done in various ways, supported by the test framework or by a logging framework for the programming language, or by both together. Selenium also supports taking screenshots of web browser windows as a helpful additional type of recording. Because of the wide variations in recording technique, this beginning section omits recording, instead emphasizing a simple approach to applying a test using an `assert` method. The scripts in Sauce Labs Demonstration Scripts include examples of setting up reporting of test results to Sauce Labs, as do the framework scripts in the Sauce Labs Sample Test Frameworks github repos.

Example

The following example runs a test by asserting that the login response message is equal to an expected success message:

```java
import junit.framework.Assert;
import junit.framework.TestCase;

WebElement messageElement = driver.findElement(By.id("loginResponse"));
String message = messageElement.getText();
String successMsg = "Welcome to foo. You logged in successfully.";
assertEquals(message, successMsg);
```

Concluding a Test

The `quit` Method

You conclude a test by invoking the `quit` method on an instance of the WebDriver interface, e.g. on the `driver` variable.

The `quit` method concludes a test by disposing of resources, which allows later tests to run without resources and application state affected by earlier tests. The `quit` method:

- quits the web browser application, closing all web pages
- quits the WebDriver server, which interacts with the web browser
- releases `driver`, the variable referencing the unique instance of the WebDriver interface.

Example

The following example invokes the `quit` method on the `driver` variable:

```java
driver.quit();
```
Example with All Steps

The following example includes code for all steps. The example also defines a Java test class `Example`, and its `main` method, so that the code can be run.

```java
import org.openqa.selenium.WebDriver;
import org.openqa.selenium.firefox.FirefoxDriver;
import org.openqa.selenium.By;
import org.openqa.selenium.WebElement;
import org.openqa.selenium.support.ui.ExpectedConditions;
import org.openqa.selenium.support.ui.WebDriverWait;
import org.junit.Assert;

public class Example {
    public static void main(String[] args) {
        // Create an instance of the driver
        WebDriver driver = new FirefoxDriver();

        // Navigate to a web page
        driver.get("http://www.foo.com");

        // Perform actions on HTML elements, entering text and submitting the form
        WebElement usernameElement = driver.findElement(By.name("username"));
        WebElement passwordElement = driver.findElement(By.name("password"));
        WebElement formElement = driver.findElement(By.id("loginForm"));

        usernameElement.sendKeys("Alan Smithee");
        passwordElement.sendKeys("twilightZone");
        formElement.submit(); // submit by text input element
        formElement.submit(); // submit by form element

        // Anticipate web browser response, with an explicit wait
        WebDriverWait wait = new WebDriverWait(driver, 10);
        WebElement messageElement = wait.until(
                ExpectedConditions.presenceOfElementLocated(By.id("loginResponse"))
        );

        // Run a test
        String message = messageElement.getText();
        String successMsg = "Welcome to foo. You logged in successfully.";
        Assert.assertEquals(message, successMsg);

        // Conclude a test
        driver.quit();
    }
}
```
More Information

- [http://www.seleniumhq.org](http://www.seleniumhq.org)  
The official Selenium website and documentation
- [https://www.youtube.com/watch?v=qq1WCsAMZsk](https://www.youtube.com/watch?v=qq1WCsAMZsk)  
  Automated testing guru Joe Colantonio demonstrates how to run a Selenium Test with Sauce Labs
- [http://elementalseleleum.com](http://elementalseleleum.com)  
  Weekly email tips on using Selenium for automated testing written by Dave Haeffner, compiled into a handy website