

Space Details

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Testing Guide

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Welcome to the Groovy Testing Guide. This guide contains information of relevance to those writing developer tests or systems and acceptance tests.

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 - [Developer Testing using Closures instead of Mocks](#)
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- [Integrating TPTP](#) — some hints for using the Eclipse TPTP facilities with Groovy
- [Test Combinations](#) — some hints for using Groovy to assist generate test data in particular all combinations and all pair combinations
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- [Test Coverage](#) — is a useful measure of the effectiveness of unit tests and can be derived for Groovy tests
 - [Code Coverage with Cobertura](#)
- [Testing Web Applications](#) — how to use NekoHTML, HtmlUnit, Watij and WebTest to test web applications
- [Testing Web Services](#) — how to test Web Services using Groovy directly and in conjunction with WebTest and SoapUI
- [Unit Testing](#) — Groovy simplifies JUnit testing, making it more Groovy, in several ways
 - [Using JUnit 4 with Groovy](#)
- [Using Testing Frameworks with Groovy](#) — explores testing features of Groovy and some other testing frameworks
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Groovy Mocks

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Groovy Mocks

Note: Groovy Mocks have been available since RC1-SNAPSHOT 16 Feb. 2006.

Mock objects are used to assist (typically unit) testing of classes in isolation.

The Groovy Mock resides in the `groovy.mock.interceptor` package. It is an all-groovy mock testing library.

In principle, it is used like this:

```
import groovy.mock.interceptor.MockFor

def mocker = new MockFor(Collaborator.class) // create the Mock support
mocker.demand.one(1..2) { 1 }                // demand the 'one' method one or two times,
returning 1
mocker.demand.two() { 2 }                    // demand the 'two' method exactly once,
returning 2
mocker.use {                                  // start using the Mock
    def caller = new Caller()                // caller will call Collaborator
    assertEquals 1, caller.collaborateOne()  // will call Collaborator.one
    assertEquals 1, caller.collaborateOne()  // will call Collaborator.one
    assertEquals 2, caller.collaborateTwo()  // will call Collaborator.two
}                                              // implicit verify for strict expectation here
```

Groovy Mocks were inspired by [EasyMock](#).

Find background information about Mocks and endo-testing under [XP2000 conference paper](#).

For an extended example, see [Using Testing Frameworks with Groovy](#)

Terms

Collaborator

An ordinary Groovy or Java class that's instance or class methods are to be called. Calling them can be time consuming or produce side effects that are unwanted when testing (e.g. database operations).

Caller

A Groovy Object that calls methods on the Collaborator, i.e. collaborates with it.

Mock

An object that can be used to augment the Collaborator. Method calls to the Collaborator will be handled by the Mock, showing a *demand*ed behavior. Method calls are *expected* to occur *strictly* in the *demand*ed sequence with a given *range* of cardinality. The use of a Mock implicitly ends with *verifying* the expectations.

Stub

Much like a Mock but the *expectation* about sequences of method calls on the Collaborator is *loose*, i.e. calls may occur out of the *demand*ed order as long as the *ranges* of cardinality are met. The use of a Stub does not end with an implicit verification since the stubbing effect is typically asserted on the Caller. An explicit call to *verify* can be issued to assert all *demand*ed method calls have been effected with the specified cardinality.

Features

- typical mock style of *failing early*
- mocks instance and class methods
- mocks final methods and final Collaborators
- mocks Groovy and Java Collaborators (but Caller must be groovy)
- can mock all objects of a given class (or a single Groovy object)
- mocks even if Collaborator cannot be injected into the Caller
- mocks even if Collaborator is not accessible on the Caller (no getter)
- demand calls specified via recording calls on the Demand object (EasyMock style).
- cardinality specified as Ranges, default is 1..1; 'optional' can be achieved with 0..1
- behavior specified via Closures, allowing static or calculated return values, throwing exceptions, asserting argument values, etc. (even tricky sequence constraints by sharing state in the testMethod scope between the behavior Closures)
- matching parameter list specified via Closure's parameter list, supporting typed or untyped params, default params, and varargs.
- not dependent on any external mock library

For an extensive list of usages see the [unit tests that show how to use the mock package](#).

Developer Testing using Closures instead of Mocks

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Groovy's 'as' operator can be used with closures in a neat way which is great for developer testing in simple scenarios. We haven't found this technique to be so powerful that we want to do away with dynamic mocking, but it can be very useful in simple cases none-the-less.

Suppose we are using [Interface Oriented Design](#) and as sometimes advocated we have defined a number of short interfaces as per below. (Note: we ignore the discussion about whether interfaces are as valuable a design approach when using dynamic languages that support duck-typing.)

```
interface Logger { def log(message) }
interface Helper { def doSomething(param) }
interface Factory { Helper getInstance() }
```

Now, using a coding style typically used with [dependency injection](#) (as you might use with [Spring](#)), we might code up an application class as follows:

```
class MyApp {
    private factory
    private logger
    MyApp(Factory factory, Logger logger) {
        this.logger = logger
        this.factory = factory
    }
    def doMyLogic(param) {
        factory.getInstance().doSomething(param)
        logger.log('Something done with: ' + param)
    }
}
```

To testing this, we could use [Groovy's built-in mocking](#) or some other Java-based dynamic mocking framework. Alternatively, we could write our own static mocks. But no one does that these days I hear you say! Well, they never had the ease of using closures, which bring dynamic power to static mocks, so here we go:

```
def param = 'DUMMY STRING'
def logger = { message -> assert message == 'Something done with: ' + param }
def helper = { assert it == param }
def factory = { helper as Helper }
def myApp = new MyApp(factory as Factory, logger as Logger)
myApp.doMyLogic(param)
```

That was easy. Behind the scenes, Groovy creates a proxy object for us that implements the interface and is backed by the closure.

Easy yes, however, the technique as described above assumes our interfaces all have one method. What about more complex examples? Well, the 'as' method works with Maps of closures too. Suppose our helper interface was defined as follows:

```
interface Helper {
    def doSomething(param)
    def doSomethingElse(param)
```

```
}
```

And our application modified to use both methods:

```
...
def doMyLogic(param) {
    def helper = factory.getInstance()
    helper.doSomething(param)
    helper.doSomethingElse(param)
    logger.log('Something done with: ' + param)
}
...
```

We simply use a map of closures with the key used being the same name as the methods of the interface, like so:

```
...
def helperMethod = { assert it == param }
def helper = [doSomething:helperMethod, doSomethingElse:helperMethod]
// as before
def factory = { helper as Helper }
...
```

Still easy!

For this simple example, where we wanted each method to be the same (i.e. implementing the same code) we could have done away with the map altogether, e.g. the following would work, making each method be backed by the closure:

```
def factory = { helperMethod as Helper }
```

More Information

See also:

- [Developer Testing using Maps and Expandos instead of Mocks](#)
- [Groovy way to implement interfaces](#)

Developer Testing using Maps and Expandos instead of Mocks

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Suppose we are trying to test the following application:

```
class MyApp {
    def factory
    def logger
    def doBusinessLogic(param) {
        def myObj = factory.instance
        myObj.doSomething(param)
        myObj.doSomethingElse(param)
        logger.log('Something done with: ' + param)
    }
}
```

We might be tempted to replace logger and factory with Groovy's [built-in mocks](#), but it turns out that Maps or Expandos are often sufficiently powerful enough in Groovy that we don't need full blown dynamic mocks for this example.

Instead of a mock for logger, we can use an Expando as follows:

```
...
def logger = new Expando()
logger.log = { msg -> assert msg == 'Something done with: ' + param }
...
```

Here the expected behaviour for our production code is captured within a Closure. (When using TDD, this closure would force the production code we saw in our original code to be created.)

Instead of a mock for factory, we can use a simple map as follows:

```
...
def factory = [instance: businessObj]
...
```

Here, `businessObj` is the object we want the factory to return, though in general this could be a Closure similar to what we did for the Expando above.

Putting this altogether yields (after some refactoring) the following complete test:

```
class MyAppTest extends GroovyTestCase {
    void testDoesBusinessLogic() {
        // triangulate
        checkDoesBusinessLogic "case1"
        checkDoesBusinessLogic "case2"
    }
    private checkDoesBusinessLogic(param) {
        def logger = setUpLoggingExpectations(param)
        def businessObj = setUpBusinessObjectExpectations(param)
        def factory = [instance: businessObj]
        def cut = new MyApp(logger:logger, factory:factory)
        cut.doBusinessLogic(param)
    }
    private setUpLoggingExpectations(param) {
```

```
def shouldProduceCorrectLogMessage =  
  { msg -> assert msg == 'Something done with: ' + param }  
def logger = new Expando()  
logger.log = shouldProduceCorrectLogMessage  
return logger  
}  
private setUpBusinessObjectExpectations(param) {  
  def shouldBeCalledWithInputParam = { assert it == param }  
  def myObj = new Expando()  
  myObj.doSomething = shouldBeCalledWithInputParam  
  myObj.doSomethingElse = shouldBeCalledWithInputParam  
  return myObj  
}  
}
```

See also: [Developer Testing using Closures instead of Mocks](#)

Integrating TPTP

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This page provides some hints for using the Eclipse TPTP facilities with Groovy.

The Eclipse Testing and Performance Tools Platform ([TPTP](#)) project addresses the entire test and performance life cycle, from early testing to production application monitoring, including test editing and execution, monitoring, tracing and profiling, and log analysis. It is primarily aimed at the Java-aware tester but can also be used with Groovy.

As one example, if you follow the introductory tutorial included in the TPTP documentation called: [Creating a datapool driven JUnit test application](#), you will create a datapool application which lets you invoke data-driven JUnit tests. If you simply replace the Java code with Groovy code you can have data-driven Groovy tests. Here is what your test might look like:

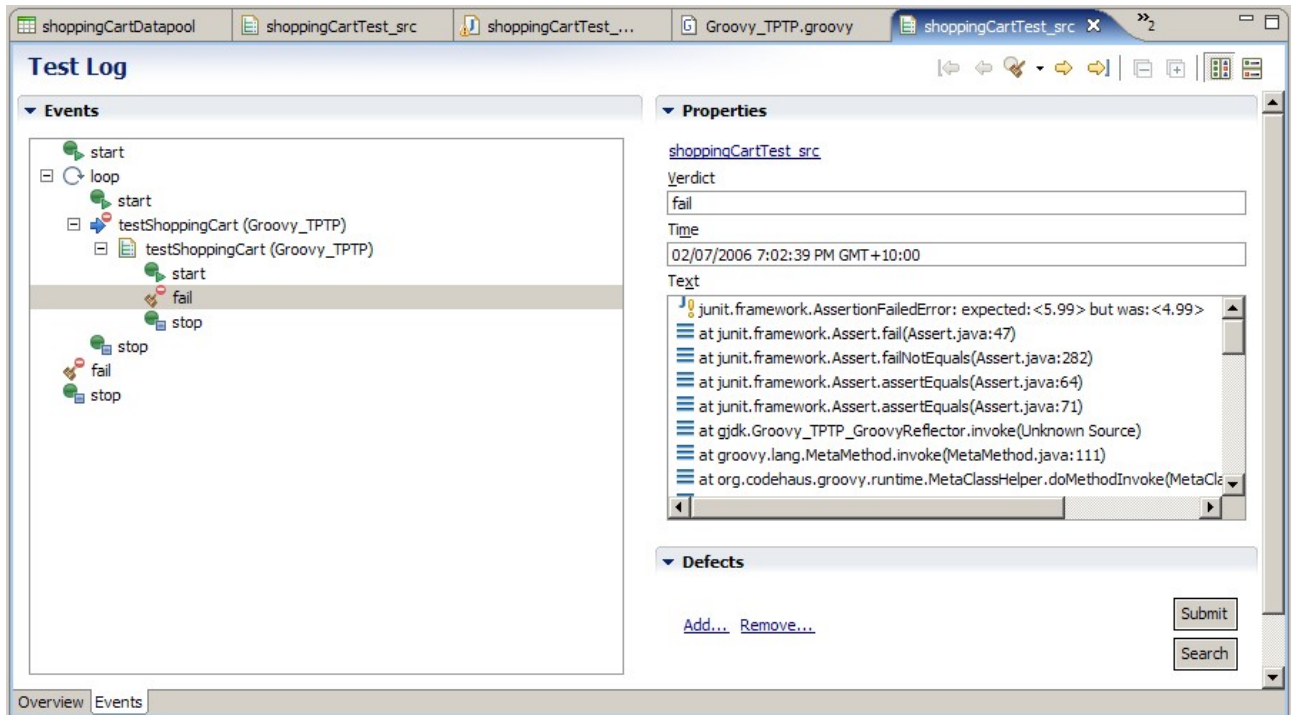
```
import org.eclipse.hyades.models.common.datapool.impl.Common_DatapoolFactoryImpl;

class Groovy_TPTP extends GroovyTestCase {
    def dpIterator

    void setUp() throws Exception {
        def dpFactory = new Common_DatapoolFactoryImpl()
        def datapool = dpFactory.load(new
java.io.File("GIA_TPTP\\shoppingCartDatapool.datapool"),false)
        dpIterator =
dpFactory.open(datapool,"org.eclipse.hyades.datapool.iterator.DatapoolIteratorSequentialPrivate")
        dpIterator.dpInitialize(datapool,0)
    }

    void testShoppingCartConstructor() {
        def cart = new MyShoppingCart()
        while(!dpIterator.dpDone()) {
            def description = dpIterator.dpCurrent().getCell("Description").stringValue
            def expectedPrice = dpIterator.dpCurrent().getCell("Price").doubleValue
            def actualPrice = cart.myFlowers[description]
            assertNotNull(actualPrice)
            assertEquals(expectedPrice, actualPrice.doubleValue())
            dpIterator.dpNext()
        }
    }
}
```

Here is what your output might look like:



In addition to allowing you to write datapool-aware Groovy tests, by making use of `GroovyTestSuite` and `AllTestSuite` you can visually select Groovy test cases to run within TPTP using its looping and selection features. This lets non-Groovy aware team members create new test cases from primitives which Groovy-aware team members can create.

For more details, see [GINA](#) or the [TPTP](#) web site.

Test Combinations

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This page provides some hints for using Groovy to assist generate test data in particular all combinations and all pair combinations.

Frequently you may have to test combinations, e.g. a method has several enumerations for its arguments or a web page has several dropdowns with multiple values, or you have assorted hardware combinations (as in the example below). You could manually work out the combinations, or you can let Groovy help you. We are going to look at two ways groovy can help you:

- By generating your test cases in Groovy
- By reading and invoking XML data produced by a specialist tool called Whitch

The most ([effective](#)) way to test large numbers of combinations is called "all pairs".

Combinations algorithms in Groovy

Here is a script which calculates all combinations for a particular example:

```
results = new HashSet()
def buildCombinations(Map partialCombinations, inputsLeft) {
    def first = inputsLeft.entrySet().toList().get(0)
    def partialResults = [ ]
    first.value.each{
        def next = [(first.key):it]
        next.putAll(partialCombinations)
        partialResults << next
    }
    if (inputsLeft.size() == 1) {
        results.addAll(partialResults)
    } else {
        partialResults.each{
            rest = inputsLeft.clone()
            rest.remove(first.key)
            buildCombinations(it, rest)
        }
    }
}

def configurations = [memory:['256M', '512M', '1G', '2G'],
                     disk:['5G', '10G'],
                     os:['MacOS', 'Windows', 'Linux']]

buildCombinations([], configurations)
println results.size() + " combinations:"
results.each{ println it }
```

Running this script yields the following results:

```
24 combinations:
["memory":"512M", "os":"MacOS", "disk":"5G"]
["memory":"2G", "os":"Linux", "disk":"5G"]
["memory":"1G", "os":"Linux", "disk":"10G"]
["memory":"512M", "os":"Linux", "disk":"5G"]
["memory":"512M", "os":"Windows", "disk":"10G"]
["memory":"2G", "os":"MacOS", "disk":"10G"]
```



```
[ "memory": "1G", "os": "Windows", "disk": "5G" ]
[ "memory": "256M", "os": "MacOS", "disk": "5G" ]
[ "memory": "1G", "os": "Linux", "disk": "5G" ]
[ "memory": "2G", "os": "Windows", "disk": "10G" ]
[ "memory": "512M", "os": "MacOS", "disk": "10G" ]
[ "memory": "256M", "os": "Windows", "disk": "5G" ]
[ "memory": "256M", "os": "Windows", "disk": "10G" ]
[ "memory": "1G", "os": "MacOS", "disk": "10G" ]
[ "memory": "1G", "os": "Windows", "disk": "10G" ]
[ "memory": "512M", "os": "Windows", "disk": "5G" ]
[ "memory": "256M", "os": "Linux", "disk": "10G" ]
[ "memory": "2G", "os": "Windows", "disk": "5G" ]
[ "memory": "2G", "os": "MacOS", "disk": "5G" ]
[ "memory": "2G", "os": "Linux", "disk": "10G" ]
[ "memory": "256M", "os": "Linux", "disk": "5G" ]
[ "memory": "1G", "os": "MacOS", "disk": "5G" ]
[ "memory": "256M", "os": "MacOS", "disk": "10G" ]
[ "memory": "512M", "os": "Linux", "disk": "10G" ]
```

Note: you would normally invoke your test method rather than just printing out the test case as we have done here.

You could then use this information as the input for a data-driven test.

It turns out though, that running all of these combinations is often overkill. If for instance, some bug occurs when memory is low on Windows, then both of the following test cases will illustrate the bug:

```
[ "memory": "256M", "os": "Windows", "disk": "5G" ]
[ "memory": "256M", "os": "Windows", "disk": "10G" ]
```

A technique known as [all pairs](#) or orthogonal array testing suggests using just a subset of the input data combinations with high likelihood of finding all bugs and greatly reduced test execution time.

To calculate all pairs for the above example, you could use the following script:

```
initialResults = new HashSet()
results = new HashSet()

def buildPairs(Map partialCombinations, inputsLeft) {
  def first = getFirstEntry(inputsLeft)
  def partialResults = [ ]
  first.value.each{
    def next = [(first.key):it]
    def nextEntry = getFirstEntry(next)
    next.putAll(partialCombinations)
    partialResults << next
  }
  if (inputsLeft.size() == 1) {
    initialResults.addAll(partialResults)
  } else {
    partialResults.each{
      rest = inputsLeft.clone()
      rest.remove(first.key)
      buildPairs(it, rest)
    }
  }
}

def adjustPairs() {
  results = initialResults.clone()
  initialResults.each {
    def rest = results.clone()
    rest.remove(it)
    if (allPairsCovered(it, rest)) {

```

```

        results.remove(it)
    }
}

def getFirstEntry(Map map) {
    return map.entrySet().toList().get(0)
}

def getAllPairsFromMap(map) {
    if (map.size() <= 1) return null
    def allPairs = new HashSet()
    def first = getFirstEntry(map)
    def rest = map.clone()
    rest.remove(first.key)
    rest.each{
        def nextPair = new HashSet()
        nextPair << first
        nextPair << it
        allPairs << nextPair
    }
    def restPairs = getAllPairsFromMap(rest)
    if (restPairs != null) {
        allPairs.addAll(restPairs)
    }
    return allPairs
}

boolean allPairsCovered(candidate, remaining) {
    def totalCount = 0
    def pairCombos = getAllPairsFromMap(candidate)
    pairCombos.each { candidatePair ->
        def pairFound = false
        def pairs = candidatePair.toList()
        for (it in remaining) {
            def entries = it.entrySet()
            if (!pairFound && entries.contains(pairs[0]) && entries.contains(pairs[1])) {
                pairFound = true
                totalCount++
            }
        }
    }
    return (totalCount == pairCombos.size())
}

def updateUsedPairs(map) {
    getAllPairsFromMap(map).each{ usedPairs << it }
}

def configurations = [memory:['256M', '512M', '1G', '2G'],
                      disk:['5G', '10G'],
                      os:['MacOS', 'Windows', 'Linux']]

buildPairs([], configurations)
adjustPairs()
println results.size() + " pairs:"
results.each{ println it }

```

This code is not optimised. It builds all combinations and then removes unneeded pairs. We could greatly reduce the amount of code by restructuring our all combinations example and then calling that - but we wanted to make each example standalone. Here is the result of running this script:

```

12 pairs:
["memory":"1G", "os":"Linux", "disk":"5G"]
["memory":"512M", "os":"MacOS", "disk":"10G"]
["memory":"256M", "os":"Windows", "disk":"10G"]
["memory":"1G", "os":"Windows", "disk":"10G"]
["memory":"512M", "os":"Windows", "disk":"5G"]
["memory":"2G", "os":"MacOS", "disk":"5G"]
["memory":"2G", "os":"Windows", "disk":"5G"]
["memory":"2G", "os":"Linux", "disk":"10G"]
["memory":"1G", "os":"MacOS", "disk":"5G"]
["memory":"256M", "os":"Linux", "disk":"5G"]

```

```
[ "memory": "512M", "os": "Linux", "disk": "10G" ]  
[ "memory": "256M", "os": "MacOS", "disk": "10G" ]
```

We saved half of the combinations. This might not seem like much but when the number of input items is large or the number of alternatives for each input data is large, the saving can be substantial.

If this is still too many combinations, we have one more additional algorithm that is sometimes useful. We call it minimal pairs. Rather than making sure each possible pair combination is covered, minimal pairs only adds a new test data item into the results if it introduces a new pair combination not previously seen. This doesn't guarantee all pairs are covered but tends to produce a minimal selection of interesting pairs across the possible combinations. Here is the script:

```
results = new HashSet()  
usedPairs = new HashSet()  
  
def buildUniquePairs(Map partialCombinations, inputsLeft) {  
  def first = getFirstEntry(inputsLeft)  
  def partialResults = [ ]  
  first.value.each {  
    def next = [(first.key):it]  
    def nextEntry = getFirstEntry(next)  
    next.putAll(partialCombinations)  
    partialResults << next  
  }  
  if (inputsLeft.size() == 1) {  
    partialResults.each {  
      if (!containsUsedPairs(it)) {  
        updateUsedPairs(it)  
        results << it  
      }  
    }  
  } else {  
    partialResults.each {  
      rest = inputsLeft.clone()  
      rest.remove(first.key)  
      buildUniquePairs(it, rest)  
    }  
  }  
}  
  
def getFirstEntry(map) {  
  return map.entrySet().toList().get(0)  
}  
  
def getAllPairsFromMap(map) {  
  if (map.size() <= 1) return null  
  def allPairs = new HashSet()  
  def first = getFirstEntry(map)  
  def rest = map.clone()  
  rest.remove(first.key)  
  rest.each {  
    def nextPair = new HashSet()  
    nextPair << first  
    nextPair << it  
    allPairs << nextPair  
  }  
  def restPairs = getAllPairsFromMap(rest)  
  if (restPairs != null) {  
    allPairs.addAll(restPairs)  
  }  
  return allPairs  
}  
  
boolean containsUsedPairs(map) {  
  if (map.size() <= 1) return false  
  def unpaired = true  
  getAllPairsFromMap(map).each {  
    if (unpaired) {  
      if (usedPairs.contains(it)) unpaired = false  
    }  
  }  
}
```

```

    }
    return !unpaired
}

def updateUsedPairs(map) {
    getAllPairsFromMap(map).each{ usedPairs << it }
}

def configurations = [memory:['256M', '512M', '1G', '2G'],
                     disk:['5G', '10G'],
                     os:['MacOS', 'Windows', 'Linux']]

buildUniquePairs([], configurations)
println results.size() + " pairs:"
results.each{ println it }

```

Here is the result of running the script:

```

6 pairs:
["memory":"512M", "os":"Windows", "disk":"5G"]
["memory":"256M", "os":"MacOS", "disk":"5G"]
["memory":"2G", "os":"Linux", "disk":"10G"]
["memory":"1G", "os":"Linux", "disk":"5G"]
["memory":"512M", "os":"MacOS", "disk":"10G"]
["memory":"256M", "os":"Windows", "disk":"10G"]

```

Combinations using Whitch

The IBM alphasworks site hosts the Intelligent Test Case Handler ([WHITCH](#)) project. From their website: *This technology is an Eclipse plug-in for generation and manipulation of test input data or configurations. It can be used to minimize the amount of testing while maintaining complete coverage of interacting variables. Intelligent Test Case Handler enables the user to generate small test suites with strong coverage properties, choose regression suites, and perform other useful operations for the creation of systematic software test plans.*

You should follow the instructions on the WHITCH site for installing the plug-in into your Eclipse directory (we used Eclipse 3.2). The user guide is then part of Eclipse help and details the features and instructions for using the tool. We will simply highlight how you might decide to use it.

First create a new Whitch file. File -> New -> Other... -> Whitch file. You must select the project and provide a file name. We used 'groovy.whitch'.

Now add your types similar to the earlier example. You should end up with something like:

Types | Attributes | Include | Exclude | Interactions | Weights

Name	Definition
Memory	[256M, 512M, 1G, 2G]
OS	[Windows, MacOS, Linux]
Disk	[5G, 10G]

Type Name:

☐ Boolean
☒ Enum
☐ Number
☐ Range

Enum values: 256M, 512M, 1G, 2G
 Add Remove

..
 Add Update

Remove Up Down

Now add some attributes corresponding to the types you have just added. The result will be something like:

Types | Attributes | Include | Exclude | Interactions | Weights

Name	Type	M...
memory	Memory	1
os	OS	1
disk	Disk	1

Attribute Name:

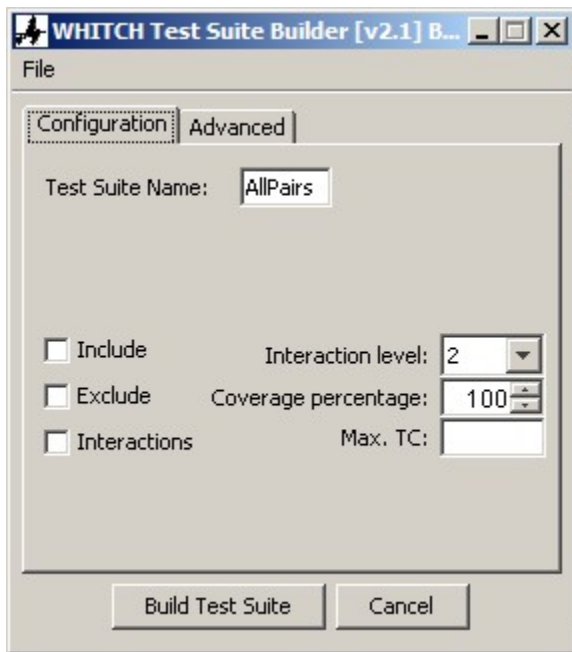
Attribute Type:

Attribute Multiplicity:

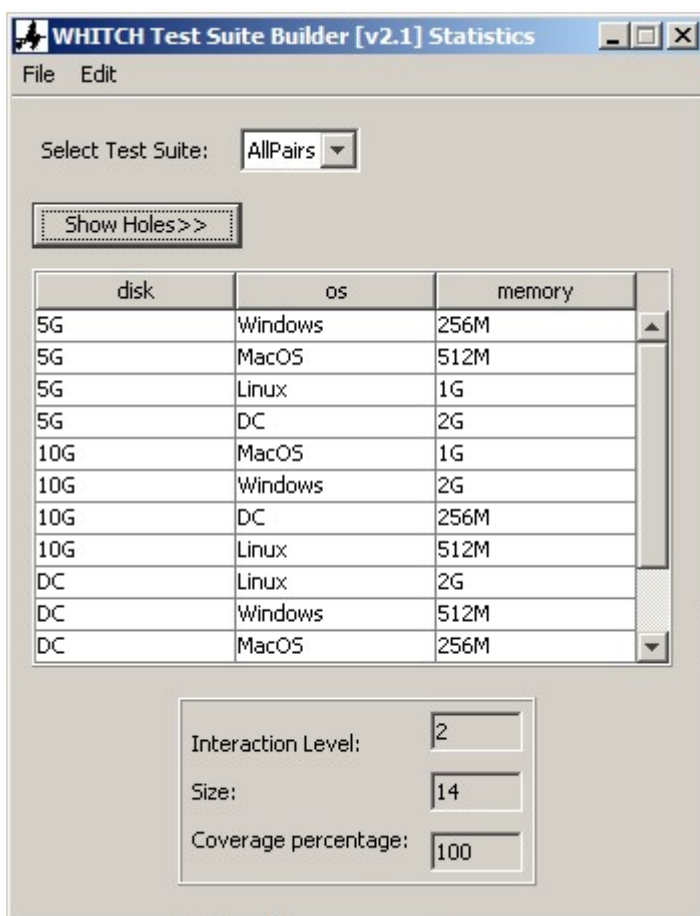
Add Update

Remove Up Down

Now select Whitch -> Build. Type in a test suite name. We used 'AllPairs' and select an interaction level of 2 (for pairs) as follows:



Now click 'Build Test Suite' to obtain your results:



Now save your Whitch file. The result will be that the test cases are now stored into an XML file.

Note: We have not shown any advanced Whitch features, e.g. it lets you add test cases in the Include tab which must always be added into the test suite and test cases which are not possible into the Exclude tab. It also lets you try to reduce your test case size, give weightings, choose different algorithms for test case generation and more. See the Whitch user guide for more details.

```
def testsuite = new XmlSlurper().parse(new File('groovy.whitch'))
def attributes = testsuite.Model.Profile.Attribute
def testcases = testsuite.TestCases.TestCase
println testcases.size() + ' pairs:'
testcases.each{ testcase ->
    def map = [:]
    (0..2).each{
        def key = attributes[it]. '@name'.toString()
        def value = testcase.Value[it]. '@val'.toString()
        map.put(key, value)
    }
    println map
}
```

Running this script yields the following results:

```
14 pairs:
["memory":"256M", "os":"Windows", "disk":"5G"]
["memory":"512M", "os":"MacOS", "disk":"5G"]
["memory":"1G", "os":"Linux", "disk":"5G"]
["memory":"2G", "os":"DC.DC", "disk":"5G"]
["memory":"1G", "os":"MacOS", "disk":"10G"]
["memory":"2G", "os":"Windows", "disk":"10G"]
["memory":"256M", "os":"DC.DC", "disk":"10G"]
["memory":"512M", "os":"Linux", "disk":"10G"]
["memory":"2G", "os":"Linux", "disk":"DC.DC"]
["memory":"512M", "os":"Windows", "disk":"DC.DC"]
["memory":"256M", "os":"MacOS", "disk":"DC.DC"]
["memory":"256M", "os":"Linux", "disk":"DC.DC"]
["memory":"2G", "os":"MacOS", "disk":"DC.DC"]
["memory":"1G", "os":"Windows", "disk":"DC.DC"]
```

Note: the value "DC.DC" indicates a don't care value and can be replaced with any value for that field.

Effectiveness of testing combinations with all pairs

This page last changed on Aug 20, 2006 by emprove@gmail.com.

Rather than testing every possible combination of things, all pairs simplifies the exercise to testing every pair of things which reduces the complexity significantly, for example instead of 700,000 possible combinations, all pairs would be about 500 combinations.

While this reduces the number of tests, does it help find bugs? All pairs works because when things break, they have a tendency to break because of the faulty interaction of two things rather than 3 or more. A long term study of medical device failures found a strong correlation for this. For all the failures reported, a quarter of them would have been found with all pairs testing. The true result is probably much better than this, because a lot of the failure reports did not have enough detail to allow proper analysis. Of the detailed reports, 98% of the failures would have been found with all pairs testing! The paper, "Failure Modes in Medical Devices", is at csrc.ncsi.nist.gov/staff/kuhn/final-rqse.pdf

If you do all pairs testing, you could still use minimal pairs to get better test effectiveness. By starting your tests with all the minimal pairs first, this would give a good broad coverage of combinations. The remaining all pairs combinations could then be used to finish the exercise.

Test Coverage

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Code coverage is a useful measure of the effectiveness of unit tests and can be derived for Groovy tests.

Consider the following Groovy code:

```
class BiggestPairCalc
{
    int sumBiggestPair(int a, int b, int c) {
        def op1 = a
        def op2 = b
        if (c > a) {
            op1 = c
        } else if (c > b) {
            op2 = c
        }
        return op1 + op2
    }
}
```

And the following test:

```
class BiggestPairCalcTest extends GroovyTestCase
{
    void testSumBiggestPair() {
        def calc = new BiggestPairCalc()
        assertEquals(9, calc.sumBiggestPair(5, 4, 1))
    }
}
```

If you use [Cobertura](#) to perform your coverage, the resulting report might look like:

Coverage Report - BiggestPairCalc

Classes in this File	Line Coverage	Branch Coverage	Complexity
BiggestPairCalc	71% <div><div></div><div></div><div></div></div> 5/7	100% <div><div></div><div></div><div></div></div> 2/2	0

1	class BiggestPairCalc
2	{
3	int sumBiggestPair(int a, int b, int c) {
4 1	def op1 = a
5 1	def op2 = b
6 1	if (c > a) {
7 0	op1 = c
8 1	} else if (c > b) {
9 0	op2 = c
10	}
11 1	return op1 + op2
12	}
13	}

Your [Ant](#) build file to make all this happen might look like:

```
<?xml version="1.0"?>
<project name="sample" default="coverage-report" basedir=".">
```

```

<!-- set up properties, paths, taskdefs, prepare targets -->
[details deleted]

<!-- compile java (if you have any) and groovy source -->
<target name="compile" depends="prepare">
  <javac srcdir="${dir.src}" destdir="${dir.build}" debug="true">
    <classpath refid="project.classpath"/>
  </javac>
  <groovyc srcdir="${dir.src}" destdir="${dir.build}" stacktrace="true">
    <classpath refid="project.classpath"/>
  </groovyc>
</target>

<!-- instrument already compiled class files -->
<target name="instrument" depends="compile">
  <cobertura-instrument todir="target/instrumented-classes">
    <fileset dir="${dir.build}">
      <include name="**/*.class"/>
    </fileset>
  </cobertura-instrument>
</target>

<!-- run all junit tests using the instrumented classes -->
<target name="cover-test" depends="instrument">
  <mkdir dir="${dir.report}/cobertura" />
  <junit printsummary="yes" haltonerror="no" haltonfailure="no" fork="yes">
    <formatter type="plain" usefile="false"/>
    <batchtest>
      <fileset dir="target/instrumented-classes" includes="**/*Test.class" />
    </batchtest>
    <classpath refid="cover-test.classpath"/>
  </junit>
</target>

<!-- create the html reports -->
<target name="coverage-report" depends="cover-test">
  <cobertura-report srcdir="${dir.src}" destdir="${dir.report}/cobertura"/>
</target>
</project>

```

For more details, see [GINA](#) or the [Cobertura](#) web site or [Code Coverage with Cobertura](#).

Code Coverage with Cobertura

This page last changed on Oct 10, 2006 by [paulk_asert](#).

Starting with v1.8, Cobertura will create detailed reports for Groovy source. It can be download from <http://cobertura.sourceforge.net/download.html>

Below is an example build file for using Cobertura in your project.

Notice that you must compile your groovy source into .class files so that Cobertura can add instrumentation to those .class files.

build.xml

```
<?xml version="1.0"?>
<project name="sample" default="jar" basedir=".">
  <!-- properties for project directory structure -->
  <property name="dir.src" value="src"/>
  <property name="dir.build" value="build"/>
  <property name="dir.dist" value="dist"/>
  <property name="dir.lib" value="lib"/>

  <!-- setup a project classpath that includes the external libs -->\
  <path id="project.classpath">
    <!-- include the classes in this project -->
    <pathelement location="${dir.build}"/>
    <!-- include external libraries -->
    <fileset dir="${dir.lib}" includes="**/*.jar"/>
  </path>

  <!-- add external tasks -->
  <taskdef name="groovyc" classpathref="project.classpath"
classna="org.codehaus.groovy.ant.Groovyc"/>
  <taskdef name="groovy" classpathref="project.classpath"
classna="org.codehaus.groovy.ant.Groovy"/>

  <!-- create output directories -->
  <target name="prepare">
    <mkdir dir="${dir.build}"/>
  </target>

  <!-- clean -->
  <target name="clean" description="Remove all generated files.">
    <delete dir="${dir.build}"/>
  </target>

  <!-- compile java (if you have any) and groovy source -->
  <target name="runGroovyC" depends="prepare,copyResourceFiles">
    <javac srcdir="${dir.src}" destdir="${dir.build}">
      <classpath refid="project.classpath"/>
    </javac>
    <groovyc srcdir="${dir.src}" destdir="${dir.build}" stacktrace="true">
      <classpath refid="project.classpath"/>
    </groovyc>

    <!-- work around if groovyc tasks doesn't work right
    <java classna="org.codehaus.groovy.ant.Groovyc" fork="yes" maxmemory="${maxmemory}">
      <classpath refid="project.classpath"/>
      <arg value="${dir.build}"/>
      <arg value="${dir.src}"/>
    </java>
    -->
  </target>

  <!-- =====>
  <!-- Cobertura Test Coverage Tool -->

```

```

<!--=====-->
<path id="cobertura.classpath">
  <fileset dir="${dir.lib}/cobertura" includes="**/*.jar"/>
  <pathelement location="target/instrumented-classes"/>
  <pathelement location="${dir.src}"/>
</path>

<taskdef classpath="${dir.lib}/cobertura/cobertura.jar" resource="tasks.properties"
  classpathref="cobertura.classpath"/>

<!-- adds the logging code to the already compiled class files -->
<target name="instrument" >
  <delete quiet="false" failonerror="false">
    <fileset dir="target/instrumented-classes" includes="**/*.class"/>
  </delete>
  <cobertura-instrument todir="target/instrumented-classes">
    <fileset dir="${dir.build}">
      <include name="**/*.class"/>
      <exclude name="**/*Test.class"/>
    </fileset>
  </cobertura-instrument>
</target>

<!-- setup class path to include instrumented classes before non-instrumented ones -->
<path id="cover-test.classpath">
  <fileset dir="${dir.lib}" includes="**/*.jar"/>
  <pathelement location="target/instrumented-classes"/>
  <pathelement location="${dir.build}"/>
</path>

<!-- run all my junit tests using the instrumented classes -->
<target name="cover-test" depends="instrument">
  <mkdir dir="${dir.report}/cobertura" />
  <junit printsummary="yes" haltonerror="no" haltonfailure="no" fork="yes">
    <formatter type="plain" usefile="false"/>
    <batchtest>
      <fileset dir="target/instrumented-classes" includes="**/*Test.class" />
    </batchtest>
    <classpath refid="cover-test.classpath"/>
  </junit>
</target>

<!-- create the html reports -->
<target name="coverage-report" depends="cover-test">
  <cobertura-report srcdir="${dir.src}" destdir="cobertura"/>
</target>
</project>

```

See also: [Test Coverage](#)

Testing Web Applications

This page last changed on Dec 11, 2006 by [fr33m3n](#).

This page discusses how to use NekoHTML, HtmlUnit, Watij and WebTest to test web applications. There are many ways to test Web Applications with Groovy:

- use Groovy (potentially in conjunction with a specialist HTML parser) to parse HTML pages as if they were XML
- use Groovy to simplify the code required to drive a Java API browser simulator, e.g. HtmlUnit or HttpUnit
- use Groovy to simplify the code required to drive a Java API for manually driving a real browser, e.g. IE or Firefox
- use Groovy to interact with a higher-level testing library which uses one of the above two approaches, e.g. Watij (for the equivalent of Watir in the Ruby world) or WebTest (to open up the possibility of testing more than just web applications)

We examine a few approaches below.

Groovy with CyberNeko HTML Parser

[NekoHTML](#) is a library which allows you to parse HTML documents (which may not be well-formed) and treat them as XML documents (i.e. XHTML). NekoHTML automatically inserts missing closing tags and does various other things to clean up the HTML if required - just as browsers do - and then makes the result available for use by normal XML parsing techniques.

Here is an example of using NekoHTML with XmlParser to find '.html' hyperlinks on the groovy homepage:

```
def parser = new org.cyberneko.html.parsers.SAXParser()
parser.setFeature('http://xml.org/sax/features/namespace', false)
def page = new XmlParser(parser).parse('http://groovy.codehaus.org/')
def data = page.depthFirst().A.'@href'.grep{ it != null && it.endsWith('.html') }
data.each { println it }
```

We turned off namespace processing which lets us select nodes using '.A' with no namespace.

Here is one way to do the same example with XmlSlurper:

```
def page = new XmlSlurper(new
org.cyberneko.html.parsers.SAXParser()).parse('http://groovy.codehaus.org/')
def data = page.depthFirst().grep{ it.name() == 'A' && it.@href.toString().endsWith('.html')
}. '@href'
data.each { println it }
```

We didn't turn off namespace processing but do the selection using just the local name, i.e. '.name()'.

Here is the output in both cases:

```
http://groovy.codehaus.org/apidocs/index.html
/faq.html
/groovy-jdk.html
http://groovy.codehaus.org/team-list.html
http://groovy.codehaus.org/xref/index.html
http://www.javamagazin.de/itr/ausgaben/psecom,id,317,nodeid,20.html
http://www.weiqigao.com/blog/2006/09/14/gruby_on_grails_tonight_at_630.html
http://www.oreillynet.com/onjava/blog/2006/09/charles_nutter_responds_our_fu.html
```

Now that we have the links we could do various kinds of assertions, e.g. check the number of links, check that a particular link was always on the page, or check that there are no broken links.

Groovy and HtmlUnit

The following example tests the Google search engine using [HtmlUnit](#):

```
import com.gargoylesoftware.htmlunit.WebClient

def webClient = new WebClient()
def page = webClient.getPage('http://www.google.com')
// check page title
assert 'Google' == page.titleText
// fill in form and submit it
def form = page.getFormByName('f')
def field = form.getInputByName('q')
field.setValueAttribute('Groovy')
def button = form.getInputByName('btnG')
def result = button.click()
// check groovy home page appears in list (assumes it's on page 1)
assert result.anchors.any{ a -> a.hrefAttribute == 'http://groovy.codehaus.org/' }
```

Groovy and Watij

The following example tests the Google search engine using [Watij](#):

```
import watij.runtime.ie.IE
import watij.finders.SymbolFactory

def ie = new IE()
ie.start('http://www.google.com')
// check page title
assert ie.title() == 'Google'
// fill in query form and submit it
ie.textField(SymbolFactory.@name, 'q').set('Groovy')
ie.button(SymbolFactory.@name, 'btnG').click()
// check groovy home page appears in list by trying to flash() it
ie.link(SymbolFactory.url, 'http://groovy.codehaus.org/').flash()
ie.close()
```

You can use Watij from within groovysh or groovyconsole if you want to have an interactive (irb-like in ruby terms) experience.

Groovy and WebTest

The following example tests the Google search engine using [WebTest](#):

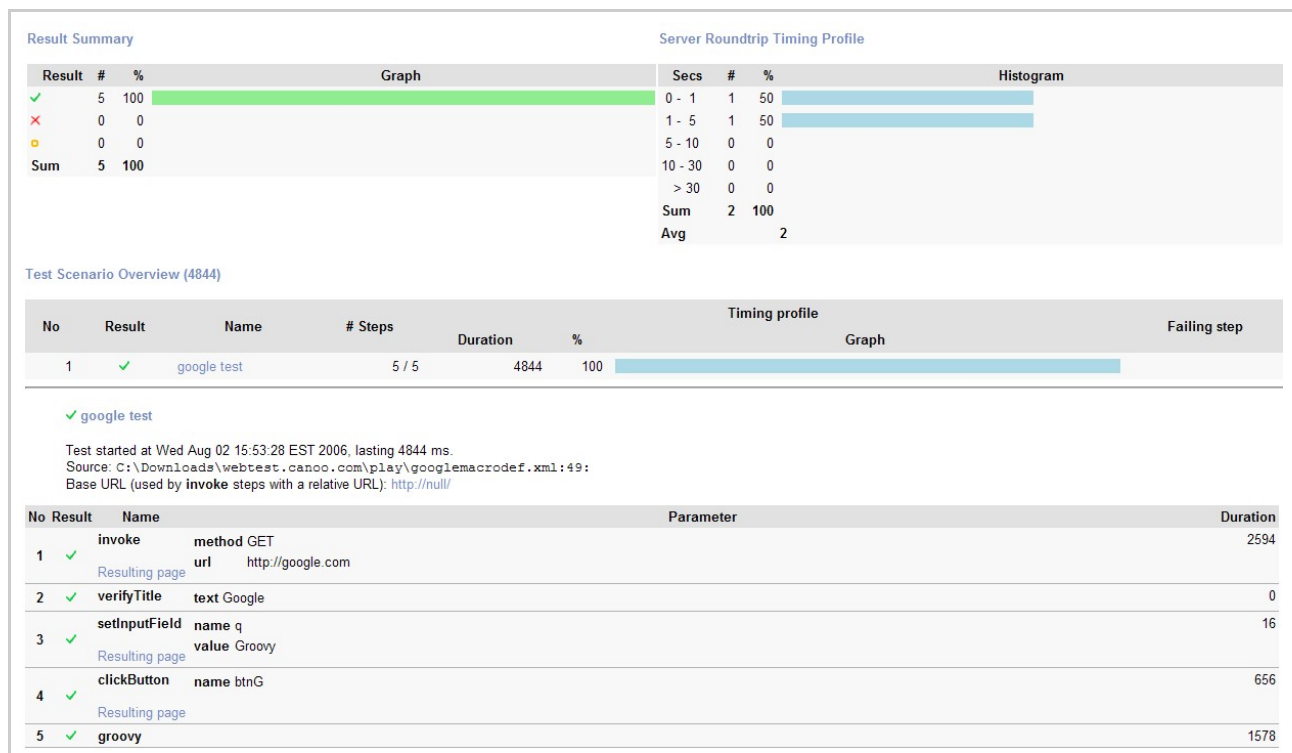
```
<webtest name="google test">
  <steps>
    <invoke url="http://google.com"/>
    <verifyTitle text="Google"/>
    <setInputField name="q" value="Groovy"/>
    <clickButton name="btnG"/>
    <verifyXPath xpath="//a[@href='http://groovy.codehaus.org/']" />
  </steps>
</webtest>
```

The above fragment can be inserted into any [Ant](#) build script where we have defined the WebTest tasks.

The above example didn't use any Groovy but we could have just as easily used some Groovy for the last line if we didn't like the XPath expression, for example:

```
<webtest name="google test">
  <steps>
    <invoke url="http://google.com"/>
    <verifyTitle text="Google"/>
    <setInputField name="q" value="Groovy"/>
    <clickButton name="btnG"/>
    <groovy>
      assert step.context.currentResponse.anchors.any{ a -> a.hrefAttribute ==
'http://groovy.codehaus.org/' }
    </groovy>
  </steps>
</webtest>
```

Depending on your setup, you could produce the following report for this test:



Alternatively, we could have written the whole test in Groovy using AntBuilder as follows:

```
def webtest_home = System.properties.'webtest.home'
```

```
def ant = new AntBuilder()

ant.taskdef(resource: 'webtest.taskdef') {
    classpath() {
        pathelement(location: "$webtest_home/lib")
        fileset(dir: "$webtest_home/lib", includes: "**/*.jar")
    }
}

ant.webtest(name: 'Test Google with Groovy, AntBuilder and WebTest') {
    steps() {
        invoke(url: 'http://www.google.com')
        verifyTitle(text: 'Google')
        setTextField(name: 'q', value: 'Groovy')
        clickButton(name: 'btnG')
        verifyXPath(xpath: "//a[@href='http://groovy.codehaus.org/']")
    }
}
```

Grails can automatically create this style of test for your generated CRUD applications, see [Grails Functional Testing](#) for more details.

Testing Web Services

This page last changed on Sep 27, 2006 by [paulk_asert](#).

This page discusses how to test Web Services using Groovy directly and in conjunction with WebTest and SoapUI.

Testing Web Services can be done in several ways. Here are three:

- act like a normal web services client and perform asserts on the returned result
- use [WebTest](#) (with either the XML or Groovy syntax)
- use [SoapUI](#) (for functional and load testing)

We are going to use the Web Service example at:

<http://groovy.codehaus.org/Groovy+SOAP>

Being a client

You can be a normal client web service client and perform asserts on the returned results:

```
import groovy.net.soap.SoapClient

def proxy = new SoapClient("http://localhost:6980/MathServiceInterface?wsdl")

def result = proxy.add(1.0, 2.0)
assert (result == 3.0)

result = proxy.square(3.0)
assert (result == 9.0)
```

Using WebTest

Using the WebTest variations makes sense if you are combining your tests into an acceptance test suite.

Here is how you would test it using traditional WebTest:

```
<steps>
  <invoke method="POST" contentFile="addreq.xml" soapAction=""
    url="http://localhost:6980/MathServiceInterface"/>
  <verifyXPath xpath="//addResponse/out[text()='3.0']"/>
  <invoke method="POST" contentFile="sqrareq.xml" soapAction=""
    url="http://localhost:6980/MathServiceInterface"/>
  <verifyXPath xpath="//squareResponse/out[text()='9.0']"/>
</steps>
```

Where addreq.xml would look something like:

```
<?xml version='1.0' encoding='UTF-8'?>
```

```
<soap:Envelope
  xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <soap:Body>
    <add xmlns="http://DefaultNamespace">
      <in0 xmlns="http://DefaultNamespace">1.0</in0>
      <in1>2.0</in1>
    </add>
  </soap:Body>
</soap:Envelope>
```

and squarereq.xml would look something like:

```
<?xml version='1.0' encoding='UTF-8'?>
<soap:Envelope
  xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <soap:Body>
    <square xmlns="http://DefaultNamespace">
      <in0 xmlns="http://DefaultNamespace">3.0</in0>
    </square>
  </soap:Body>
</soap:Envelope>
```

Alternatively, testing using groovy within WebTest would look like:

```
<steps>
  <groovy>
    import groovy.net.soap.SoapClient

    def proxy = new SoapClient("http://localhost:6980/MathServiceInterface?wsdl")

    def result = proxy.add(1.0, 2.0)
    assert (result == 3.0)

    result = proxy.square(3.0)
    assert (result == 9.0)
  </groovy>
</steps>
```

Note: you will need to place the jars mentioned on that page in your webtest lib directory (i.e. groovysoap, stax, jaf and mail jars) when using this variation.

The first approach (traditional webtest) produces more information in the test summary reporting but requires you to do more work (i.e. keep the requests around as XML). It depends if you already have those XML files around for other purposes, e.g. manual testing.

Using SOAPUI

[soapui](#) is a SOAP functional and load testing tool. It can use Groovy steps within its testcases. For further details, see the soapui documentation for the [Groovy Step](#). This step supports data-driven tests, allows control of test execution and allows customised reporting.

SoapUI 1.0.2

File Window

Projects

- Amazon
 - AWSECommerceServicePortType
 - Amazon Tests
 - Simple TestCase
 - Test Book Search
 - Transfer values - Author
 - Book Search on first Author
 - Delay for 10000ms
 - Restart
- strikeiron
- jira
- JiraSoapService
- Sample Project
- CurrencyConvertorSoap
- XMethodsQuerySoapPortType
- Test Suite

Test Case: Amazon Tests:Simple Test Case:Test Book Search

0%

Test Steps

- Test Book Search
- Transfer values - Author
- Book Search on first Author
- Delay for 10000ms
- Restart

Test Log

TestRequest Properties

Property	Value
Name	Test Book Search
Encoding	UTF-8
Endpoint	http://soap.amazon.com/...
Username	
Password	
Domain	

Test-Step: Amazon Tests: Simple Test Case: Test Book Search

http://soap.amazon.com/onca/soap?Service=AWSECo... UTF-8

```

<soapenv:Envelope xmlns:ns="http://webs...
<soapenv:Body>
  <ns:ItemSearch>
    <ns:SubscriptionId>05QXTS0ESY2E
    <ns:Request>
      <ns:SearchIndex>Books</ns:Se
      <ns:Title>Oxford</ns:Title>
    </ns:Request>
    </ns:ItemSearch>
  </soapenv:Body>
</soapenv:Envelope>
  
```

```

<SOAP-ENV:Envelope xmlns:SOAP-ENC="ht
<SOAP-ENV:Body>
  <ItemSearchResponse xmlns="ht
    <OperationRequest>
      <Header Name="UserAg
    </HTTPHeaders>
    <RequestId>0AYZAE6NM5Y8
    <Arguments>
      <Argument Name="Serv
    </Arguments>
    <RequestProcessingTime>
    </OperationRequest>
    <Items>
      <Request>
        <IsValid>True</IsVal
        <ItemSearchRequest>
          <SearchIndex>Book
          <Title>Oxford</Ti
        </ItemSearchRequest>
      </Request>
    </Items>
  </ItemSearchResponse>
  
```

Schema Compliance - VALID
 XPath Match - VALID
 XPath Match - VALID

Assertions Request Log

18:22:10 : INFO : Got response for [AWSECommerceServicePortType.ItemSearch:Book Search on first Author] in 510ms (6891 bytes)

Unit Testing

This page last changed on Mar 29, 2007 by [paulk_asert](#).

The Groovy Advantage

Groovy simplifies JUnit testing, making it more Groovy, in several ways, including:

- JUnit is built into the groovy runtime, so you can script JUnit tests for your groovy and java classes using groovy syntax.
- Groovy provides many additional JUnit assertion statements (see below)
- Groovy unit tests are easily scriptable with Ant / Maven (see below)
- Groovy provides [Groovy Mocks](#)

See also:

- [Unit test your java code with groovy](#)
- [testngroove project page](#)
- [Using JUnit 4 with Groovy](#)

Example

To write unit tests in groovy, you have to create a class extending `groovy.util.GroovyTestCase`.

```
import groovy.util.GroovyTestCase

class MyTest extends GroovyTestCase {
    void testSomething() {
        assert 1 == 1
        assert 2 + 2 == 4 : "We're in trouble, arithmetic is broken"
    }
}
```

Groovy Test Assertions

Apart from the [default assertion methods inherited](#) from the JUnit framework's `TestCase` class, `GroovyTestCase` also offers additional test assertions:

- `assertArrayEquals(Object[] expected, Object[] value)`
- `assertLength(int length, char[] array)`
- `assertLength(int length, int[] array)`
- `assertLength(int length, Object[] array)`
- `assertContains(char expected, char[] array)`
- `assertContains(int expected, int[] array)`
- `assertToString(Object value, String expected)`
- `assertInspect(Object value, String expected)`
- `assertScript(final String script) // assert that a script runs without exceptions`
- `shouldFail(Closure code) // assert that an exception was thrown in that closure`

- `shouldFail(Class clazz, Closure code) // the same but for a class`

Details

By default Groovy unit test cases generate java bytecode and so are just the same as any other Java unit test cases. One thing to watch is often Ant / Maven look for *.java files to find unit tests with pattern matching, rather than *.class files.

There's an option in Maven to ensure you search for classes (and so find any Groovy unit test cases) via this property

```
maven.test.search.classdir = true
```

Once you've got this enabled you can use Maven goals to run individual test cases like this

```
maven test:single -Dtestcase=foo.MyGroovyTest
```

Running GroovyTestCases on the command-line

Since beta-6, you can also run your groovy tests (extending `GroovyTestCase`) on the command-line. It has simple as launching any other Groovy script or class:

```
groovy MyTest.groovy
```

Running GroovyTestCases in IDEs

Most IDEs support JUnit but maybe don't yet handle Groovy shame! 😊.

Firstly if you compile the groovy code to bytecode, then it'll just work in any JUnit IDE just fine.

Sometimes though you want to just hack the unit test script and run from in your IDE without doing a build.

If you're IDE doesn't automatically recompile Groovy for you then there's a utility to help you run Groovy unit test cases inside any JUnit IDE without needing to run your Ant / Maven build.

The

[GroovyTestSuite](#)

class is a JUnit TestSuite which will compile and run a GroovyUnit test case from a command line argument (when run as an application) or from the `_test_` system property when run as a JUnit test suite.

To run the GroovyUnitTest as an application, just do the equivalent of this in your IDE

```
java groovy.util.GroovyTestSuite src/test/Foo.groovy
```

Or to run the test suite inside your IDE, just run the `GroovyTestSuite` test with this system property defined

```
-Dtest=src/test/Foo.groovy
```

Either of the above can really help improve the development experience of writing Groovy unit test cases in IDEs that don't yet support Groovy natively.

Running a TestSuite containing GroovyTestCase scripts directly in Eclipse

You can take advantage of

[GroovyTestSuite](#)

's ability to compile `GroovyTestCase` scripts into classes to build a `TestSuite` which can be run from Eclipse's JUnit runner directly.

The `suite()` method of `TestSuite` creates and returns a `Test`. Within your `TestSuite`'s `suite()` method, you can create a `GroovyTestSuite` and use it to compile groovy scripts into Class instances, and add them to a `TestSuite` that you are building using `TestSuite.addSuite(Class)`.

Here's a `TestSuite` that contains some `GroovyTestCase` scripts:

```
public class MyTestSuite extends TestSuite {
    // Since Eclipse launches tests relative to the project root,
    // declare the relative path to the test scripts for convenience
    private static final String TEST_ROOT = "test/java/com/foo/bar";
    public static Test suite() throws Exception {
        TestSuite suite = new TestSuite();
        GroovyTestSuite gsuite = new GroovyTestSuite();
        suite.addTestSuite(FooTest.class); // non-groovy test cases welcome, too.
        suite.addTestSuite(gsuite.compile(TEST_ROOT + "BarTest.groovy"));
        suite.addTestSuite(gsuite.compile(TEST_ROOT + "FooFactoryTest.groovy"));
        suite.addTestSuite(gsuite.compile(TEST_ROOT + "BaazTest.groovy"));
        return suite;
    }
}
```

This `TestSuite` subclass can then be launched as a normal `TestSuite` in Eclipse. For example, right-click, Run As -> JUnit Test.

From there, the behavior of the JUnit test runner is the same; hierarchy view of all tests and individual methods, their results, etc.

Using normal scripts as unit test cases

You can write scripts like this

```
x = [1, 2, 3]
assert x.size() == 3
```

and use these scripts as unit test cases if you use the `GroovyTestSuite` class to run them as described above.

When the above script is compiled, it doesn't actually implement JUnit's `TestCase` and so needs a special runner so that it can be used inside a JUnit test framework. This is what `GroovyTestSuite` does, it detects scripts like the above and wraps them in a JUnit Test adapter so you can run scripts like the above as a unit test case inside your IDE.

New AllTestSuite since Groovy-1.0-JSR-05 (SNAPSHOT Jan 1st 06, 7:00 pm)

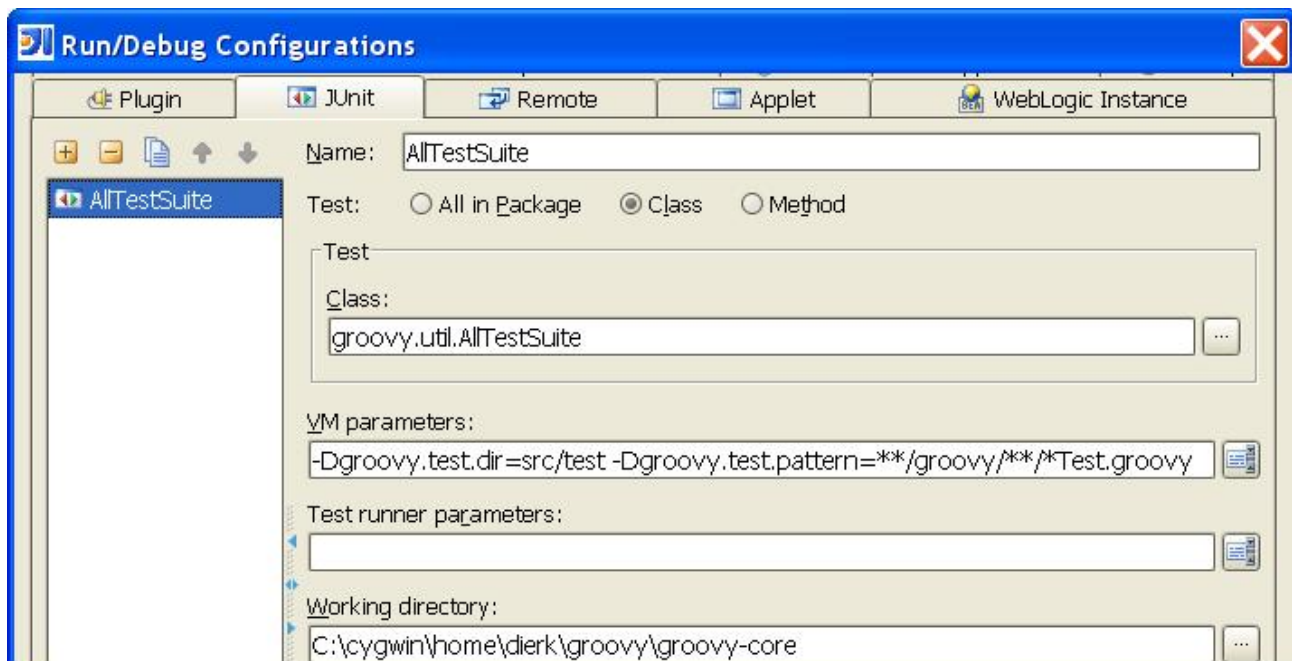
There is a new class `groovy.util.AllTestSuite` that transparently cares for all the above.

Simply make a Run Configuration in your IDE for this class, providing the following System Properties:

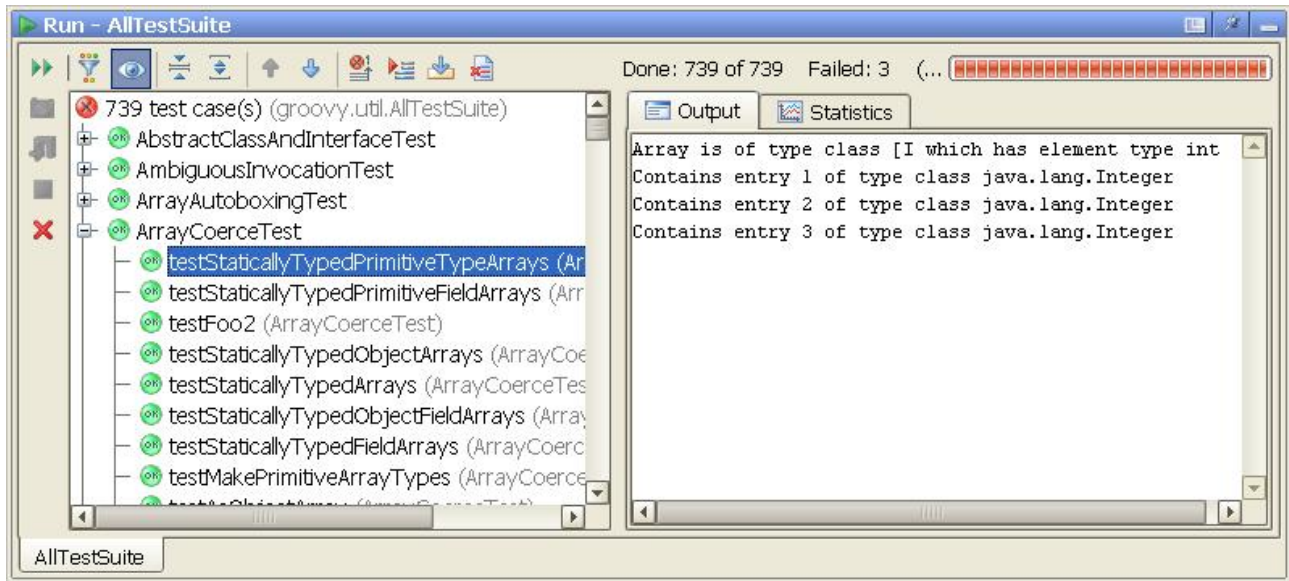
Property name	meaning	default
<code>groovy.test.dir</code>	the directory to search for groovy tests	<code>./test/</code>
<code>groovy.test.pattern</code>	the ant fileset pattern to search below the dir	<code>**/*Test.groovy</code>

See the API documentation of `groovy.util.AllTestSuite` for more details.

Here is the run config for JetBrains IDEA:



Here is how it looks like when running the `AllTestSuite` for the the groovy Unit tests of the Groovy project itself:



Using JUnit 4 with Groovy

This page last changed on Mar 30, 2007 by [paulk_asert](#).

Groovy has excellent support for Unit Testing with JUnit 3.8.2 and Mocking built right in. Currently, special support doesn't exist for JUnit 4 but its easy to use so long as you are using Groovy 1.1 (currently only available as a SNAPSHOT). Here is an example.

Make sure you are using Groovy 1.1 and JUnit 4.x.

Suppose we want to test the following program:

```
class GroovyMultiplier {
    int triple(int val) {
        return val * 3
    }
}
```

Here is what your code might look like. This example uses parameterization.

```
import org.junit.Test
import org.junit.Before
import org.junit.runner.RunWith
import org.junit.runner.JUnit4Core
import org.junit.runners.Parameterized
import org.junit.runners.Parameterized.*

@RunWith(Parameterized)
class GroovyMultiplierJUnit4Test {
    def testee
    def param
    def expectedResult

    @Parameters static data() {
        return (2..4).collect{ [it, it * 3] as Integer[] }
    }

    GroovyMultiplierJUnit4Test(a, b) {
        param = a
        expectedResult = b
    }

    @Before void setUp() {
        testee = new GroovyMultiplier()
    }

    @Test void positivesFixed() {
        assert testee.triple(1) == 3: "+ve multiplier error"
    }

    @Test void positivesParameterized() {
        assert testee.triple(param) == expectedResult
    }

    @Test void negativesParameterized() {
        assert testee.triple(-param) == -expectedResult
    }

    @Test(expected=ArithmeticException) void divideByZero() {
        println 1/0
    }

    static main(args) {
        JUnit4Core.main('GroovyMultiplierJUnit4Test')
    }
}
```

```
}
```

The output will look something like this:

```
JUnit version 4.3.1
.....
Time: 0.172

OK (12 tests)
```

Using Testing Frameworks with Groovy

This page last changed on Apr 21, 2007 by [paulk_asert](#).

Groovy is great for Agile development in general and testing in particular because:

- it has built-in support for the JUnit testing framework
- it has built-in mocking capabilities
- it provides a very expressive language in which to write tests which can utilise Closure syntax and Groovy's other features which support the creation of testing domain specific languages (DSLs)
- it's built-in AntBuilder support makes it easy to set up integration tests

This page explores testing features of Groovy and some other testing frameworks that you may sometimes wish to use to complement Groovy's built-in capabilities.

Two main examples are used:

- A Stack Example
- An Item Storer Example



Some of the examples on this page rely on annotations: a feature currently available in the Groovy 1.1 snapshot releases when used with Java 5 and above.

A Stack Example

Inspired by the [RSpec](#) stack example, suppose we want to test the following Groovy classes:

```
class StackOverflowException extends RuntimeException {}

class StackUnderflowException extends RuntimeException {}

class FixedStack {
    public static MAXSIZE = 10
    private items = []

    def push(object) {
        if (items.size() == MAXSIZE) throw new StackOverflowException()
        items << object
    }

    def pop() {
        if (!items) throw new StackUnderflowException()
        items.pop()
    }

    def peek() {
        if (!items) throw new StackUnderflowException()
        items[-1]
    }
}
```

```

    }

    boolean isEmpty() {
        items.isEmpty()
    }

    boolean isFull() {
        items.size() == MAXSIZE
    }
}

```

We can test this with vanilla Groovy using the following tests:

```

class NonEmptyFixedStackTest extends GroovyTestCase {
    private stack

    void setUp() {
        stack = new FixedStack()
        ["a", "b", "c"].each { x -> stack.push x }
    }

    void testPreConditions() {
        assert !stack.isEmpty()
    }

    void testShouldAddToTheTopWhenSentPush() {
        stack.push "d"
        assert stack.peek() == "d"
    }

    void testShouldBeUnchangedWhenSentPushThenPop() {
        stack.push "anything"
        stack.pop()
        assert stack.peek() == "c"
    }

    void testShouldReturnTheTopItemWhenSentPeek() {
        assert stack.peek() == "c"
    }

    void testShouldNotRemoveTheTopItemWhenSentPeek() {
        assert stack.peek() == "c"
        assert stack.peek() == "c"
    }

    void testShouldReturnTheTopItemWhenSentPop() {
        assert stack.pop() == "c"
    }

    void testShouldRemoveTheTopItemWhenSentPop() {
        assert stack.pop() == "c"
        assert stack.pop() == "b"
    }
}

class EmptyFixedStackTest extends GroovyTestCase {
    private stack = new FixedStack()

    void testPreConditions() {
        assert stack.isEmpty()
    }

    void testShouldNoLongerBeEmptyAfterPush() {
        stack.push "anything"
        assert !stack.isEmpty()
    }

    void testShouldComplainWhenSentPeek() {
        shouldFail(StackUnderflowException) {
            stack.peek()
        }
    }
}

```

```

        void testShouldComplainWhenSentPop() {
            shouldFail(StackUnderflowException) {
                stack.pop()
            }
        }
    }

    class FullFixedStackTest extends GroovyTestCase {
        private stack

        void setUp() {
            stack = new FixedStack()
            (1..FixedStack.MAXSIZE).each{ x -> stack.push x }
        }

        void testPreConditions() {
            assert stack.isFull()
        }

        void testShouldRemainFullAfterPeek() {
            stack.peek()
            assert stack.isFull()
        }

        void testShouldNoLongerBeFullAfterPop() {
            stack.pop()
            assert !stack.isFull()
        }

        void testShouldComplainOnPush() {
            shouldFail(StackOverflowException) {
                stack.push "anything"
            }
        }
    }

    class AlmostFullFixedStackTest extends GroovyTestCase {
        private stack

        void setUp() {
            stack = new FixedStack()
            (1..<FixedStack.MAXSIZE).each{ x -> stack.push x }
        }

        void testPreConditions() {
            assert !stack.isFull()
        }

        void testShouldBecomeFullAfterPush() {
            stack.push "anything"
            assert stack.isFull()
        }
    }

    class AlmostEmptyFixedStackTest extends GroovyTestCase {
        private stack

        void setUp() {
            stack = new FixedStack()
            stack.push "anything"
        }

        void testPreConditions() {
            assert !stack.isEmpty()
        }

        void testShouldRemainNotEmptyAfterPeek() {
            stack.peek()
            testPreConditions()
        }

        void testShouldBecomeEmptyAfterPop() {
            stack.pop()
            assert stack.isEmpty()
        }
    }
}

```

Of course, even within vanilla Groovy we have a few options. E.g., we could use no test class, just a script, in which case, the naming conventions required by JUnit 3.x (used above) wouldn't apply. Or, we could have used JUnit 4 and annotations to allow us to use alternate naming conventions for the methods. Alternatively, we could use a single test class with different test fixtures, e.g. `fullStack` and `emptyStack`. The other frameworks [mentioned below](#) allow additional possibilities for organising and naming our tests.

An Item Storer Example

Suppose we have the following Java interface (Groovy supports interface-oriented programming as well as dynamic programming using duck-typing and here we want to illustrate Java test/mock libraries later):

```
// Java
public interface Reverser {
    Object reverse(Object item);
}
```

Now suppose we have an implementation method as follows:

```
class GroovyReverser implements Reverser {
    def reverse(item) {
        if (item instanceof Number) return -item
        return item.reverse()
    }
}
```

For numbers, the `reverse()` method will negate them. Thanks to duck-typing, other objects that we try to reverse will just call their respective types `reverse()` method if it exists, e.g. so it will work for `String` and `List` objects.

Now suppose we make use of a reverser in some code we are trying to test.

```
class Storer {
    def stored
    Reverser reverser = new GroovyReverser()
    def put(item) {
        stored = item
    }
    def get() {
        return stored
    }
    def getReverse() {
        return reverser.reverse(stored)
    }
}
```

Integration Testing

We can integration test this class as follows:

```
def checkPersistAndReverse(cut, value, reverseValue) {
    cut.put(value)
```

```

    assert value == cut.get()
    assert reverseValue == cut.getReverse()
}

def testBehavior(cut) {
    checkPersistAndReverse cut, 123.456, -123.456
    checkPersistAndReverse cut, 'hello', 'olleh'
    checkPersistAndReverse cut, [1, 3, 5], [5, 3, 1]
}

testBehavior(new Storer())

```

Mocking Groovy Classes

The above integration tests exercise our class under test with the production `reverser` in place. For this particular example, we might argue that such a test is appropriate and sufficient. However, in more complicated scenarios, the dependent collaboration class (`GroovyReverser` in this case) might be difficult or expensive to construct. In those cases, we would want to replace it with a mock or stub. See [Groovy Mocks](#) for a definition of terms.

Here is how we would use Groovy's built-in mock support to test our class under test in isolation:

```

import groovy.mock.interceptor.MockFor

def mockReverser = new MockFor(GroovyReverser.class)
mockReverser.demand.reverse{ arg -> -arg }
mockReverser.demand.reverse{ arg -> arg.reverse() }
mockReverser.use {
    testBehavior(new Storer())
}

```

Note that we didn't need to do anything to inject our mocks into the class under test. Inside the `use` method, all attempts to create a `GroovyReverser` object will be replaced by a mock object. This also works for Java objects created by Groovy objects, as the following shows:

```

mockReverser = new MockFor(JavaReverser.class)
mockReverser.demand.reverse{ arg -> -arg }
mockReverser.demand.reverse{ arg -> arg.reverse() }
mockReverser.use {
    testBehavior(new Storer(reverser:new JavaReverser()))
}

```

Here `JavaReverser` is a class that we have defined as follows:

```

import java.util.List;
import java.util.ArrayList;
import java.util.ListIterator;

public class JavaReverser implements Reverser {
    public Object reverse(Object item) {
        if (item instanceof Number) {
            Number n = (Number) item;
            return new Double(-n.doubleValue());
        }
        if (item instanceof String) {
            String s = (String) item;
            int size = s.length();
            StringBuffer sb = new StringBuffer(size);
            for (int i = size - 1; i >= 0; i--) {

```

```

        sb.append(s.charAt(i));
    }
    return sb.toString();
}
if (item instanceof List) {
    List l = (List) item;
    int size = l.size();
    List result = new ArrayList(size);
    ListIterator iter = l.listIterator(size);
    while (iter.hasPrevious()) {
        result.add(iter.previous());
    }
    return result;
}
throw new UnsupportedOperationException();
}
}

```

Hmmm. Quite a bit longer than the Groovy version. But that's another story.

Testing Java classes which use other Java classes

Now, consider now the following Java class:

```

public class JavaStorer {
    Object stored;
    Reverser reverser;

    public JavaStorer(Reverser reverser) {
        this.reverser = reverser;
    }

    void put(Object item) {
        stored = item;
    }
    Object get() {
        return stored;
    }
    Object getReverse() {
        return reverser.reverse(stored);
    }
}

```

We now want to test this too and we want to use Groovy to write the tests. Unfortunately, Groovy's built-in mock support won't help us here. It doesn't allow us to test Java classes like this one as it relies on hooking into Groovy's object lifecycle mechanisms. Instead, we can use any of the available Java mocking packages such as the ones [mentioned below](#).

Using Other Frameworks

Sometimes you may wish to consider complementing Groovy's built-in capabilities with one or more of the following frameworks:

- [Using EasyMock with Groovy](#)
- [Using GSpec with Groovy](#)
- [Using Instinct with Groovy](#)
- [Using JBehave with Groovy](#)
- [Using JDummy with Groovy](#)
- [Using JMock with Groovy](#)

- [Using RMock with Groovy](#)
- [Using TestNG with Groovy](#)

Using EasyMock with Groovy

This page last changed on Apr 22, 2007 by [paulk_asert](#).

[EasyMock](#) is a mocking framework for Java. Here we look at EasyMock 2.2 which requires Java 5 and has the following benefits:

- Hand-writing classes for Mock Objects is not needed.
- Supports refactoring-safe Mock Objects: test code will not break at runtime when renaming methods or reordering method parameters
- Supports return values and exceptions.
- Supports checking the order of method calls, for one or more Mock Objects.

The sections below illustrate using EasyMock for the mocking parts of [Using Testing Frameworks with Groovy](#).

The Item Storer Example

We are going to consider how you might use EasyMock as part of testing the [Item Storer Example](#).

Here is how we can test `JavaStorer`:

```
// require(groupId:'easymock', artifactId:'easymock', version='2.2')
import org.easymock.EasyMock

mockControl = EasyMock.createStrictControl()
mockReverser = mockControl.createMock(Reverser.class)
storer = new JavaStorer(mockReverser)
testStorage()

def testStorage() {
    expectReverse(123.456, -123.456)
    expectReverse('hello', 'olleh')
    mockControl.replay()
    checkReverse(123.456, -123.456)
    checkReverse('hello', 'olleh')
    mockControl.verify()
}

def expectReverse(input, output) {
    // it's a pity mockControl doesn't have an expect() method
    EasyMock.expect(mockReverser.reverse(input)).andReturn(output)
}

def checkReverse(value, reverseValue) {
    storer.put(value)
    assert value == storer.get()
    assert reverseValue == storer.getReverse()
}
```

Using GSpec with Groovy

This page last changed on Apr 21, 2007 by [paulk_asert](#).

[GSpec](#) is an evolving framework to allow you to apply a [BDD](#) style of programming when using Groovy. The sections below illustrate using GSpec for the examples from [Using Testing Frameworks with Groovy](#).

The Stack Example

Here is how you might test the [Stack Example](#) with GSpec:

```
import com.craig.gspec.GSpecBuilderRunner

def the = new GSpecBuilderRunner()

the.context('A non-empty stack') {
    initially {
        the.stack = new FixedStack()
        ('a'..'c').each { x -> the.stack.push x }
        the.stack.should_not_be_empty
    }

    specify('should return the top item when sent #peek') {
        the.stack.peek().should_equal 'c'
    }

    specify('should NOT remove the top item when sent #peek') {
        the.stack.peek().should_equal 'c'
        the.stack.peek().should_equal 'c'
    }

    specify('should be unchanged when sent #push then #pop') {
        the.stack.push 'Anything'
        the.stack.pop()
        the.stack.peek().should_equal 'c'
    }

    specify('should return the top item when sent #pop') {
        the.stack.pop().should_equal 'c'
        the.stack.push 'c' // put it back the way it was
    }

    specify('should remove the top item when sent #pop') {
        the.stack.pop().should_equal 'c'
        the.stack.pop().should_equal 'b'
    }

    specify('should add to the top when sent #push') {
        the.stack.push 'd'
        the.stack.peek().should_equal 'd'
    }
}

the.context('An empty stack') {
    initially {
        the.stack = new FixedStack()
        the.stack.should_be_empty
    }

    specify('should no longer be empty after #push') {
        the.stack.push 'anything'
        the.stack.should_not_be_empty
    }

    specify('should complain when sent #peek') {
        // the.stack.peek().should_fail_with StackUnderflowException
    }
}
```

```

    specify('should complain when sent #pop') {
//      the.stack.pop().should_fail_with StackUnderflowException
    }
  }

  the.context('A stack with one item') {
    initially {
      the.stack = new FixedStack()
      the.stack.push 'anything'
      the.stack.should_not_be_empty
    }

    specify('should remain not empty after #peek') {
      the.stack.peek()
      the.stack.should_not_be_empty
    }

    specify('should become empty after #pop') {
      the.stack.pop()
      the.stack.should_be_empty
    }
  }

  the.context('A stack with one item less than capacity') {
    initially {
      the.stack = new FixedStack()
      (1..<FixedStack.MAXSIZE).each { x -> the.stack.push x }
      the.stack.should_not_be_full
    }

    specify('should become full after #push') {
      the.stack.push 'Anything'
      the.stack.should_be_full
    }
  }

  the.context('A full stack') {
    initially {
      the.stack = new FixedStack()
      (1..FixedStack.MAXSIZE).each { x -> the.stack.push x }
      the.stack.should_be_full
    }

    specify('should remain full after #peek') {
      the.stack.peek()
      the.stack.should_be_full
    }

    specify('should no longer be full after #pop') {
      the.stack.pop()
      the.stack.should_not_be_full
    }

    specify('should complain on #push') {
//      the.stack.push('Anything').should_fail_with StackOverflowException
    }
  }
}

```

The Item Storer Example

Here is how you might integration test the [Item Storer Example](#) with GSpec:

```

import com.craig.gspec.GSpecBuilderRunner

def checkPersistAndReverse(storer, orig, reversed){
  storer.put orig
  storer.get().should_equal orig
  storer.getReverse().should_equal reversed
}

def the = new GSpecBuilderRunner()

```

```
the.context('A new storer') {
  initially() {
    the.storer = new Storer()
  }
  specify('Should persist and reverse strings') {
    checkPersistAndReverse the.storer, 'hello', 'olleh'
  }
  specify('Should persist and reverse numbers') {
    checkPersistAndReverse the.storer, 123.456, -123.456
  }
  specify('Should persist and reverse lists') {
    checkPersistAndReverse the.storer, [1, 3, 5], [5, 3, 1]
  }
}
```

Using Instinct with Groovy

This page last changed on Apr 24, 2007 by [paulk_asert](#).

[Instinct](#) is a Behaviour Driven Development ([BDD](#)) framework for Java. Inspired by [RSpec](#), Instinct provides:

- flexible annotation of contexts, specifications, test actors, etc. (via Java 1.5 annotations, marker interfaces or naming conventions)
- automatic creation of test doubles (dummies, mocks and stubs) and test subjects
- state and behavioural (mocks) expectation API
- JUnit test runner integration
- Ant tasks

The sections below illustrate using Instinct for the examples from [Using Testing Frameworks with Groovy](#).

The Stack Example

Here is how you might use Instinct to test the [Stack Example](#):

```
// require(url:'http://code.google.com/p/instinct', jar:'instinct-0.1.3.jar')
// require(url:'http://geekscape.org/static/boost.html', jar:'boost-982.jar')
import com.googlecode.instinct.marker.annotate.BeforeSpecification
import com.googlecode.instinct.marker.annotate.Specification
import com.googlecode.instinct.runner.TextContextRunner

class AlmostEmptyFixedStackContext {
    private stack

    @BeforeSpecification
    void initially() {
        stack = new FixedStack()
        stack.push 'anything'
        assert !stack.isEmpty()
    }

    @Specification
    void shouldRemainNotEmptyAfterPeek() {
        stack.peek()
        assert !stack.isEmpty()
    }

    @Specification
    void shouldBecomeEmptyAfterPop() {
        stack.pop()
        assert stack.isEmpty()
    }
}

class AlmostFullFixedStackContext {
    private stack

    @BeforeSpecification
    void initially() {
        stack = new FixedStack()
        (1..<FixedStack.MAXSIZE).each{ x -> stack.push x }
        assert !stack.isFull()
    }

    @Specification
    void shouldBecomeFullAfterPush() {
        stack.push 'anything'
        assert stack.isFull()
    }
}
```

```

    }
}

class EmptyFixedStackContext extends GroovyTestCase {
    private stack = new FixedStack()

    @BeforeSpecification
    void preCondition() {
        assert stack.isEmpty()
    }

    @Specification
    void shouldNoLongerBeEmptyAfterPush() {
        stack.push 'anything'
        assert !stack.isEmpty()
    }

    @Specification
    void shouldComplainWhenSentPeek() {
        shouldFail(StackUnderflowException) {
            stack.peek()
        }
    }

    @Specification
    void shouldComplainWhenSentPop() {
        shouldFail(StackUnderflowException) {
            stack.pop()
        }
    }
}

class FullFixedStackContext extends GroovyTestCase {
    private stack

    @BeforeSpecification
    void initially() {
        stack = new FixedStack()
        (1..FixedStack.MAXSIZE).each{ x -> stack.push x }
        assert stack.isFull()
    }

    @Specification
    void shouldRemainFullAfterPeek() {
        stack.peek()
        assert stack.isFull()
    }

    @Specification
    void shouldNoLongerBeFullAfterPop() {
        stack.pop()
        assert !stack.isFull()
    }

    @Specification
    void shouldComplainOnPush() {
        shouldFail(StackOverflowException) {
            stack.push 'anything'
        }
    }
}

class NonEmptyFixedStackContext {
    private stack

    @BeforeSpecification
    void initially() {
        stack = new FixedStack()
        ('a'..'c').each{ x -> stack.push x }
        assert !stack.isEmpty()
    }

    @Specification
    void shouldAddToTheTopWhenSentPush() {
        stack.push 'd'
        assert stack.peek() == 'd'
    }
}

```

```

@Specification
void shouldBeUnchangedWhenSentPushThenPop() {
    stack.push('anything')
    stack.pop()
    assert stack.peek() == 'c'
}

@Specification
void shouldReturnTheTopItemWhenSentPeek() {
    assert stack.peek() == 'c'
}

@Specification
void shouldNotRemoveTheTopItemWhenSentPeek() {
    assert stack.peek() == 'c'
    assert stack.peek() == 'c'
}

@Specification
void shouldReturnTheTopItemWhenSentPop() {
    assert stack.pop() == 'c'
}

@Specification
void shouldRemoveTheTopItemWhenSentPop() {
    assert stack.pop() == 'c'
    assert stack.pop() == 'b'
}
}

Class[] contexts = [
    AlmostEmptyFixedStackContext,
    AlmostFullFixedStackContext,
    EmptyFixedStackContext,
    FullFixedStackContext,
    NonEmptyFixedStackContext
]

TextContextRunner.runContexts(contexts)

```

The Item Storer Example

Here is how you might use Instinct to integration test the [Item Storer Example](#):

```

// require(url:'http://code.google.com/p/instinct', jar:'instinct-0.1.3.jar')
// require(url:'http://geekscape.org/static/boost.html', jar:'boost-982.jar')
import com.googlecode.instinct.marker.annotate.BeforeSpecification
import com.googlecode.instinct.marker.annotate.BehaviourContext
import com.googlecode.instinct.marker.annotate.Specification
import com.googlecode.instinct.runner.TextContextRunner

@BehaviourContext
class InstinctIntegrationContext {
    def storer

    @BeforeSpecification
    void setUp() {
        storer = new Storer()
    }

    private checkPersistAndReverse(value, reverseValue) {
        storer.put(value)
        assert value == storer.get()
        assert reverseValue == storer.getReverse()
    }

    @Specification
    void shouldReverseNumbers() {
        checkPersistAndReverse 123.456, -123.456
    }
}

```



```
@Specification
void shouldReverseStrings() {
    checkPersistAndReverse 'hello', 'olleh'
}

@Specification
void shouldReverseLists() {
    checkPersistAndReverse([1, 3, 5], [5, 3, 1])
}

new TextContextRunner().run(InstinctIntegrationContext)
```

Using JBehave with Groovy

This page last changed on Apr 22, 2007 by [paulk_asert](#).

[JBehave](#) is a Behaviour Driven Development ([BDD](#)) framework for Java.

The sections below illustrate using JBehave for the examples from [Using Testing Frameworks with Groovy](#).

The Stack Example

Here is how you might use JBehave to test the [Stack Example](#):

```
// require(url:'http://jbehave.org/', jar='jbehave-1.0.1.jar')
import org.jbehave.core.Run
import org.jbehave.core.behaviour.Behaviours

class AlmostEmptyFixedStackBehavior {
    private stack

    void setUp() {
        stack = new FixedStack()
        stack.push 'anything'
        assert !stack.isEmpty()
    }

    void shouldRemainNotEmptyAfterPeek() {
        stack.peek()
        assert !stack.isEmpty()
    }

    void shouldBecomeEmptyAfterPop() {
        stack.pop()
        assert stack.isEmpty()
    }
}

class AlmostFullFixedStackBehavior {
    private stack

    void setUp() {
        stack = new FixedStack()
        (1..<FixedStack.MAXSIZE).each{ x -> stack.push x }
        assert !stack.isFull()
    }

    void shouldBecomeFullAfterPush() {
        stack.push 'anything'
        assert stack.isFull()
    }
}

class EmptyFixedStackBehavior extends GroovyTestCase {
    private stack = new FixedStack()

    void shouldInitiallyBeEmpty() {
        assert stack.isEmpty()
    }

    void shouldNoLongerBeEmptyAfterPush() {
        stack.push 'anything'
        assert !stack.isEmpty()
    }

    void shouldComplainWhenSentPeek() {
        shouldFail(StackUnderflowException) {

```

```

        stack.peek()
    }
}

void shouldComplainWhenSentPop() {
    shouldFail(StackUnderflowException) {
        stack.pop()
    }
}

}

class FullFixedStackBehavior extends GroovyTestCase {
    private stack

    void setUp() {
        stack = new FixedStack()
        (1..FixedStack.MAXSIZE).each{ x -> stack.push x }
        assert stack.isFull()
    }

    void shouldRemainFullAfterPeek() {
        stack.peek()
        assert stack.isFull()
    }

    void shouldNoLongerBeFullAfterPop() {
        stack.pop()
        assert !stack.isFull()
    }

    void shouldComplainOnPush() {
        shouldFail(StackOverflowException) {
            stack.push 'anything'
        }
    }
}

class NonEmptyFixedStackBehavior {
    private stack

    void setUp() {
        stack = new FixedStack()
        ('a'..'c').each{ x -> stack.push x }
        assert !stack.isEmpty()
    }

    void shouldAddToTheTopWhenSentPush() {
        stack.push 'd'
        assert stack.peek() == 'd'
    }

    void shouldBeUnchangedWhenSentPushThenPop() {
        stack.push 'anything'
        stack.pop()
        assert stack.peek() == 'c'
    }

    void shouldReturnTheTopItemWhenSentPeek() {
        assert stack.peek() == 'c'
    }

    void shouldNotRemoveTheTopItemWhenSentPeek() {
        assert stack.peek() == 'c'
        assert stack.peek() == 'c'
    }

    void shouldReturnTheTopItemWhenSentPop() {
        assert stack.pop() == 'c'
    }

    void shouldRemoveTheTopItemWhenSentPop() {
        assert stack.pop() == 'c'
        assert stack.pop() == 'b'
    }
}

class AllBehaviours implements Behaviours {
    Class[] getBehaviours() {

```

```

        return [
            AlmostEmptyFixedStackBehavior,
            AlmostFullFixedStackBehavior,
            EmptyFixedStackBehavior,
            FullFixedStackBehavior,
            NonEmptyFixedStackBehavior
        ]
    }
}

Run.main('AllBehaviours')

```

The Item Storer Example

Here is how you might use JBehave to test the [Item Storer Example](#):

```

// require(url:'http://jbehave.org/', jar='jbehave-1.0.1.jar')
import org.jbehave.core.Run

class JBehaveStorerBehavior {
    def storer = new Storer()

    def static checkPersistAndReverse(cut, value, reverseValue) {
        cut.put(value)
        assert value == cut.get()
        assert reverseValue == cut.getReverse()
    }

    void shouldReverseStrings() {
        checkPersistAndReverse storer, 'hello', 'olleh'
    }

    void shouldReverseNumbers() {
        checkPersistAndReverse storer, 123.456, -123.456
    }

    void shouldReverseLists() {
        checkPersistAndReverse storer, [1, 3, 5], [5, 3, 1]
    }
}

Run.main('JBehaveStorerBehavior')

```

Using JDummy with Groovy

This page last changed on Apr 22, 2007 by [paulk_asert](#).

[JDummy](#) is a thin API which sits above JMock. It allows very succinct expectation setting code when the expectation code would normally involve many stubs.

The sections below illustrate using JDummy for the mocking parts of [Using Testing Frameworks with Groovy](#).

The Item Storer Example

We are going to consider how you might use JDummy as part of testing the [Item Storer Example](#).

Here is how we can test `JavaStorer`:

```
// require(groupId:'jmock', artifactId:'jmock', version='1.2.0')
// require(groupId:'jmock', artifactId:'jmock-cglib', version='1.2.0')
// require(groupId:'junit', artifactId:'junit', version='3.8.2')
// require(groupId:'cglib', artifactId:'cglib-nodep', version='2.2_beta1')
// require(url:'jdummy.sf.net', jar:'jdummy-1.3.3.jar')
import net.sf.jdummy.JDummyTestCase

class JDummyTest extends JDummyTestCase {
    def mockReverser, storer

    protected void setUp() throws Exception {
        mockReverser = mimicWithDummyValues(Reverser.class)
        storer = new JavaStorer(mockReverser)
    }

    void testStorage() {
        expectReverse(123.456, -123.456)
        expectReverse('hello', 'olleh')
        checkReverse(123.456, -123.456)
        checkReverse('hello', 'olleh')
    }

    def expectReverse(input, output) {
        // with is a keyword in Groovy so we quote it
        assertBehavior(mockReverser).expects(once()).method('reverse').'with'(eq(input)).will(returnValue(output))
    }

    def checkReverse(value, reverseValue) {
        storer.put(value)
        assert value == storer.get()
        assert reverseValue == storer.getReverse()
    }
}

def suite = new junit.framework.TestSuite()
suite.addTestSuite(JDummyTest.class)
junit.textui.TestRunner.run(suite)
```

Note: Our example is so simple, that JDummy's power is not really illustrated here.

Using JMock with Groovy

This page last changed on Apr 22, 2007 by [paulk_asert](#).

[JMock](#) is a popular mocking framework for Java. Several versions are available.

The sections below illustrate using various versions of JMock for the mocking parts of [Using Testing Frameworks with Groovy](#).

The Item Storer Example

We are going to consider how you might use JMock as part of testing the [Item Storer Example](#).

Here is how we can test `JavaStorer` using version 1.x of JMock using its JUnit 3 integration:

```
// require(groupId:'jmock', artifactId:'jmock-core', version='1.2.0')
// require(groupId:'junit', artifactId:'junit', version='3.8.2')
import org.jmock.MockObjectTestCase

class JMock1Test extends MockObjectTestCase {
    def mockControl, mockReverser, storer

    protected void setUp() throws Exception {
        mockControl = mock(Reverser.class)
        mockReverser = mockControl.proxy()
        storer = new JavaStorer(mockReverser)
    }

    void testStorage() {
        expectReverse(123.456, -123.456)
        expectReverse('hello', 'olleh')
        checkReverse(123.456, -123.456)
        checkReverse('hello', 'olleh')
    }

    def expectReverse(input, output) {
        // with is a keyword in Groovy so we quote it
        mockControl.expects(once()).method('reverse').with(eq(input)).will(returnValue(output))
    }

    def checkReverse(value, reverseValue) {
        storer.put(value)
        assert value == storer.get()
        assert reverseValue == storer.getReverse()
    }
}

def suite = new junit.framework.TestSuite()
suite.addTestSuite(JMock1Test.class)
junit.textui.TestRunner.run(suite)
```

Here is how we can test `JavaStorer` using version 2.x of JMock using its JUnit 4 integration:

```
// require(groupId:'junit', artifactId:'junit4', version='4.3.1')
// require(groupId:'jmock', artifactId:'jmock', version='2.0.0')
// require(groupId:'jmock', artifactId:'jmock-junit4', version='2.0.0')
import org.jmock.integration.junit4.JMock
import org.jmock.Mockery
import org.junit.Test
import org.junit.Before
import org.junit.runner.RunWith
```

```

import org.junit.runner.JUnitCore

@RunWith(JMock)
class JMock2Test {
    Mockery context = new JUnit4GroovyMockery()
    def mockReverser, storer

    @Before void setUp() throws Exception {
        mockReverser = context.mock(Reverser.class)
        storer = new JavaStorer(mockReverser)
    }

    @Test void testStorage() {
        expectReverse(123.456, -123.456)
        expectReverse('hello', 'olleh')
        checkReverse(123.456, -123.456)
        checkReverse('hello', 'olleh')
    }

    def expectReverse(input, output) {
        context.checking{
            one(mockReverser).reverse(input); will(returnValue(output))
        }
    }

    def checkReverse(value, reverseValue) {
        storer.put(value)
        assert value == storer.get()
        assert reverseValue == storer.getReverse()
    }
}

JUnitCore.main('JMock2Test')

```

To make our tests a little more DSL-like, we used the following helper class with JMock 2:

```

import groovy.lang.Closure;
import org.jmock.Expectations;
import org.jmock.integration.junit4.JUnit4Mockery;

public class JUnit4GroovyMockery extends JUnit4Mockery {
    class ClosureExpectations extends Expectations {
        void closureInit(Closure cl, Object delegate) {
            cl.setDelegate(delegate);
            cl.call();
        }
    }

    public void checking(Closure c) {
        ClosureExpectations expectations = new ClosureExpectations();
        expectations.closureInit(c, expectations);
        super.checking(expectations);
    }
}

```

Using RMock with Groovy

This page last changed on Apr 22, 2007 by [paulk_asert](#).

[RMock](#) is a Java mock object framework typically used with JUnit 3.x. RMock has support for a setup-modify-run-verify workflow when writing JUnit tests. It integrates better with IDE refactoring support than some other popular mocking frameworks and allows designing classes and interfaces in a true test-first fashion.

The sections below illustrate using RMock for the mocking parts of [Using Testing Frameworks with Groovy](#).

The Item Storer Example

We are going to consider how you might use RMock as part of testing the [Item Storer Example](#).

Here is how we can test `JavaStorer`:

```
// require(groupId:'com.agical.rmock.rmock', artifactId:'rmock', version='2.0.0')
// require(groupId:'junit', artifactId:'junit', version='3.8.2')
// require(groupId:'cglib', artifactId:'cglib-nodep', version='2.2_beta1')
import com.agical.rmock.extension.junit.RMockTestCase

class RmockTest extends RMockTestCase {
    def mockReverser, storer

    protected void setUp() throws Exception {
        mockReverser = mock(Reverser.class, 'mockReverser')
        storer = new JavaStorer(mockReverser)
    }

    void testStorage() {
        expectReverse(123.456, -123.456)
        expectReverse('hello', 'olleh')
        startVerification()
        checkReverse(123.456, -123.456)
        checkReverse('hello', 'olleh')
    }

    def expectReverse(input, output) {
        mockReverser.reverse(input)
        modify().returnValue(output)
    }

    def checkReverse(value, reverseValue) {
        storer.put(value)
        assert value == storer.get()
        assert reverseValue == storer.getReverse()
    }
}

def suite = new junit.framework.TestSuite()
suite.addTestSuite(RmockTest.class)
junit.textui.TestRunner.run(suite)
```


Using TestNG with Groovy

This page last changed on Apr 24, 2007 by [paulk_asert](#).

[TestNG](#) is a testing framework inspired from JUnit and NUnit but with new functionality to make it more powerful and easier to use. Features include:

- JDK 5 Annotations (JDK 1.4 is also supported with JavaDoc annotations)
- Flexible test configuration
- Support for data-driven testing (with `@DataProvider`)
- Support for parameters
- Allows distribution of tests on slave machines
- Powerful execution model (no more TestSuite)
- Supported by a variety of tools and plug-ins (Eclipse, IDEA, Maven, etc...)
- Embeds BeanShell for further flexibility
- Default JDK functions for runtime and logging (no dependencies)
- Dependent methods for application server testing

TestNG is designed to cover all categories of tests: unit, functional, end-to-end, integration, etc...

The sections below illustrate using TestNG for the examples from [Using Testing Frameworks with Groovy](#).

The Item Storer Example

Here is how you might use TestNG to integration test the [Item Storer Example](#):

```
// require(groupId:'org.testng', artifactId:'testng', version='5.5')
import org.testng.annotations.*
import org.testng.TestNG
import org.testng.TestListenerAdapter

class StorerIntegrationTest {

    private storer

    @BeforeClass
    def setUp() {
        storer = new Storer()
    }

    private checkPersistAndReverse(value, reverseValue) {
        storer.put(value)
        assert value == storer.get()
        assert reverseValue == storer.getReverse()
    }

    @Test
    void shouldPersistAndReverseStrings() {
        checkPersistAndReverse 'hello', 'olleh'
    }

    @Test
    void shouldPersistAndReverseNumbers() {
        checkPersistAndReverse 123.456, -123.456
    }

    @Test
    void shouldPersistAndReverseLists() {
        checkPersistAndReverse([1, 3, 5], [5, 3, 1])
    }
}
```

```
    }  
}  
  
def testng = new TestNG()  
testng.setTestClasses([StorerIntegrationTest] as Class[])  
testng.addListener(new TestListenerAdapter())  
testng.run()
```

You might also like to consider the special Groovy integration from the [Test'N'Groove](#) project which provides command-line runners and ant tasks for using TestNG with Groovy.

Advanced Topics

This page last changed on Sep 24, 2006 by paulk_asert.

- [Ant Task Troubleshooting](#)
- [BuilderSupport](#)
- [Compiling Groovy](#)
 - [Compiling With Maven2](#)
- [Embedding Groovy](#)
- [Influencing class loading at runtime](#)
- [Leveraging Spring](#)
- [Make a builder](#)
- [Mixed Java and Groovy Applications](#)
- [Security](#)
- [Writing Domain-Specific Languages](#)

Ant Task Troubleshooting

This page last changed on Feb 04, 2007 by [mcspanky](#).

Ant Task Troubleshooting

The Common Problem

Very often, the groovy or groovyc tasks fail with a `ClassNotFoundException` for the class `GroovySourceAst`.

The Reason

If it's failing with a `ClassNotFoundException` for a class other than `GroovySourceAst`, welcome to Ant. As the Ant manual for [external tasks](#) says, "Don't add anything to the CLASSPATH environment variable - this is often the reason for very obscure errors. Use Ant's own mechanisms for adding libraries." And as its [library directories](#) section says, "Ant should work perfectly well with an empty CLASSPATH environment variable, something the the `-noclasspath` option actually enforces. We get many more support calls related to classpath problems (especially quoting problems) than we like." So try running Ant as `ant -noclasspath`, or even alias ant to that in your shell.

If the class that isn't found is `GroovySourceAst` and the above doesn't help, somewhere you have a conflicting antlr in your classpath. This may be because you are using maven and one of this parts is polluting the classpath or you have a different antlr jar in your classpath somewhere.

Solution 1: groovy-all

Use the `groovy-all-VERSION.jar` from the groovy distribution and not the normal groovy jar. The `groovy-all-VERSION.jar` does already contain antlr and asm libs in a separate namespace so there should be no conflict with other libs around.

Solution 2: using loaderref

Sometimes it's not possible to use the `groovy-all-VERSION.jar`, for example because you want to build groovy before creating the jar. In this case you have to add a `loaderref` to the task definition. But that alone will not help. You have to add the `rootLoaderRef` task to set this loader reference. For example:

```
<taskdef name="rootLoaderRef"
         classname="org.codehaus.groovy.ant.RootLoaderRef"
         classpathref="task.classpath"/>

<rootLoaderRef ref="tmp.groovy.groovyc">
  <classpath refid="execution.classpath"/>
</rootLoaderRef>

<rootLoaderRef />
```

```
<taskdef name="groovy"
  classname="org.codehaus.groovy.ant.Groovy"
  loaderref="tmp.groovy.groovyc"/>
```

The groovy task will now be created using the tmp.groovy.groovyc class loader, which tries to avoid loading conflicting jars like antlr. It's important to execute the rootLoaderRef task once before the taskdef using the loaderref defined by the rootLoaderRef.

All Solved?

No, both Solutions will not help if you have conflicting ant jars or common-logging jars somewhere. Solution 2 is able to solve much more difficult jar problems as long as your classpath is as clean as possible. if you want to be on the safe side you have to fork the javaVM which means you have to use the task like this:

```
<!-- lets fork a JVM to avoid classpath hell -->
<java classname="org.codehaus.groovy.ant.Groovyc" fork="yes" failonerror="true">
  <classpath refid="project.classpath"/>
  <arg value="${build.classes.dir}"/>
  <arg value="${src.dir}"/>
</java>
```

References

- [Groovyc Task](#)
- [Groovy Task](#)
- [Ant Scripting with AntBuilder](#)
- [Developing Custom Tasks](#)

BuilderSupport

This page last changed on Apr 04, 2007 by [mszklano](#).

I was curious how the abstract BuilderSupport class is working that does all those great things for e.g. the SwingBuilder and AntBuilder.

So I wrote the following Groovy Test that exposes its behaviour:

```
package groovy.util

class SpoofBuilder extends BuilderSupport{
    def log = []
    protected void setParent(Object parent, Object child){
        log << "sp"
        log << parent
        log << child
    }
    protected Object createNode(Object name){
        log << 'cn1'
        log << name
        return 'x'
    }
    protected Object createNode(Object name, Object value){
        log << 'cn2'
        log << name
        log << value
        return 'x'
    }
    protected Object createNode(Object name, Map attributes){
        log << 'cn3'
        log << name
        attributes.each{entry -> log << entry.key; log << entry.value}
        return 'x'
    }
    protected Object createNode(Object name, Map attributes, Object value){
        log << 'cn4'
        log << name
        attributes.each{entry -> log << entry.key; log << entry.value}
        log << value
        return 'x'
    }
    protected void nodeCompleted(Object parent, Object node) {
        log << 'nc'
        log << parent
        log << node
    }
}

// simple node
def b = new SpoofBuilder()
assert b.log == []
def node = b.foo()
assert b.log == ['cn1','foo','nc',null, node]

// simple node with value
def b = new SpoofBuilder()
def node = b.foo('value')
assert b.log == ['cn2','foo','value', 'nc',null,node]

// simple node with one attribute
def b = new SpoofBuilder()
def node = b.foo(name:'value')
assert b.log == [
    'cn3','foo', 'name','value', 'nc',null,'x']

// how is closure applied?
def b = new SpoofBuilder()
b.foo(){
```

```
b.bar()  
}  
assert b.log == [  
    'cnl','foo',  
    'cnl','bar',  
    'sp', 'x', 'x',  
    'nc', 'x', 'x',  
    'nc',null,'x']
```

The SpoofBuilder is a sample instance of the abstract BuilderSupport class that does nothing but logging how it was called, returning 'x' for each node.

The test sections call the SpoofBuilder in various ways and the log reveals what methods were called during the "Build".

This test allowed me to verify my assumption on how the builder pattern works here. I used this knowledge to write a specialized AntBuilder for

[Canoo WebTest](#)

. This "MacroStepBuilder" allows using the Canoo WebTest "steps" (that walk through a webapp for testing) from Groovy Code. Groovy has now become a first-class citizen in the

[Canoo WebTest Community](#)

.

When writing the above test I stumbled over a few things, here are two of them:

- I was not able to write a fully fledged subclass of GroovyTestCase with separate methods for the various tests. I couldn't find out how to make the SpoofBuilder an inner class of my TestCase. I would very much appreciate help on this.
- Coming from Ruby I expected the << operator on Strings to operate on the String itself (like it does on Lists) rather than giving back a modified copy. It appears to me that << on Strings and on Lists is not consistent. Same with the "+" operator.

What I especially appreciated:

- == on Lists is clear and compact
- display of evaluated expression when assert fails saves a lot of work when writing assertions. Most of the time you need no extra message.

keep up the good work!
mittie

Compiling Groovy

This page last changed on Sep 24, 2006 by [paulk_asert](#).

There are various options for compiling Groovy code and then either running it or using the Java objects it creates in Java code.

Compiling Groovy code to bytecode using a script

There is an Ant task called **groovyc** which works pretty similarly to the **javac** Ant task which takes a bunch of groovy source files and compiles them into Java bytecode. Each groovy class then just becomes a normal Java class you can use inside your Java code if you wish. Indeed the generated Java class is indistinguishable from a normal Java class, other than it implements the

[GroovyObject](#) interface.

Compiling Groovy code to bytecode using Ant and Maven

The [groovyc](#) Ant task is implemented by the [Groovyc](#) class. You can see an example of this in action inside Groovy's maven.xml file (just search for 'groovyc')

There is also an excellent [article on DeveloperWorks](#) which will show you how to compile Groovy code from within Maven, similarly to what is done with Ant.

You can also use the Ant task [from within Maven2](#).

Dynamically using Groovy inside Java applications

If you don't want to explicitly compile groovy code to bytecode you can just [embed groovy](#) directly into your Java application.

Runtime dependencies

As well as Java 1.4 and the Groovy jar we also depend at runtime on the ASM library (asm and asm-tree mainly), as well as Antlr. You can also use the groovy-all-xxx.jar from your GROOVY_HOME/embeddable directory, which embeds ASM and Antlr in its own namespace, to avoid Jar version hell.

Compiling With Maven2

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Here's an example of a Maven2 build using the Ant plugin to compile a groovy project. Note that the Ant plugin is bound to the compile and test-compile phases of the build in the example below. It will be invoked during these phases and the contained tasks will be carried out which runs the Groovy compiler over the source and test directories. The resulting Java classes will coexist with and be treated like any standard Java classes compiled from Java source and will appear no different to the JRE, or the JUnit runtime.

```
<project xmlns="http://maven.apache.org/POM/4.0.0"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://maven.apache.org/POM/4.0.0
http://maven.apache.org/maven-v4_0_0.xsd">
  <modelVersion>4.0.0</modelVersion>
  <groupId>com.mycomp.MyGroovy</groupId>
  <artifactId>MyGroovy</artifactId>
  <packaging>jar</packaging>
  <version>1.0-SNAPSHOT</version>
  <name>Maven Example building a Groovy project</name>
  <dependencies>
    <dependency>
      <groupId>junit</groupId>
      <artifactId>junit</artifactId>
      <version>3.8.1</version>
      <scope>test</scope>
    </dependency>
    <dependency>
      <groupId>groovy</groupId>
      <artifactId>groovy-all-1.0-jsr</artifactId>
      <version>05</version>
    </dependency>
  </dependencies>
  <build>
    <plugins>
      <plugin>
        <artifactId>maven-antrun-plugin</artifactId>
        <executions>
          <execution>
            <id>compile</id>
            <phase>compile</phase>
            <configuration>
              <tasks>
                <taskdef name="groovyc"
                  classname="org.codehaus.groovy.ant.Groovyc">
                  <classpath refid="maven.compile.classpath"/>
                </taskdef>
                <mkdir dir="${project.build.outputDirectory}"/>
                <groovyc destdir="${project.build.outputDirectory}"
                  srcdir="${basedir}/src/main/groovy/" listfiles="true">
                  <classpath refid="maven.compile.classpath"/>
                </groovyc>
              </tasks>
            </configuration>
            <goals>
              <goal>run</goal>
            </goals>
          </execution>
          <execution>
            <id>test-compile</id>
            <phase>test-compile</phase>
            <configuration>
              <tasks>
                <taskdef name="groovyc"
                  classname="org.codehaus.groovy.ant.Groovyc">
                  <classpath refid="maven.compile.classpath"/>
                </taskdef>
                <mkdir dir="${project.build.testOutputDirectory}"/>
                <groovyc destdir="${project.build.testOutputDirectory}"
                  srcdir="${basedir}/src/test/groovy/" listfiles="true">

```

```

        <classpath refid="maven.test.classpath" />
      </groovyc>
    </tasks>
  </configuration>
  <goals>
    <goal>run</goal>
  </goals>
</execution>
</executions>
</plugin>
</plugins>
</build>
</project>

```

This assumes you have a Maven project setup with "groovy" subfolders as peers to the java src and test subfolders. You can use the java/jar archetype to set this up then rename the java folders to groovy or keep the java folders and just create groovy peer folders. There exists, also a groovy plugin which has not been tested or used in production. After defining the build section as in the above example, you can invoke the typical Maven build phases normally. For example, "mvn test" will execute the test phase, compiling Groovy source and Groovy test source and finally executing the unit tests. If you run "mvn jar" it will execute the jar phase bundling up all of your compiled production classes into a jar after all of the unit tests pass. For more detail on Maven build phases consult the Maven2 documentation.

Embedding Groovy

This page last changed on Jan 26, 2007 by ceharris@vt.edu.

Groovy is a great language just on its own in various scenarios. It is also extremely useful in mixed Groovy/Java environments. With this in mind, Groovy has been designed to be very lightweight and easy to embed into any Java application system.

There are three main approaches for natively integrating Groovy with Java. Each of these is discussed in more detail below.

Alternatively, you can use [Bean Scripting Framework](#) to embed any scripting language into your Java code, giving you other language options if you needed them (though we can't imagine why 😊). Using BSF allows you to be more loosely coupled to your scripting language; however, native integration is more light weight and offers closer integration.

Evaluate scripts or expressions using the shell

You can evaluate any expression or script in Groovy using the [GroovyShell](#).

The GroovyShell allows you to pass in and out variables via the [Binding](#) object.

```
// call groovy expressions from Java code
Binding binding = new Binding();
binding.setVariable("foo", new Integer(2));
GroovyShell shell = new GroovyShell(binding);

Object value = shell.evaluate("println 'Hello World!'; x = 123; return foo * 10");
assert value.equals(new Integer(20));
assert binding.getVariable("x").equals(new Integer(123));
```

Dynamically loading and running Groovy code inside Java

You can use the [GroovyClassLoader](#) to load classes dynamically into a Java program and execute them (or use them) directly. The following Java code shows an example:

```
ClassLoader parent = getClass().getClassLoader();
GroovyClassLoader loader = new GroovyClassLoader(parent);
Class groovyClass = loader.parseClass(new File("src/test/groovy/script/HelloWorld.groovy"));

// let's call some method on an instance
GroovyObject groovyObject = (GroovyObject) groovyClass.newInstance();
Object[] args = {};
groovyObject.invokeMethod("run", args);
```

If you have an interface you wish to use which you implement in the Groovy script you can use it as follows:

```
GroovyClassLoader gcl = new GroovyClassLoader();
Class clazz = gcl.parseClass(myStringwithGroovyClassSource, "SomeName.groovy");
Object aScript = clazz.newInstance();
MyInterface myObject = (MyInterface) aScript;
myObject.interfaceMethod();
...
```

This works fine if the Groovy class implements the interface `MyInterface`. `myObject` can from then on be used as every other Java object implementing `MyInterface`.

One thing to remember is that the `parseClass` will try to create an object from your String `fileName`. Another way to do the `gcl.parseClass` is:

```
Class clazz = gcl.parseClass(new File("SomeName.groovy"));
```

Full Example:

```
TestInterface.java
public interface TestInterface {
    public void printIt();
}

Tester.groovy
public class Tester implements TestInterface {
    public void printIt() {
        println "this is in the test class";
    }
}

TestClass.java -- inside of a method
String fileName = "Tester.groovy";
GroovyClassLoader gcl = new GroovyClassLoader();
Class clazz = gcl.parseClass(new File(fileName));
Object aScript = clazz.newInstance();

TestInterface ifc = (TestInterface) aScript;
ifc.printIt();
```

Note that all of the error handling has been removed -- you won't be able to do this in a java class. I actually use the Interface invocation for Groovy inside of a Utility Class.

The GroovyScriptEngine

The most complete solution for people who want to embed groovy scripts into their servers and have them reloaded on modification is the `GroovyScriptEngine`. You initialize the `GroovyScriptEngine` with a set of CLASSPATH like roots that can be URLs or directory names. You can then execute any Groovy script within those roots. The GSE will also track dependencies between scripts so that if any dependent script is modified the whole tree will be recompiled and reloaded.

Additionally, each time you run a script you can pass in a `Binding` that contains properties that the script can access. Any properties set in the script will also be available in that binding after the script has run. Here is a simple example:

```
/my/groovy/script/path/hello.groovy:
```

```
output = "Hello, ${input}!"
```

```
import groovy.lang.Binding;
import groovy.util.GroovyScriptEngine;

String[] roots = new String[] { "/my/groovy/script/path" };
GroovyScriptEngine gse = new GroovyScriptEngine(roots);
Binding binding = new Binding();
binding.setVariable("input", "world");
gse.run("hello.groovy", binding);
System.out.println(binding.getVariable("output"));
```

This will print "Hello, world!".

Runtime dependencies

As well as Java 1.4 and the Groovy jar we also depend at runtime on the ASM library constituted of five jars (asm-2.2.jar, asm-attrs-2.2.jar, asm-analysis-2.2, asm-tree-2.2.jar, and asm-util-2.2.jar) plus the ANTLR library (antlr-2.7.5.jar). That's it. So just add these 7 jars to your classpath and away you go, you can happily embed Groovy into your application.

Alternatively, instead of several jars, you can use groovy-all-1.0-beta-x.jar included in the GROOVY_HOME/embeddable directory of your distribution: this jar contains both Groovy and ASM combined in a single and convenient archive, with the ASM classes in a different namespace, so conflicts with other libraries also using ASM will be avoided 😊

Influencing class loading at runtime

This page last changed on Feb 05, 2007 by [akaranta](#).

When writing a script, it may be unwieldy to call the script defining the whole classpath at the command line, e.g.

```
groovy -cp %JAXB_HOME%\bin\activation.jar;%JAXB_HOME%\bin\... myscript.groovy
```

You can go the other way - let the script itself find the jars it needs and add them to the classpath before using them. To do this, you need to

1. get the groovy rootloader

```
def loader = this.class.classLoader.rootLoader
```

2. introduce the necessary urls to groovy rootloader. Use whatever logic suits your situations to find the jars / class directories

```
def jardir = new File( System.getenv( 'JAXB_HOME' ), 'lib' )
def jars    = jardir.listFiles().findAll { it.name.endsWith('.jar') }
jars.each { loader.addURL(it.toURI().toURL()) }
```

3. Load the classes you need:

```
// in a script run from command line this is ok:
JAXBContext = Class.forName( 'javax.xml.bind.JAXBContext' )
Marshaller  = Class.forName( 'javax.xml.bind.Marshaller' )

// if the groovy script / class is loaded from a java app, then the above may fail as it uses
the same classloader to load the class as the containing script / class was loaded by. In that
case, this should work:

JAXBContext = Class.forName( 'javax.xml.bind.JAXBContext', true, loader )
Marshaller  = Class.forName( 'javax.xml.bind.Marshaller', true, loader )
```

4. To instantiate the classes, use the newInstance method:

```
def jaxbContext = JAXBContext.newInstance( MyDataClass )
```

Note that newInstance is on steroids when called from groovy. In addition to being able to call the parameterless constructor (as w/ Java's Class.newInstance()), you can give any parameters to invoke any constructor, e.g.

```
def i = MyClass.newInstance( "Foo", 12 ) // invokes the constructor w/ String and int as params
```

You can also pass a map to initialize properties, e.g.

```
def i2 = MyClass.newInstance(foo:'bar', boo:12) // creates a new instance using the
parameterless constructor and then sets property foo to 'bar' and property boo to 12
```

The downside of using this approach is that you can't inherit from the classes you load this way - classes inherited from need to be known before the script starts to run.

Leveraging Spring

This page last changed on Nov 28, 2006 by [paulk_asert](#).

Spring and Java

The [Spring Framework](#) is a leading full-stack Java/J2EE application framework. It is aimed primarily at Java projects and delivers significant benefits such as reducing development effort and costs while providing facilities to improve test coverage and quality.

Let's have a look at Spring in action for a Java application which prints out information about a country.

Suppose we have the following interface:

```
package spring;

public interface Country {
    long getPopulation();
    String getCapital();
}
```

And the following implementation class:

```
package spring;

public class USA implements Country {
    private final String capital;
    private final long population;

    public USA(String capital, long population) {
        this.population = population;
        this.capital = capital;
    }

    public String toString() {
        return "USA[Capital=" + capital + ", Population=" + population + "]";
    }

    public long getPopulation() {
        return population;
    }

    public String getCapital() {
        return capital;
    }
}
```

Spring supports the [Dependency Injection](#) style of coding. This style encourages classes which depend on classes like `USA` not to hard-code that dependency, e.g. no fragments of code like `'new USA(...)'` and no `'import ...USA;'`. Such a style allows us to change the concrete implementations we depend on for testing purposes or at a future point in time as our program evolves. In our example above, we might declaratively state our dependencies in a `beans.xml` file as follows:

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:lang="http://www.springframework.org/schema/lang"
```



```

    xsi:schemaLocation="
http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
http://www.springframework.org/schema/lang
http://www.springframework.org/schema/lang/spring-lang-2.0.xsd">
    <bean id="usa" class="spring.USA">
        <constructor-arg value="Washington, D.C."/>
        <constructor-arg value="298444215"/>
    </bean>
</beans>

```

In this example, the `<constructor-arg/>` element allows us to use constructor-based injection.

Having done this, we can get access to our beans through a variety of mechanisms. Normally, access to the beans is mostly transparent. In our case though, we are going to make access explicit so you can see what is going on. Our main method might look like this:

```

package spring;

import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

import java.util.Arrays;

public class SortMain {
    public static void main(String[] args) {
        try {
            ApplicationContext ctx = new ClassPathXmlApplicationContext("beans.xml");
            Country usa = (Country) ctx.getBean("usa");
            System.out.println("USA Info:\n" + usa);
        } catch (Exception e) {
            e.printStackTrace();
        }
    }
}

```

Running this results in:

```

USA Info:
USA[Capital=Washington, D.C., Population=298444215]

```

Spring and Groovy

We can extend this example and introduce Groovy in a number of ways. Firstly, we can create the following Groovy class:

```

package spring
public class Australia implements Country {
    String capital
    long population
    String toString() {
        return "Australia[Capital=" + capital + ", Population=" + population + "]"
    }
}

```

And this one too:

```
package spring
public class NewZealand extends Australia implements Country {
    String toString() {
        return "NewZealand[Capital=" + capital + ", Population=" + population + "]"
    }
}
```

So long as the first class is available on the classpath in compiled form, we can simply reference this class in our `beans.xml` file as follows:

```
...
<bean id="country1" class="spring.Australia">
    <property name="capital" value="Canberra"/>
    <property name="population" value="20264082"/>
</bean>
...
```

Alternatively, if the source file will be on the classpath, we can use:

```
...
<lang:groovy id="country3" script-source="classpath:spring/NewZealand.groovy">
    <lang:property name="capital" value="Wellington" />
    <lang:property name="population" value="4076140" />
</lang:groovy>
...
```

In these examples, the `<property/>` and `<lang:property/>` elements allows us to use setter-based injection.

Spring and Ruby

If we prefer to code in another language (with a few restrictions - see below), Spring supports other languages too, e.g.:

```
require 'java'

include_class 'spring.Country'

class Fiji < Country
    def getCapital()
        @capital
    end
    def getPopulation()
        @population
    end
    def setCapital(capital)
        @capital = capital
    end
    def setPopulation(population)
        @population = population
    end
    def to_s()
        "Fiji[Capital=" + @capital + ", Population=" + getPopulation().to_s() + "]"
    end
end
Fiji.new()
```

```

...
<lang:jruby id="country4" script-interfaces="spring.Country"
script-source="classpath:spring/Fiji.rb">
  <lang:property name="capital" value="Suva" />
  <lang:property name="population" value="905949" />
</lang:jruby>
...

```

Spring and Groovy Again

But wait there's more ...

Suppose now that we wish to sort our countries according to population size. We don't want to use Java's built-in sort mechanisms as some of them rely on our objects implementing the `Comparable` interface and we don't want that noise in our Ruby script. Instead we will use Groovy. We could simply write a `Sort` class in Groovy and reference as we have done above. This time however we are going to use an additional Spring feature and have the scripting code within our `beans.xml` file. First we define the following interface:

```

package spring;

import java.util.List;

public interface Sorter {
    List sort(Country[] unsorted);
}

```

We can then include the Groovy sort code directly into the `beans.xml` file as follows:

```

...
<lang:groovy id="sorter">
<lang:inline-script><![CDATA[
    package spring
    class CountrySorter implements Sorter {
        String order
        List sort(Country[] items) {
            List result = items.toList().sort{ p1, p2 -> p1.population <= p2.population }
            if (order == "reverse") return result.reverse() else return result
        }
    }
]]></lang:inline-script>
  <lang:property name="order" value="forward" />
</lang:groovy>
...

```

Putting it all together

We now combine all of the approaches above in a final example.

Here is the complete `beans.xml` file:

```

<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"

```

```

    xmlns:lang="http://www.springframework.org/schema/lang"
    xsi:schemaLocation="
http://www.springframework.org/schema/beans
http://www.springframework.org/schema/beans/spring-beans-2.0.xsd
http://www.springframework.org/schema/lang
http://www.springframework.org/schema/lang/spring-lang-2.0.xsd">
<bean id="country1" class="spring.Australia">
  <property name="capital" value="Canberra"/>
  <property name="population" value="20264082"/>
</bean>
<bean id="country2" class="spring.USA">
  <constructor-arg value="Washington, D.C."/>
  <constructor-arg value="298444215"/>
</bean>
<lang:groovy id="country3" script-source="classpath:spring/NewZealand.groovy">
  <lang:property name="capital" value="Wellington" />
  <lang:property name="population" value="4076140" />
</lang:groovy>
<lang:jruby id="country4" script-interfaces="spring.Country"
script-source="classpath:spring/Fiji.rb">
  <lang:property name="capital" value="Suva" />
  <lang:property name="population" value="905949" />
</lang:jruby>
<lang:groovy id="sorter">
<lang:inline-script><![CDATA[
package spring
class CountrySorter implements Sorter {
  String order
  List sort(Country[] items) {
    List result = items.toList().sort{ p1, p2 -> p1.population <= p2.population }
    if (order == "reverse") return result.reverse() else return result
  }
}
]]></lang:inline-script>
  <lang:property name="order" value="forward" />
</lang:groovy>
</beans>

```

Our Java code to use this example looks like:

```

package spring;

import java.util.Arrays;
import org.springframework.context.ApplicationContext;
import org.springframework.context.support.ClassPathXmlApplicationContext;

public class SortMain {
  public static void main(String[] args) {
    try {
      ApplicationContext ctx = new ClassPathXmlApplicationContext("beans.xml");
      Country[] countries = {
        (Country) ctx.getBean("country1"), (Country) ctx.getBean("country2"),
        (Country) ctx.getBean("country3"), (Country) ctx.getBean("country4")
      };
      Sorter sorter = (Sorter) ctx.getBean("sorter");
      System.out.println("Unsorted:\n" + Arrays.asList(countries));
      System.out.println("Sorted:\n" + sorter.sort(countries));
    } catch (Exception e) {
      e.printStackTrace();
    }
  }
}

```

And the resulting output (with a little bit of hand formatting) looks like:

```

Unsorted:
[Australia[Capital=Canberra, Population=20264082],
USA[Capital=Washington, D.C., Population=298444215],
NewZealand[Capital=Wellington, Population=4076140],
JRuby object [Fiji[Capital=Suva, Population=905949]]]

```

```
Sorted:
[JRuby object [Fiji[Capital=Suva, Population=905949]],
NewZealand[Capital=Wellington, Population=4076140],
Australia[Capital=Canberra, Population=20264082],
USA[Capital=Washington, D.C., Population=298444215]]
```

What we didn't tell you yet

- Spring supports [BeanShell](#) in addition to JRuby and Groovy
- Spring supports the concept of *refreshable* beans when using the `<lang:language/>` element so that if your bean source code changes, the bean will be reloaded (see GINA or the Spring doco for more details)
- The Groovy scripting examples in the current Spring documentation are based on an old version of Groovy, ignore the `@Property` keywords and use the latest `groovy-all-xxx.jar` instead of the jars they recommend
- The `<lang:language/>` element currently only supports setter-based injection
- Spring automatically converts between the object models of the various languages but there are some limitations (particularly with JRuby - see the next section)

Current Limitations

Currently using the Groovy language through Spring is extensively supported. Using other languages like JRuby takes a little more care. Try restricting your JRuby methods to ones which take and return simple data types, e.g. `long` and `String`. You may also find that certain operations don't work as you'd expect when working between Ruby and other languages, e.g. if you defined a `compareTo` method in our `Fiji.rb` file, it would return `long` by default rather than the `int` which Java is expecting. In addition, the `compareTo` method takes an `other` object as a parameter. Currently the wrapping of this *other* object from Java or Groovy into a Ruby object hides the original Java methods.

Further Information

- Section 11.5 of [GINA](#)
- Spring [documentation](#) for [scripting](#)

Make a builder

This page last changed on Mar 09, 2007 by [mktany2k](#).

To create a new builder like a the MarkupBuilder or AntBuilder, you have to implement in java (in groovy later too) a subclass of the groovy.util.BuilderSupport class.

The main methods to be implemnted are the following :

- protected abstract void setParent(Object parent, Object child);
- protected abstract Object createNode(Object name); // anode without parameter and closure
- protected abstract Object createNode(Object name, Object value); //a node without parameters, but with closure
- protected abstract Object createNode(Object name, Map attributes); // aNode without closure but with parameters
- protected abstract Object createNode(Object name, Map attributes, Object value); //a node with closure and parameters
- protected Object getName(String methodName)

The BuilderSupport.java class

```
package groovy.util;

import groovy.lang.Closure;
import groovy.lang.GroovyObjectSupport;

import java.util.List;
import java.util.Map;

import org.codehaus.groovy.runtime.InvokerHelper;

public abstract class BuilderSupport extends GroovyObjectSupport {

    private Object current;
    private Closure nameMappingClosure;
    private BuilderSupport proxyBuilder;

    public BuilderSupport() {
        this.proxyBuilder = this;
    }

    public BuilderSupport(BuilderSupport proxyBuilder) {
        this(null, proxyBuilder);
    }

    public BuilderSupport(Closure nameMappingClosure, BuilderSupport proxyBuilder) {
        this.nameMappingClosure = nameMappingClosure;
        this.proxyBuilder = proxyBuilder;
    }

    public Object invokeMethod(String methodName, Object args) {
        Object name = getName(methodName);
        return doInvokeMethod(methodName, name, args);
    }

    protected Object doInvokeMethod(String methodName, Object name, Object args) {
        Object node = null;
        Closure closure = null;
        List list = InvokerHelper.asList(args);

        //System.out.println("Called invokeMethod with name: " + name + " arguments: " + list);

        switch (list.size()) {
            case 0:
                break;
```

```

        case 1:
        {
            Object object = list.get(0);
            if (object instanceof Map) {
                node = proxyBuilder.createNode(name, (Map) object);
            } else if (object instanceof Closure) {
                closure = (Closure) object;
                node = proxyBuilder.createNode(name);
            } else {
                node = proxyBuilder.createNode(name, object);
            }
        }
        break;
        case 2:
        {
            Object object1 = list.get(0);
            Object object2 = list.get(1);
            if (object1 instanceof Map) {
                if (object2 instanceof Closure) {
                    closure = (Closure) object2;
                    node = proxyBuilder.createNode(name, (Map) object1);
                } else {
                    node = proxyBuilder.createNode(name, (Map) object1,
object2);
                }
            } else {
                if (object2 instanceof Closure) {
                    closure = (Closure) object2;
                    node = proxyBuilder.createNode(name, object1);
                }
            }
        }
        break;
        case 3:
        {
            Object attributes = list.get(0);
            Object value = list.get(1);
            closure = (Closure) list.get(2);
            node = proxyBuilder.createNode(name, (Map) attributes, value);
        }
        break;
    }

    if (node == null) {
        node = proxyBuilder.createNode(name);
    }

    if (current != null) {
        proxyBuilder.setParent(current, node);
    }

    if (closure != null) {
        // push new node on stack
        Object oldCurrent = current;
        current = node;

        // lets register the builder as the delegate
        setClosureDelegate(closure, node);
        closure.call();

        current = oldCurrent;
    }

    proxyBuilder.nodeCompleted(current, node);
    return node;
}

protected void setClosureDelegate(Closure closure, Object node) {
    closure.setDelegate(this);
}

protected abstract void setParent(Object parent, Object child);
protected abstract Object createNode(Object name);
protected abstract Object createNode(Object name, Object value);
protected abstract Object createNode(Object name, Map attributes);
protected abstract Object createNode(Object name, Map attributes, Object value);

```

```

protected Object getName(String methodName) {
    if (nameMappingClosure != null) {
        return nameMappingClosure.call(methodName);
    }
    return methodName;
}

protected void nodeCompleted(Object parent, Object node) {
}

protected Object getCurrent() {
    return current;
}

protected void setCurrent(Object current) {
    this.current = current;
}
}

```

The NodeBuilder example

To be able to write such a code :

```

def someBuilder = new NodeBuilder()

someBuilder.people(kind:'folks', groovy:true) {
    person(x:123, name:'James', cheese:'edam') {
        project(name:'groovy')
        project(name:'geronimo')
    }
    person(x:234, name:'bob', cheese:'cheddar') {
        project(name:'groovy')
        project(name:'drools')
    }
}

```

we need :

```

package groovy.util;

import java.util.ArrayList;
import java.util.Map;

/**
 * A helper class for creating nested trees of Node objects for
 * handling arbitrary data
 *
 * @author <a href="mailto:james@coredevelopers.net">James Strachan</a>
 * @version $Revision: 1.3 $
 */
public class NodeBuilder extends BuilderSupport {

    public static NodeBuilder newInstance() {
        return new NodeBuilder();
    }

    protected void setParent(Object parent, Object child) {
    }

    protected Object createNode(Object name) {
        return new Node(getCurrentNode(), name, new ArrayList());
    }

    protected Object createNode(Object name, Object value) {
        return new Node(getCurrentNode(), name, value);
    }

    protected Object createNode(Object name, Map attributes) {
    }
}

```



```

        return new Node(getCurrentNode(), name, attributes, new ArrayList());
    }

    protected Object createNode(Object name, Map attributes, Object value) {
        return new Node(getCurrentNode(), name, attributes, value);
    }

    protected Node getCurrentNode() {
        return (Node) getCurrent();
    }
}

```

The MarkupBuilder.java class as second example

```

package groovy.xml;

import groovy.util.BuilderSupport;
import groovy.util.IndentPrinter;

import java.io.PrintWriter;
import java.io.Writer;
import java.util.Iterator;
import java.util.Map;

/**
 * A helper class for creating XML or HTML markup
 *
 * @author <a href="mailto:james@coredevelopers.net">James Strachan</a>
 * @author Stefan Matthias Aust
 * @version $Revision: 1.8 $
 */
public class MarkupBuilder extends BuilderSupport {

    private IndentPrinter out;
    private boolean nospace;
    private int state;
    private boolean nodeIsEmpty = true;

    public MarkupBuilder() {
        this(new IndentPrinter());
    }

    public MarkupBuilder(PrintWriter writer) {
        this(new IndentPrinter(writer));
    }

    public MarkupBuilder(Writer writer) {
        this(new IndentPrinter(new PrintWriter(writer)));
    }

    public MarkupBuilder(IndentPrinter out) {
        this.out = out;
    }

    protected void setParent(Object parent, Object child) {
    }

    /**
     * public Object getProperty(String property) {
     *     if (property.equals("_")) {
     *         nospace = true;
     *         return null;
     *     } else {
     *         Object node = createNode(property);
     *         nodeCompleted(getCurrent(), node);
     *         return node;
     *     }
     * }
     */

    protected Object createNode(Object name) {
        toState(1, name);
        return name;
    }
}

```

```

    }

    protected Object createNode(Object name, Object value) {
        toState(2, name);
        out.print(">");
        out.print(value.toString());
        return name;
    }

    protected Object createNode(Object name, Map attributes, Object value) {
        toState(1, name);
        for (Iterator iter = attributes.entrySet().iterator(); iter.hasNext();) {
            Map.Entry entry = (Map.Entry) iter.next();
            out.print(" ");
            print(transformName(entry.getKey().toString()));
            out.print("=");
            print(transformValue(entry.getValue().toString()));
            out.print("");
        }
        if (value != null)
        {
            nodeIsEmpty = false;
            out.print(">" + value + "</" + name + ">");
        }
        return name;
    }

    protected Object createNode(Object name, Map attributes) {
        return createNode(name, attributes, null);
    }

    protected void nodeCompleted(Object parent, Object node) {
        toState(3, node);
        out.flush();
    }

    protected void print(Object node) {
        out.print(node == null ? "null" : node.toString());
    }

    protected Object getName(String methodName) {
        return super.getName(transformName(methodName));
    }

    protected String transformName(String name) {
        if (name.startsWith("_")) name = name.substring(1);
        return name.replace('_', '-');
    }

    protected String transformValue(String value) {
        return value.replaceAll("\\\\", "&quot;");
    }

    private void toState(int next, Object name) {
        switch (state) {
            case 0:
                switch (next) {
                    case 1:
                    case 2:
                        out.print("<");
                        print(name);
                        break;
                    case 3:
                        throw new Error();
                }
                break;
            case 1:
                switch (next) {
                    case 1:
                    case 2:
                        out.print(">");
                        if (nospace) {
                            nospace = false;
                        } else {
                            out.println();
                            out.incrementIndent();
                            out.printIndent();
                        }
                }
        }
    }

```

```

        out.print("<");
        print(name);
        break;
    case 3:
        if (nodeIsEmpty) {
            out.print(" />");
        }
        break;
    }
    break;
case 2:
    switch (next) {
        case 1:
        case 2:
            throw new Error();
        case 3:
            out.print("</");
            print(name);
            out.print(">");
            break;
    }
    break;
case 3:
    switch (next) {
        case 1:
        case 2:
            if (nospace) {
                nospace = false;
            } else {
                out.println();
                out.printIndent();
            }
            out.print("<");
            print(name);
            break;
        case 3:
            if (nospace) {
                nospace = false;
            } else {
                out.println();
                out.decrementIndent();
                out.printIndent();
            }
            out.print("</");
            print(name);
            out.print(">");
            break;
    }
    break;
}
state = next;
}
}

```

Mixed Java and Groovy Applications

This page last changed on Nov 19, 2006 by [paulk_asert](#).

This example looks at the issues surrounding a mixed Java/Groovy application. This issue only arises when there is mutual dependencies between your mixed language source files. So, if part of your system is pure Java for instance, you won't have this problem. You would just compile that part of your system first and reference the resulting class/jar file(s) from the part of your system that was written in Groovy.

The legacy version of our application

Suppose you have an initial application written in Java. It deals with packages sent through the post. It has the following `Postpack` class (you would typically need some additional fields but we have simplified our domain to keep the example simple):

```
package v1;

public class Postpack implements Comparable {
    private final int weight;
    private final int zip;

    public int getWeight() {
        return weight;
    }

    public int getZip() {
        return zip;
    }

    public String toString() {
        return "Postpack[Weight=" + weight + ", Zip=" + zip + "]";
    }

    public int compareTo(Object o) {
        Postpack other = (Postpack) o;
        return zip - other.getZip();
    }

    public Postpack(int weight, int zip) {
        this.weight = weight;
        this.zip = zip;
    }
}
```

Now suppose you also have a sort helper class `ZipSorter` as follows:

```
package v1;

import java.util.List;
import java.util.Collections;

public class ZipSorter {
    public List sort(List items) {
        Collections.sort(items);
        return items;
    }
}
```

Finally, you have a main application as follows:

```

package v1;

import java.util.Arrays;

public class SortMain {
    private static Postpack[] packs = { new Postpack(60, 12345),
                                         new Postpack(55, 98765),
                                         new Postpack(50, 54321) };

    private static ZipSorter sorter = new ZipSorter();
    public static void main(String[] args) {
        System.out.println("Sorted=" + sorter.sort(Arrays.asList(packs)));
    }
}

```

A futile attempt at a quick hack

We have been asked to make a version 2 of our application which supports not only `Postpack` objects but also `Box` objects. We must also support the ability to sort by weight as well as Zip. We have been given incredibly short time scales to develop the application, so we decide to write all of the new functionality using Groovy.

We start by creating a Groovy `Box` class and make it behave in the way `ZipSorter` is expecting, e.g. we make it implement `Comparable` even though this wouldn't be needed if everything was going to be in Groovy. We then modify `ZipSorter` to know about `Box`. We then create `WeightSorter` and write it to know about both `Postpack` and `Box`.

To simplify development (we think) we create separate `groovy` and `java` source directories. We develop our files incrementally in our IDE and everything works fine. We think we are finished, so we do a rebuild all for our project. All of a sudden the project won't compile. We dive out to `ant` and use the `javac` and `groovyc` tasks to put compile our separated source directories. Still no luck. What happened?

We inadvertently introduced a cyclic dependency into our codebase and we only got away with it originally because the incremental development style we were using hid away the problem. The issue is that IDEs and current build systems like `Ant` use different compilers for Java and Groovy. So while Java and Groovy are the same at the bytecode level, their respective compilers know nothing about the source code of the other language. (Recent discussions have begun about how to eventually remove this separation).

Our hack failed because if we run `javac` first, `ZipSorter` won't have the `Box` class available because it is written in Groovy. If we run `groovyc` first, `WeightSorter` doesn't have the `Postpack` class because it is written in Java. Similarly, if using our IDE, we will face the same deadly embrace problem.

A proper version 2 of our application

The way we get around this problem is to define some common interfaces as follows:

```

package v2;

public interface Parcel {
    int getWeight();
    int getZip();
}

```

```

package v2;

import java.util.List;

public interface Sorter {
    List sort(Parcel[] unsorted);
}

```

Now we write our Java and Groovy parts of the system being careful to refer only to the interfaces, e.g. the Java files would become:

```

package v2;

public class Postpack implements Parcel, Comparable {
    private final int weight;
    private final int zip;

    public int getWeight() {
        return weight;
    }

    public int getZip() {
        return zip;
    }

    public String toString() {
        return "Postpack[Weight=" + weight + ", Zip=" + zip + "]";
    }

    public Postpack(int weight, int zip) {
        this.weight = weight;
        this.zip = zip;
    }

    public int compareTo(Object o) {
        Parcel other = (Parcel) o;
        return zip - other.getZip();
    }
}

```

```

package v2;

import java.util.List;
import java.util.Arrays;

public class ZipSorter implements Sorter {
    public List sort(Parcel[] items) {
        Arrays.sort(items);
        return Arrays.asList(items);
    }
}

```

And the Groovy ones look like:

```

package v2
public class Box implements Parcel, Comparable {
    int weight
    int zip
    String toString() {
        return "Box[Weight=" + weight + ", Zip=" + zip + "]"
    }
    int compareTo(other) { return zip - other.zip }
}

```

```

package v2
public class WeightSorter implements Sorter {
    List sort(Parcel[] items) {
        items.toList().sort{ p1, p2 -> p1.weight <=> p2.weight }
    }
}

```

Finally, our main method looks like:

```

package v2;

import java.util.Arrays;

public class SortMain {
    private static Box box1 = new Box();
    private static Parcel[] packs = { new Postpack(60, 12345), box1,
                                       new Postpack(50, 54321) };
    private static Sorter zipSorter = new ZipSorter();
    private static Sorter weightSorter = new WeightSorter();
    public static void main(String[] args) {
        box1.setWeight(55);
        box1.setZip(99999);
        System.out.println("Unsorted:      " + Arrays.asList(packs));
        System.out.println("Sorted by weight: " + weightSorter.sort(packs));
        System.out.println("Sorted by zip:   " + zipSorter.sort(packs));
    }
}

```

We need to compile the interfaces first, then we can compile the Groovy or Java files (excluding `SortMain`) in either order. Finally we compile `SortMain` as it is the class that knows about the concrete implementations. If we were using dependency injection or our own factory methods we could have reduced or eliminated the need to treat `SortMain` as a special case, e.g. using Spring we could have the concrete classes listed in an external `beans.xml` file and `SortMain` whether it was written in Java or Groovy could have been compiled along with all the other files written in its language.

Now when we run the program we get the following output:

```

Unsorted:      [Postpack[Weight=60, Zip=12345], Box[Weight=55, Zip=99999],
Postpack[Weight=50, Zip=54321]]
Sorted by weight: [Postpack[Weight=50, Zip=54321], Box[Weight=55, Zip=99999],
Postpack[Weight=60, Zip=12345]]
Sorted by zip:   [Postpack[Weight=60, Zip=12345], Postpack[Weight=50, Zip=54321],
Box[Weight=55, Zip=99999]]

```

For more details, see chapter 11 of [GINA](#).

Security

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Groovy is integrated with the Java security model. Groovy scripts can be compiled and executed in the presence of a `SecurityManager` and a `Policy` that dictates what permissions are granted to the script.

In a typical java environment, permissions are granted to code according to its **codeSource**. A `codeSource` consists of a **codebase** (essentially, the URL the code was loaded from by the class loader) and optionally the certificates used to verify the code (when it is obtained from a signed jar file). Since groovy can produce java `.class` files which can be loaded by existing secure class loaders (e.g. `URLClassLoader`), the traditional mechanisms can be used to enforce security policies without doing anything special. Setting up and running java security can be a little tricky, so consider the following resources for more information:

- [Java Security Tutorial](#)
- [Java Application Security](#)
- [Permissions in the Java 2 SDK](#)
- [Java 1.4 Security](#)
- [Java Security, 2nd Edition – O'Reilly](#)

The last of these is a book which covers the Java security model in detail.

In a typical groovy environment, there are additional considerations – often groovy scripts are loaded dynamically from some filesystem and translated *on the fly* into java class files. In other cases, groovy scripts may be entered via an interactive shell, or retrieved from a database for dynamic translation.

Filesystem based Groovy scripts

In the case where the script is read from the filesystem, groovy uses a custom class loader [GroovyClassLoader](#) that searches the `CLASSPATH` for `.groovy` files and gives them a `codeSource` constructed from a `codebase` built from the source file URL. This class loader also supports signed `.jar` files containing `.groovy` scripts so that both `codebase` and certificates can be used to verify the source code. Once the groovy scripts are loaded as classes, they behave just like java classes with respect to security.

Non-URL based Groovy scripts

In the case where the script has no URL, there is not necessarily any definitive way for groovy to associate an appropriate `codeSource` with the script. In these cases, groovy allows a `codebase` to be specified for the script that is being compiled (by specifying a [GroovyCodeSource](#)), subject to the caller having permission to specify that specific `codebase`. This `codebase` takes the form of a URL, but need not refer to a physical file location.

To illustrate this more clearly, consider the case where some server system is responsible for fetching and loading scripts that will be executed on behalf of a client. Assume that the server is trusted (i.e. it has permission to do anything) while the client belongs to a class of restricted clients that only (for example) have permission to access the normally restricted property `"file.encoding"`. For this simple

example, assume that the security Policy in effect has been specified by the following policy file:

```
Unable to find source-code formatter for language: policy. Available languages are:
actionscrip, html, java, javascript, none, sql, xhtml, xml
```

```
grant codeBase "file:${server.home}/classes/-" {
    permission java.security.AllPermission;
};

grant codeBase "file:/serverCodeBase/restrictedClient" {
    permission java.util.PropertyPermission "file.encoding", "read";
};
```

The groovy script to be executed on behalf of the client is:

```
Unable to find source-code formatter for language: groovysecurity. Available languages
are: actionscrip, html, java, javascript, none, sql, xhtml, xml
```

```
//Do some work... then access the file.encoding property:
fileEncoding = System.getProperty("file.encoding");
```

When the client calls the server and passes this script for execution, the server can evaluate it, specifying a specific codebase:

```
Unable to find source-code formatter for language: groovysecurity. Available languages
are: actionscrip, html, java, javascript, none, sql, xhtml, xml
```

```
new GroovyShell().evaluate(new GroovyCodeSource(clientscriptStr, "RestrictedScript",
"/serverCodeBase/restrictedClient")
```

In order for the server to be able to create a `GroovyCodeSource` with a specific codeBase, it must be granted permission by the Policy. The specific permission required is a [GroovyCodeSourcePermission](#), which the server has by implication (the policy file grant of `java.security.AllPermission`).

The net effect of this is to compile the client script with the codeBase `"/serverCodeBase/restrictedClient"`, and execute the compiled script. When executed, the policy file grant(s) for the codeBase `"/serverCodeBase/restrictedClient"` will be in effect.

Additional information

For more information, check out the security test cases in the groovy source code distribution. These tests specify a custom policy file `groovy.policy`, which is located in the security directory under the groovy-core CVS module. The class `SecurityTestSupport` (located at `src/test/groovy/security`) activates this policy by specifying it in the system property `"java.security.policy"`. Examining this policy file along with the test cases should detail the concepts discussed here.

Note that in a typical application environment, the policy would be located and activated either by using the default lookup mechanism (policy.url.<n> setting in `JAVA_HOME/jre/lib/security/java.security`) or as a VM argument: `-Djava.security.policy=/my/policy/file`.

Writing Domain-Specific Languages

This page last changed on Apr 20, 2007 by [bherrmann7](#).

Tutorial on DSLs

Guillaume Laforge and John Wilson presented a [tutorial on Groovy DSLs](#) at the QCon 2007 conference in London.

Groovy features enabling DSLs

Groovy is particularly well suited for writing a DSL: [Domain-Specific Language](#). A DSL is a mini-language aiming at representing constructs for a given domain. Groovy provides various features to let you easily embed DSLs in your Groovy code:

- the [builder](#) concept lets you write tree structured languages
- you can add new methods and properties on arbitrary classes through categories or custom metaclasses, even numbers: 3.euros, 5.days, etc
- most [operators can be overloaded](#): 5.days + 6.hours, myAccount += 400.euros
- passing maps to methods makes your code look like methods have named parameters: move(x: 500.meters, y: 1.kilometer)
- you can also create your own control structures by passing [closures](#) as the last argument of a method call: ifOnce(condition)
{ ... }; inTransaction { ... }
- it is also possible to add dynamic methods or properties (methods or properties which don't really exist but that can be intercepted and acted upon) by implementing [GroovyObject](#) or creating a custom [MetaClass](#)

Guillaume Laforge gave some [thoughts and examples](#) on that topic on his blog. John Wilson has implemented a DSL in his [Google Data Support](#) to make operations on dates easier.

Inspired by an article from Bruce Tate [IBMs Alphaworks](#) a couple of samples were written in groovy.

- [Chris vanBuskirk](#) uses arrays and maps to model the injection of the state transitions.
- [Edward Sumerfield](#) uses closures to inject the state transitions.

Inspired by [RSpec](#) (and also by random episodes of Family Guy) [an example](#) of a unit testing DSL using Groovy

- [Clifton Craig](#) uses Builders in Groovy to create [GSpec](#).

When Groovy's not enough

If you have the need to write your own language completely, consider using a compiler compiler. There are many to choose from, e.g. Antlr, JavaCC, SableCC, Coco/R, Cup/JLex/JFl/ex, BYacc/J, Beaver, etc. See [wikipedia](#) for an interesting list. Some of these can even benefit from Groovy. Here is a groovy

example for [JParsec](#).

Developer Guide

This page last changed on Dec 15, 2006 by [mittie](#).

The developer guide contains information mainly of interest to the developers involved in creating Groovy and its supporting modules and tools:

- [From source code to bytecode](#)
- [Groovy Backstage](#)
 - [Groovy Method Invokation](#)
- [Groovy Internals](#)
- [Ivy](#)
- [Setup Groovy development environment](#)

- [JavaDoc](#)
- [Continuous Integration](#)

From source code to bytecode

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Here are some tips on how to debug what is happening on the transition from groovy source code into the generated bytecode.

artifact	transformation	artifact
source (Hello.groovy)	- GroovyLexer ->	antlr tokens
antlr tokens	- GroovyRecognizer ->	antlr ast
antlr ast	- AntlrParserPlugin ->	groovy ast
groovy ast	- AsmClassGenerator->	bytecode (Hello.class)

Note1 [groovy.g](#) is used to generate [GroovyLexer](#) and [GroovyRecognizer](#)

Note2 [GroovyRecognizer](#) is sometimes easier to understand in its [syntax diagram](#) form

Note3 [AntlrParserPlugin](#) source available.

Example

For these examples let's assume the file [Hello.groovy](#) contains

```
class Hello {
    static void main(args) {
        println "hello world"
    }
}
```

GroovyLexer (viewing Antlr Tokens)

To view the antlr tokens that the source code has been broken into you need to do the following in groovy-core subdirectory

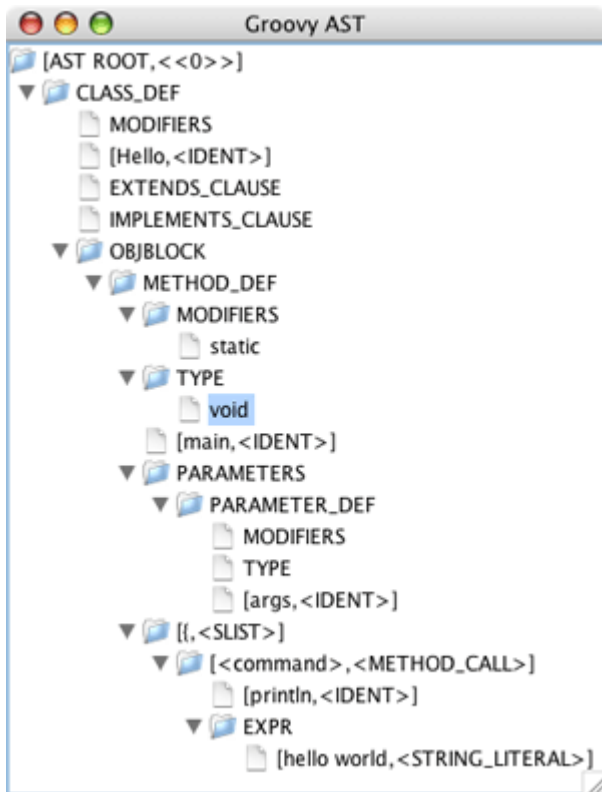
```
java -cp
target/install/embeddable/groovy-all-1.0-jsr-01-SNAPSHOT.jar
:target/install/lib/antlr-2.7.5.jar
org.codehaus.groovy.antlr.LexerFrame
```



GroovyRecognizer (viewing Antlr AST)

To view the antlr AST that the recognized tokens have built

```
java -cp  
    target/install/embeddable/groovy-all-1.0-jsr-01-SNAPSHOT.jar  
    :target/install/lib/antlr-2.7.5.jar  
    org.codehaus.groovy.antlr.Main  
    -showtree Hello.groovy
```



AntlrParserPlugin (viewing Groovy AST)

To view the Groovy AST that is one step closer to the generated bytecode you can generate [Hello.groovy.xml](#) using these unix commands.

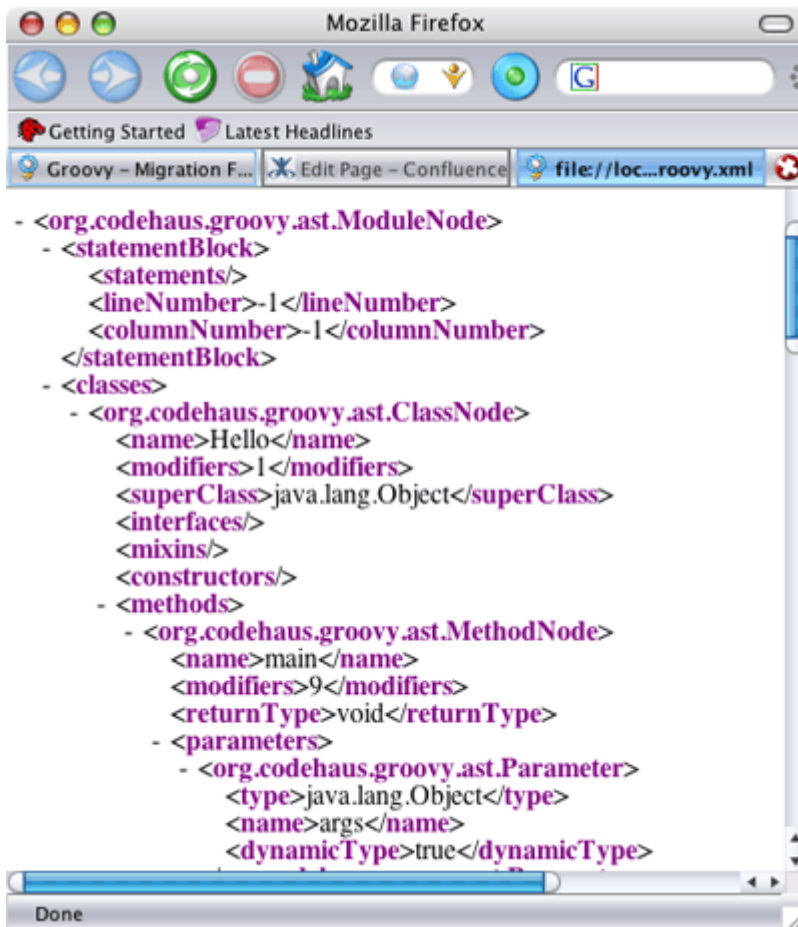
This can be generated using both classic and jsr parsers, by changing the **groovy.jsr** system property. By doing this we can diff the generated Groovy AST artifacts for debugging and migration purposes.

jsr parser

```
$ export JAVA_OPTS="-Dgroovy.ast=xml -Dgroovy.jsr=true"
$ groovyc Hello.groovy
Written AST to Hello.groovy.xml
```

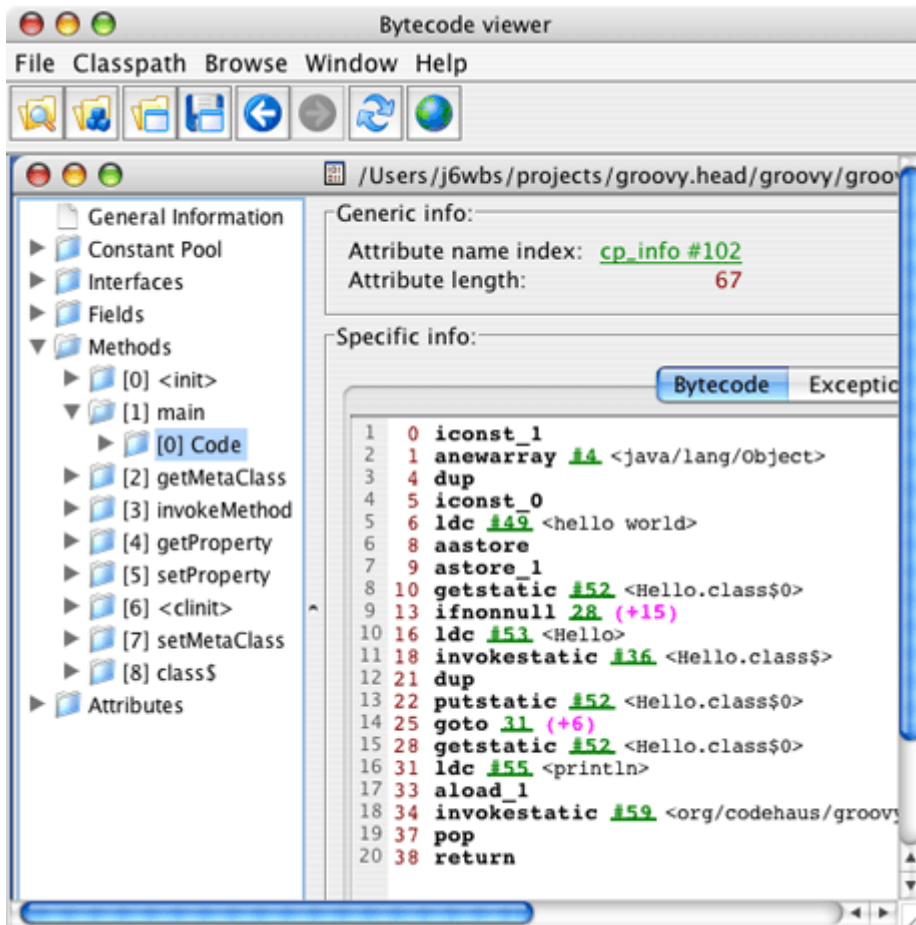
classic parser

```
$ export JAVA_OPTS="-Dgroovy.ast=xml -Dgroovy.jsr=false"
$ groovyc Hello.groovy
Written AST to Hello.groovy.xml
```



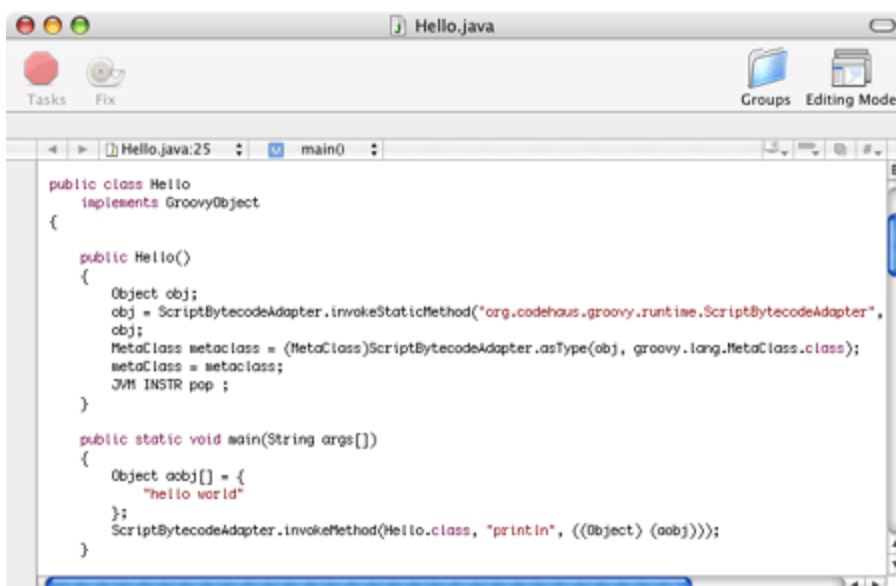
Viewing Bytecode

One interesting bytecode viewer is [jclasslib](#) which renders [Hello.class](#) in this manner...



Decompiling bytecode back to Java

If, however, you are bamboozled by bytecode... The easiest to grok mechanism for reading the compiled code is to use a tool like [JAD](#) to decompile the [Hello.class](#) into a readable [Hello.java](#)



How Groovy works behind the scenes

With your Groovy scripts, you have multiple options on how to use them:

- run groovyc on them to create Java *.class files
- evaluate the script at runtime (either from a file or from a Java String)
- make your script available as Java Class-objects through the GroovyClassLoader (no *.class files generated!)

*No *.java source files are ever generated.*

All the above may seem like magic and it somehow is: the magic of imaginative, mindful software engineering.

Everything starts with the Groovy grammar.

There is the notion of the 'new' and the 'old' parser. Only the new one (as of Feb.05) is described here.

The Groovy grammar is written in terms of an ANTLR (= *ANother Tool for Language Recognition*) grammar. The tool can handle grammars of type LL(k), where the Java grammar is of type LL(2) and Groovy is of type LL(3).

The difference is in the number of tokens that the parser needs to look ahead for recognizing e.g. "==" (2 tokens for Java) or "===" (3 tokens for Groovy). To be more correct, the problem is in recognizing the first "=" character. The parser needs to "look ahead" to derive its meaning.

ANTLR formulates the grammar in terms of "rules" that fully implement EBNF (Extended Backus-Naur Form) enriched with Java code blocks, special functions and some other things.

With the recognition of a rule, actions can be triggered that come as usual Java code. ANTLR dumps out Javacode representing a parser capable to recognize the given grammar. And this parser executes the embedded code blocks from the grammar - the "action".

Parser Generation and AST

ANTLR takes the Groovy grammar file "Groovy.g" to create the Groovy parser.

When the parser is fed with the source code of a Groovy script, it produces the AST (= *Abstract Syntax Tree*) that represents that code as a run-time structure.

Byte Code Generation

From the AST, it is possible to create Java Byte Code: either for making it persistent as *.class files or for making it directly available as Class objects through the GroovyClassLoader.

This ClassGeneration is done with the help of objectweb's ASM tool. (The ASM name does not mean anything: it is just a reference to the "asm" keyword in C, which allows some functions to be implemented in assembly language.)

ASM provides a Java API to construct or modify Byte Code on a given AST.

The API for bytecode generation heavily relies on the Visitor Pattern. The main entry point for the class generation is `org.org.codehaus.groovy.classgen.AsmClassGenerator.java`.

It is a large class. There are `visitXYExpression` methods called when converting the AST to bytecode. For example `visitArrayExpression` is called when creating arrays in bytecode.

More Links on the topic

[Groovy Method Invokation](#)

Tools:

- <http://wwwantlr.org/>
- <http://asm.objectweb.org/>

General:

- <http://compilers.iecc.com/comparch/article/99-02-109>
- http://en.wikipedia.org/wiki/Category:Parsing_algorithms
- <http://lambda.uta.edu/cse5317/spring02/notes/notes.html>

Groovy Method Invokation

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Where it all starts

Say you have a Groovy code like

```
println 'hi'
```

As explained in [Groovy Backstage](#), there is bytecode generated to achieve the desired behaviour of printing to stdout.

The easiest way of looking at the generated bytecode is to groovyc your Groovy source to a class file and process it with a Java Decompiler (e.g. JAD).

see also: [From source code to bytecode](#)

The resulting code looks as follows (only the relevant snippet):

```
...
Object aobj[] = { "hi" };
ScriptBytecodeAdapter.invokeMethod(this, "println", ((Object) (aobj)));
...
```

Invokation scheme

There is a delegation scheme like

- `ScriptBytecodeAdapter.invokeMethod(...)` (static method)
 - `InvokerHelper.invokeMethod(...)` (static method)
 - `Invoker.invokeMethod(...)` (instance method called on `InvokerHelper`'s single instance)

MetaClass and MetaClassRegistry

Invoker calls `invokeMethod(...)` on the **MetaClass** of our class (with exceptions, see below). It finds this **MetaClass** by looking it up in the **MetaClassRegistry**.

The Invoker holds a single instance of this registry.



When working with the **MetaClassRegistry**, `InvokerHelper.getInstance().getMetaRegistry()` is the only instance, you should ever use.

Exceptions (when `MetaClass.invokeMethod(...)` is not used):

- for Closures, `Closure.invoke(...)` is used

- for GroovyObjects *obj* of type `GroovyInterceptable`,
`obj.invokeMethod(methodName,asArray(arguments))` is called
- for any other GroovyObject *obj* when method invocation through its `MetaClass` fails,
`obj.invokeMethod(methodName,asArray(arguments))` is called

`MetaClass.invokeMethod(...)` finally cares for the invocation, either by reflection or by dynamic bytecode generation.

Dynamic bytecode generation is supposed to be faster. For a class `MyClass` it generates `gjdk.groovy.lang.MyClass_GroovyReflector` with an `invoke` method.

Does `MyClass_GroovyReflector` contain methods according to `MyClass.groovy` that can be called directly



The cool thing about `MetaClass` is that you can dynamically add or remove methods to it. One can even replace the whole `MetaClass` in the `MetaClassRegistry`. See `ProxyMetaClass` for an example.

back to [Groovy Backstage](#)

Groovy Internals

This page last changed on May 30, 2006 by [paulk_asert](#).

This page is work in progress. It will document the internals of groovy, the ideas and the techniques used so other developers may it have more easy to contribute to groovy in the future.

Parser

Package Layout

Bytecode Hints

ClassLoader Structure

One Class One Class Loader

When are two classes the same? If the name is equal and if the class loader is equal. This means you can have multiple versions of the same class if you load the class through different class loaders. Of course this versions don't really have to be the same. This also means if you have code like

```
Class cls = foo.class
assert cls.name==Foo.class.name
assert cls==Foo.class
```

may fail because cls is not Foo. This also means calling a method like

```
def f(Foo f){
    println "f(Foo) called"
}

def f(Object o){
    println "f(Object) called"
}
```

with an Foo does not mean that "f(Foo) called" will be printed! This is no secret, you will find it in the language specification.

Class Loading Conventions

There are small conventions about how to do class loading in Java.

1. always return the same class for the same name
2. use your cache before asking a parent loader

3. no parent loader doesn't mean the system loader
4. ask your parent loader before trying to load a class by yourself

Most of the loaders in groovy are violating one or more of these rules. I will explain why and how in the next sections

RootLoader

First let us start with the RootLoader. This one is used to start the console programs and is something like an advanced java launcher. When using Groovy embedded this loader is usually not used. The RootLoader sees itself as a root in a class loader tree. Against the convention to ask the parent before loading a class this loader tries to load it by itself first. Only when this fails the parent is asked. The parent is usually the system class loader then. This step was needed because of many problems with multiple versions of libs, causing multiple classes of the same name where they are not expected, or classes loaded from the wrong libs. Because of that reason this loader may also be used in ant or maven to avoid clashes with the classes used by ant.

GroovyClassLoader

ReflectorLoader

Ivy

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Done. Deleted the table since Ivy is supposed to generate those reports for us.

Checkout the example at and run it with Ivy installed.

svn co <http://engrm.com/svn/track/trunk/codehaus/groovy/>
ant resolve

- [Axion](#)

Notes on Xerces 2.4.0. Ant is using Xerces 2.6.2 so I'm going to simply pull that dependency, unless you want to be sure to test against the old dependency.

Posted a question at Jayasoft about [the structure of the Ant Ivy](#).

Groovy vendor track with Ivy and pure Ant build.

<http://engrm.com/svn/track/trunk/codehaus/groovy/>

Files of particular interest.

<http://engrm.com/svn/track/trunk/codehaus/groovy/groovy.build.xml>
<http://engrm.com/svn/track/trunk/codehaus/groovy/ivy.xml>
<http://engrm.com/svn/track/trunk/codehaus/groovy/ivyconf.html>

Setup Groovy development environment

This page last changed on Oct 06, 2006 by [jbaumann](#).

Steps to setup development environment for Groovy core with Eclipse and Maven

1. Install JDK 1.4.2 or above (e.g. Sun JDK 5.0 version 1.5.0_06).
 - JDK is available on <http://java.sun.com> or other sources.
 - Remember to set JAVA_HOME system variable after installation
 - (Optional) Add JAVA_HOME/bin to PATH for executing java commands
2. Install Eclipse 3.1 or above (e.g. Eclipse 3.2)
 - Eclipse is available on <http://www.eclipse.org>
 - Install a Subversion-Plugin e.g.,
 - Subclipse, the plugin provided by the subversion authors, <http://subclipse.tigris.org> (Update Site is <http://subclipse.tigris.org/update>)
 - Subversive, another plugin integrating Subversion support, <http://www.polarion.org/index.php?page=overview&project=subversive> (Update Site is <http://www.polarion.org/projects/subversive/download/1.1/update-site/>)
 - or another plugin supporting Subversion
3. Install Maven 1.0.2
 - Maven 1.0.2 is available on <http://maven.apache.org/maven-1.x/>
 - Remember to set MAVEN_HOME system variable after the installation
 - Remember to add MAVEN_HOME/bin to PATH for executing maven command
4. Extract groovy source
 - Open Eclipse installed, decide where your workspace is (will be reference later), switch to the SVN perspective. If you are not familiar with Eclipse, in menu Help -> Welcome may help you a lot.
 - Browse [SVN](#) to know SVN info
 - Create a new repository, extract groovy source (the folder groovy-core. You can extract it as project name groovy)
5. Build groovy source
 - In command line, go to the groovy project you extracted, execute "maven" in command line, make sure the build success, browse groovy/target/test-reports if you got JUnit test fails.
6. Make Eclipse Groovy project work (can be built and without error in Problem view)
 - Close Eclipse
 - execute "maven -Dmaven.eclipse.workspace=ECLIPSE_WORKSPACE eclipse:add-maven-repo". The ECLIPSE_WORKSPACE is the path of your eclipse workspace, not the project you just checked out (e.g. in MS Windows, it may be c:\eclipse\workspace). Refer to <http://maven.apache.org/maven-1.x/plugins/eclipse/goals.html> if you need further information about Maven goals for Eclipse.
 - start Eclipse and refresh the groovy project, make sure there is no errors in Problem view
7. Done!

Modules

This page last changed on Jan 13, 2007 by [paulk_asert](#).

The following modules are currently available:

- [COM Scripting](#) — allows you to script any ActiveX or COM Windows component from within your Groovy scripts
- [Gant](#) — a build tool for scripting Ant tasks using Groovy instead of XML to specify the build logic
 - [Gant_Script](#)
 - [Gant_Tasks](#)
 - [Gants_Build_Script](#)
- [Google Data Support](#) — makes using the Google Data APIs easier from within Groovy
- [Gram](#) — a simple xdoclet-like tool for processing doclet tags or Java 5 annotations
- [Groovy Jabber-RPC](#) — allows you to make XML-RPC calls using the Jabber protocol
- [Groovy Monkey](#) — is a dynamic scripting tool for the Eclipse Platform
- [Groovy SOAP](#) — allows you to create a SOAP server and/or make calls to remote SOAP servers using Groovy
- [GroovySWT](#) — a wrapper around SWT, the eclipse Standard Widget Toolkit
- [GSP](#) — means GroovyServer Pages, which is similar to JSP (JavaServer Pages)
- [GSQL](#) — supports easier access to databases using Groovy
- [Native Launcher](#) — a native program for launching groovy scripts
- [Process](#) — provides a shell-like capability for handling external processes
- [XMLRPC](#) — allows you to create a local XML-RPC server and/or to make calls on remote XML-RPC servers

- [Grails](#) — a Groovy-based web framework inspired by Ruby on Rails
- [GORM](#) — the Grails Object-Relational Mapping persistence framework
- [GroovyPlugin](#) — A Groovy plugin for JSPWiki

Introduction

Scriptom is an optional Groovy module developed by [Guillaume Laforge](#) leveraging the [Jacob library \(JAvA COM Bridge\)](#). Once installed in your Groovy installation, it allows you to script any ActiveX or COM Windows component from within your Groovy scripts. Of course, this module can be used on Windows only.

Scriptom is especially interesting if you are developing Groovy shell scripts under Windows. You can combine both Groovy code and any Java library with the platform-specific features available to Windows Scripting Host or OLE COM automation from Office.

Installation

Zip bundle

The easiest way for installing Scriptom is to unzip the [Zip bundle](#) in your **%GROOVY_HOME%** directory. The distribution contains the jacob.jar and jacob.dll, and the scriptom.jar. The DLL needs to be in the bin directory, or in your **java.library.path** to be loaded by jacob.jar.

Building from sources

If you are brave enough and prefer using the very latest fresh version from CVS Head, you can build **Scriptom** from sources. Checkout modules/scriptom, and use Maven to do the installation automatically. If your **%GROOVY_HOME%** points at the target/install directory of your groovy-core source tree, just type:

```
maven
```

Otherwise, if you have installed Groovy in a different directory, you have two possibilities, either you change the property **groovy.install.staging.dest** to your **%GROOVY_HOME%** directory in the **project.properties** file, and run maven, or you can type:

```
maven -Dgroovy.install.staging.dest=%GROOVY_HOME%
```

Usage

Let's say we want to script Internet Explorer. First, we're going to import the ActiveX proxy class.

Then, we're going to create a `GroovyObjectSupport` wrapper around the `ActiveXComponent` class of Jacob. And now, we're ready to use properties or methods from the component:

```
import org.codehaus.groovy.scriptom.ActiveXProxy

// instantiate Internet Explorer
def explorer = new ActiveXProxy("InternetExplorer.Application")

// set its properties
explorer.Visible = true
explorer.AddressBar = true

// navigate to a site by calling the Navigate() method
explorer.Navigate("http://glaforge.free.fr/weblog")
```

Note however that `explorer.Visible` returns a proxy, if you want to get the real value of that property, you will have to use the expression **`explorer.Visible.value`** or **`explorer.Visible.getValue()`**.

Limitations

For the moment, **Scriptom** is in a beta stage, so you may encounter some bugs or limitations with certain ActiveX or COM component, so don't hesitate to post bugs either in JIRA or on the mailing lists. There may be some issues with the mappings of certain objects returned by the component and the Java/Groovy counterpart.

An important limitation for the first release is that it is not yet possible to subscribe to events generated by the components you are scripting. In the next releases, I hope I will be able to let you define your own event handlers with closures, with something like:

```
import org.codehaus.groovy.scriptom.ActiveXProxy

def explorer = new ActiveXProxy("InternetExplorer.Application")
explorer.events.OnQuit = { println "Quit" }
explorer.events.listen()
```

But for the moment, event callbacks are not supported.

There is an experimental implementation currently in CVS Head, it does not work with the groovy command, but it does work when launching a script from a Java program with the `GroovyShell` object. There is perhaps a problem with Classworlds or Jacob, and the different classloaders. If anyone has a clue, I'm game!

Samples

If you checkout the **Scriptom** sources, you will find a few samples in the **src/script** directory. I will show you some samples in the following sub-sections.

Scripting Internet Explorer

```

import org.codehaus.groovy.scriptom.ActiveXProxy

// instantiate Internet Explorer
def explorer = new ActiveXProxy("InternetExplorer.Application")

// set its properties
explorer.Visible = true
explorer.AddressBar = true

// navigate to a site
explorer.Navigate("http://glaforge.free.fr/weblog")
Thread.sleep(1000)
explorer.StatusText = "Guillaume Laforge's weblog"
Thread.sleep(2000)

// quit Internet Explorer
explorer.Quit()

```

Scripting Excel

```

import org.codehaus.groovy.scriptom.ActiveXProxy

// create a proxy for Excel
def xls = new ActiveXProxy("Excel.Application")
xls.Visible = true

Thread.sleep(1000)

// get the workbooks object
def workbooks = xls.Workbooks
// add a new workbook
def workbook = workbooks.Add()

// select the active sheet
def sheet = workbook.ActiveSheet

// get a handle on two cells
a1 = sheet.Range('A1')
a2 = sheet.Range('A2')

// sets a value for A1
a1.Value = 123.456
// defines a formula in A2
a2.Formula = '=A1*2'

println "a1: ${a1.Value.value}"
println "a2: ${a2.Value.getValue()}"

// close the workbook without asking for saving the file
workbook.Close(false, null, false)
// quits excel
xls.Quit()

```

Warning: on my machine (WinXP Home), there is still an Excel.exe process running. I have no clue why Excel is still running.

Mixing VBScript or JScript with Groovy

```

import org.codehaus.groovy.scriptom.ActiveXProxy

// invoke some VBScript from Groovy and get the results!
def sc = new ActiveXProxy("ScriptControl")
sc.Language = "VBScript"
println sc.Eval("1 + 1").value

```

Scripting the Windows Shell object

```
import org.codehaus.groovy.scriptom.ActiveXProxy

// showing the current directory
def cmd = new ActiveXProxy("Scripting.FileSystemObject")
println cmd.GetAbsolutePathName(".").value

sh = new ActiveXProxy("Shell.Application")

// minimizing all opened windows
sh.MinimizeAll()

// opens an Explorer at the current location
sh.Explore(cmd.GetAbsolutePathName(".").value)

// choosing a folder from a native windows directory chooser
def folder = sh.BrowseForFolder(0, "Choose a folder", 0)
println folder.Items().Item().Path.value

def wshell = new ActiveXProxy("WScript.Shell")
// create a popup
wshell.popup("Groovy popup")

// show some key from the registry
def key = "HKEY_CURRENT_USER\\Software\\Microsoft\\Windows\\CurrentVersion\\Internet
Settings\\User Agent"
println wshell.RegRead(key).value

def net = new ActiveXProxy("WScript.Network")
// prints the computer name
println net.ComputerName.value
```

Scripting Windows Media Player

```
import org.codehaus.groovy.scriptom.ActiveXProxy
import java.io.File

// create a proxy for the Shell object
def sh = new ActiveXProxy("Shell.Application")

// use a Windows standard folder chooser
def folder = sh.BrowseForFolder(0, "Choose a folder with wav files", 0)

// get the folder chosen
def folderName = folder.Items().Item().Path.value
println "Playing Wav files from: ${folderName}"

// create a Windows Media Player (from its Class ID)
def player = new ActiveXProxy("clsid:{6BF52A52-394A-11D3-B153-00C04F79FAA6}")

// for each file in the folder
new File(folderName).eachFile{ file ->
    if (file.name.endsWith("wav")) {
        println file
        player.URL = file.absolutePath
        // play the wav for one second
        control = player.controls.play()
        Thread.sleep(1000)
    }
}

// close the player
player.close()
```

When event callbacks are supported, you will be able to subscribe to the `player.statusChange` event, so that you can play the wav entirely, before loading a new sample (instead of listening only to the first

second of each sample).

Converting a Word document into HTML

This program takes a Word document as first parameter, and generate an HTML file with the same name, but with the .html extension.

```
import org.codehaus.groovy.scriptom.ActiveXProxy
import java.io.File

def word = new ActiveXProxy("Word.Application")

word.Documents.Open(new File(args[0]).canonicalPath)
word.ActiveDocument.SaveAs(new File(args[0] - ".doc" + ".html").canonicalPath, 8)
word.Quit()
```

Printing the contents of your Outlook Inbox

```
import org.codehaus.groovy.scriptom.ActiveXProxy

def outlook = new ActiveXProxy("Outlook.Application")
def namespace = outlook.GetNamespace("MAPI") // There is only "MAPI"

// 6 == Inbox; other values in Outlook's VBA documentation
def inbox = namespace.GetDefaultFolder(6)
def mails = inbox.Items

println "Elements in your Inbox: " + mails.Count.value

for (i in 1..mails.Count.value) {
    def mail = mails.Item(i)
    println i + ": " + mail.Subject.value + " (" + mail.Size.value + " bytes)"
}
```


Gant

This page last changed on Mar 07, 2007 by [russel](#).

Gant is a build tool for scripting Ant tasks using Groovy instead of XML to specify the build logic: A Gant build specification is just a Groovy script and so can bring all the power of Groovy to bear directly, something not possible with Ant scripts. Whilst it might be seen as a competitor to Ant, Gant relies on all the Ant tasks for actually doing things, so it is really an alternative way of doing builds using Ant, but using a programming language rather than XML to specify the build rules.

Here is an example Gant script:

```
includeTargets << gant.targets.Clean
cleanPattern << [ '**/*~' , '**/*.bak' ]
cleanDirectory << 'build'

task ( 'default' : 'The default target.' ) {
    println ( 'Default' )
    depends ( clean )
    Ant.echo ( message : 'A default message from Ant.' )
    otherStuff ( )
}

task ( otherStuff : 'Other stuff' ) {
    println ( 'OtherStuff' )
    Ant.echo ( message : 'Another message from Ant.' )
    clean ( )
}
```

In this script there are two targets, default and otherStuff -- the target default is the what is run when Gant is executed from the command line with no target as parameter.

Tasks are closures so they can be called as functions, in which case they are executed as you expect, or they can be dependencies to other tasks by being parameters to the depends function, in which case they are executed if and only if they have not been executed already in this run. (There is a page with some more information on [Tasks](#).)

You may be wondering about the stuff at the beginning of the script. Gant has two ways of using pre-built sub-scripts, either textual inclusion of another Gant script or the inclusion of a pre-compiled class. The example here shows the latter -- the class gant.targets.Clean is a class that provides simple clean capabilities.

The default name for the Gant script is build.gant, in the same way that the default for an Ant build script is build.xml.

Gant provides a way of finding what the documented targets are:

```
|> gant -T
gant clean -- Action the cleaning.
gant clobber -- Action the clobbering. Does the cleaning first.
gant default -- The default target.
gant otherStuff -- Other stuff
|>
```

The messages on this output are exactly the strings associated with the task name in the introduction to the task.

Currently Gant builds and installs itself in an existing Groovy installation and is being used by me for various build tasks including building static websites. The ability to have arbitrary Groovy methods within the build scripts makes a Gant build script so much easier to work with than the mix of XML and Groovy scripts that using Ant necessitates. But then maybe this is an issue of individual perception. But then Gant is not about replacing Ant, it is about having a different way of working with the tasks and infrastructure that Ant provides.

Some pages providing more details:

[Gant Scripts](#)
[Gant's Build Script](#)
[Tasks](#)

Gant is currently in version 0.2.4, it requires Groovy version 1.0 or later. The following downloads are available:

	Binary Distribution	SourceDistribution
Tarball	gant-0.2.4.tgz	gant_src-0.2.4.tgz
Zip File	gant-0.2.4.zip	gant_src-0.2.4.zip

Gant version 0.2.2 is required with Groovy RC-1:

	Binary Distribution	SourceDistribution
Tarball	gant-0.2.2.tgz	gant_src-0.2.2.tgz
Zip File	gant-0.2.2.zip	gant_src-0.2.2.zip

There is a file README_Install.txt in the distribution.

NB Gant cannot be used with versions of Groovy prior to RC-1. If you are using Groovy RC-1 then you need use Gant 0.2.2, but note that Gant 0.2.2 only works with Groovy RC-1. If you are using a Groovy version later than RC-1, you need to be using Gant 0.2.3 or later. Most installations should be Groovy 1.0 or later and Gant 0.2.4 or later

If you would prefer to work with the version in the Groovy Subversion repository, you can get a copy by:

```
svn co http://svn.codehaus.org/groovy/trunk/groovy/modules/gant
```

This requires Groovy 1.0 or later to be used.

Obviously the first time you install Gant there is no Gant to build and install Gant. For people using the Subversion checkout there is an Ant build script to allow the bootstrapping.

If you give it a go and have some feedback, do let me know either on the Groovy User mailing list or by direct email to me russel@russel.org.uk

BTW Gant is not a toy, it is used for task management in [Grails](#)! In fact there is a very nice [page on the Grails site](#) showing how Gant scripts can be used in Grails.

Russel Winder

Gant_Script

This page last changed on Jan 24, 2007 by [gerrit](#).

A Gant script is a Groovy script that contains task definitions, calls to a pre-defined AntBuilder, and operations on some other predefined objects. The two main pre-defined objects are called `includeTargets` and `includeTool`. `includeTargets` is for including tasks defined in other Gant scripts or appropriately constructed classes. `includeTool` is for including classes that provide services for use in a Gant file. The following script shows some examples:

```
Ant.property ( environment : 'environment' )
Ant.taskdef ( name : 'groovyc' , classname : 'org.codehaus.groovy.ant.Groovyc' )
includeTargets << org.codehaus.groovy.gant.targets.Clean
cleanPattern << '**/*~'
includeTool << org.codehaus.groovy.gant.targets.Ivy
```

In this case we include tasks from a pre-compiled class called `Clean`. This defined an object `cleanPattern` that we can add new patterns to. As well as classes we can use files:

```
includeTargets << new File ( 'source/org/codehaus/groovy/gant/targets/clean.gant' )
```

It is also possible to use string literals for the situation where task definitions will be constructed programmatically.

As an example, if we have a directory with a source code sub-directory containing Java and Groovy source that needs compiling then we might have the Gant script:

```
sourceDirectory = 'source'
buildDirectory = 'build'
includeTargets << org.codehaus.groovy.gant.targets.Clean
cleanPattern << '**/*~'
cleanDirectory << buildDirectory
Ant.taskdef ( name : 'groovyc' , classname : 'org.codehaus.groovy.ant.Groovyc' )
task ( compile : 'Compile source to build directory.' ) {
    Ant.javac ( srcdir : sourceDirectory , destdir : buildDirectory , debug : 'on' )
    Ant.groovyc ( srcdir : sourceDirectory , destdir : buildDirectory )
}
```

Now from the command line we can issue the command "gant compile" or "gant clean". If we want a default target then we have to specify what it is by defining the task 'default':

```
task ( 'default' : 'Default task is compile.' ) { compile ( ) }
```

NB we have to explicitly make the name a string to avoid the compiler thinking it is the default keyword.

Gant_Tasks

This page last changed on Oct 24, 2006 by [russel](#).

A Gant task is a Groovy code sequence that has a name and an associate description:

task (*task-name* : *task-description*) *task-closure*

So for example:

```
task ( flob : 'Some message or other.' ) {  
    print ( 'Some message.' )  
}
```

Any legal Groovy string can be used as the *task-name* but if it a Groovy keyword then it must be explicitly a string. So the default task must have the name 'default' so that the Groovy compiler does not try and interpret the name of the task as the default keyword.

The *task-description* string is used as the string to output when executing "gant -T" to discover the the list of allowed command-line targets. The string must always be present but, if it is the empty string, the task will not be treated as a target callable from the command line, and so will not appear in the target listing. Only tasks with non-empty descriptions are treated as targets.

The *task-closure* can contain any legal Groovy code. An AntBuilder is pre-defined and is called Ant, so calls can be made to any Ant task:

```
task ( flob : 'Some message or other.' ) {  
    Ant.echo ( message : 'Some message.' )  
}
```

The usual rules associated with working with an AntBuilder apply.

As each task labels a closure then tasks can be called from other tasks:

```
task ( adob : 'A task called adob.' ) {  
    flob ( )  
}
```

Task flob is called as part of task adob. This allows a lot of dependency information to be expressed. However, the calls are always made, there is no implicit checking whether a task has already been executed. Instead there is a method depends that can be used to handle the situation where a task should only be called if it has not been executed already in this run.

```
task ( adob : 'A task called adob.' ) {  
    depends ( flob )  
}
```

The depends method is an executable method so it can be called at any time in a task closure. This allows for a much more flexible expression of dependency than specifying dependencies as a property of

the task (as is done in Ant for example).

Gants_Build_Script

This page last changed on Mar 03, 2007 by [russel](#).

As an example of a working Gant script this is the Gant script that is Gant's own Gant script as at 2007-03-03 17:55:13. If you find any errors in inefficiencies, do let me know.

```
// Gant -- A Groovy build tool based on scripting Ant tasks
//
// Copyright © 2006-7 Russel Winder <russel@russel.org.uk>
//
// Licensed under the Apache License, Version 2.0 (the "License"); you may not use this file
except in
// compliance with the License. You may obtain a copy of the License at
//
// http://www.apache.org/licenses/LICENSE-2.0
//
// Unless required by applicable law or agreed to in writing, software distributed under the
License is
// distributed on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either
express or
// implied. See the License for the specific language governing permissions and limitations
under the
// License.
//
// Author : Russel Winder
// $Revision: 5372 $
// $Date: 2007-03-03 17:55:13 +0000 (Sat, 03 Mar 2007) $

Ant.property ( file : 'build.properties' )
Ant.property ( file : 'local.build.properties' )

gantVersion = Ant.project.properties.gantVersion

installationHome = System.getenv ( ).'GROOVY_HOME'
try { if ( grailsBuild ) { installationHome = System.getenv ( ).'GRAILS_HOME' } }
catch ( MissingPropertyException mpe ) { grailsBuild = false }

if ( ( installationHome == null ) || ( installationHome == '' ) ) {
    println ( 'Must set environment variable ' + ( grailsBuild ? 'GRAILS_HOME' : 'GROOVY_HOME' )
+ ' to compile Gant.' )
    return
}

sourceDirectory = 'source'
testsDirectory = 'tests'
jarsDirectory = 'jarfiles'

buildDirectory = 'build'
buildClassesDirectory = buildDirectory + '/classes'
buildTestsDirectory = buildDirectory + '/tests'
buildLibDirectory = buildDirectory + '/lib'
buildReportsDirectory = buildDirectory + '/reports'

buildMetadataDirectory = buildClassesDirectory + '/META-INF'

distributionTopLevelFiles = [
    'build.gant' , 'build.properties' , 'build.xml' ,
    '.classpath' , '.project' ,
    'lgpl.txt' , 'licence.txt' ,
    'README_Distribution.txt' , 'README_Install.txt'
]

distributionDirectories = [ 'documentation' , 'examples' , '.settings' , sourceDirectory ,
testsDirectory ]

includeTargets << new File ( 'source/gant/targets/clean.gant' )
cleanPattern << '**/*~'
clobberDirectory << buildDirectory

Ant.path ( id : 'installationJarSet' ) { fileset ( dir : installationHome + '/lib' , includes :
 '*.jar' ) }
Ant.taskdef ( name : 'groovyc' , classname : 'org.codehaus.groovy.ant.Groovyc' , classpathref :
```

```

'installationJarSet' )

makeManifest = {
    Ant.mkdir ( dir : buildMetadataDirectory )
    Ant.copy ( todir : buildMetadataDirectory , file : 'LICENSE.txt' )
    Ant.manifest ( file : buildMetadataDirectory + '/MANIFEST.MF' ) {
        attribute ( name : 'Built-By' , value : System.properties.'user.name' )
        attribute ( name : 'Extension-Name' , value : 'gant' )
        attribute ( name : 'Specification-Title' , value : 'Gant: scripting Ant tasks with Groovy.' )
    }
    attribute ( name : 'Specification-Version' , value : gantVersion )
    attribute ( name : 'Specification-Vendor' , value : 'The Codehaus' )
    attribute ( name : 'Implementation-Title' , value : 'Gant: scripting Ant tasks with Groovy.' )
    attribute ( name : 'Implementation-Version' , value : gantVersion )
    attribute ( name : 'Implementation-Vendor' , value : 'The Codehaus' )
}

task ( compile : 'Compile everything needed for a Gant installation.' ) {
    Ant.mkdir ( dir : buildClassesDirectory )
    Ant.mkdir ( dir : buildLibDirectory )
    makeManifest ( )
    Ant.javac ( srcdir : sourceDirectory , destDir : buildClassesDirectory , source : '1.4' ,
target : '1.4' , debug : 'on' , classpathref : 'installationJarSet' )
    Ant.groovyc ( srcdir : sourceDirectory , destDir : buildClassesDirectory , classpath :
buildClassesDirectory , excludes : 'bin/*.groovy' )
    Ant.jar ( destfile : buildLibDirectory + "/gant-${gantVersion}.jar" , basedir :
buildClassesDirectory , includes : 'org/**/*.gant/**' )
}

task ( compileTests : 'Compile all the tests for a newly built Gant.' ) {
    depends ( compile )
    Ant.mkdir ( dir : buildTestsDirectory )
    Ant.javac ( srcdir : testsDirectory , destDir : buildTestsDirectory , source : '1.4' , target
: '1.4' , debug : 'on' ) {
        classpath {
            path ( refid : 'installationJarSet' )
            pathelement ( location : buildClassesDirectory )
        }
    }
    Ant.groovyc ( srcdir : testsDirectory , destdir : buildTestsDirectory ) {
        classpath {
            pathelement ( location : buildTestsDirectory )
            pathelement ( location : buildClassesDirectory )
        }
    }
}

task ( test : 'Test a build.' ) {
    depends ( compileTests )
    Ant.mkdir ( dir : buildReportsDirectory )
    Ant.junit ( printsummary : 'yes' ) {
        formatter ( type : 'plain' )
        batchtest ( fork : 'yes' , todir : buildReportsDirectory ) {
            fileset ( dir : buildTestsDirectory , includes : '**/*_Test.class' )
        }
        classpath {
            pathelement ( location : buildTestsDirectory )
            pathelement ( location : buildClassesDirectory )
            path ( refid : 'installationJarSet' )
        }
    }
}

task ( install : "Compile everything and install it to ${installationHome}" ) {
    depends ( compile )
    Ant.copy ( todir : installationHome ) {
        if ( ! grailsBuild ) { fileset ( dir : sourceDirectory , includes : 'bin/gant*' ) }
        fileset ( dir : buildDirectory , includes : 'lib/gant*.jar' )
    }
    Ant.copy ( todir : installationHome + '/lib' ) { fileset ( dir : jarsDirectory , includes :
'ivy*.jar' ) }
    Ant.chmod ( perm : 'a+x' ) { fileset ( dir : installationHome + '/bin' , includes : 'gant*' )
}
}

task ( uninstall : "Uninstall Gant from ${installationHome}." ) {

```



```

    Ant.delete {
        if ( ! grailsBuild ) { fileset ( dir : installationHome + '/bin' , includes : 'gant*' ) }
        fileset ( dir : installationHome + '/lib' , includes : 'gant*.jar' )
    }
}

task ( 'package' : 'Create the distribution.' ) {
    depends ( compile )
    def prefix = "gant-${gantVersion}"
    def archiveRoot = "${buildDirectory}/gant-${gantVersion}"
    Ant.zip ( destfile : "${archiveRoot}.zip" ) {
        zipfileset ( dir : buildDirectory , includes : 'lib/gant*.jar' , prefix : prefix )
        zipfileset ( dir : sourceDirectory , includes : 'bin/gant*,bin/install.groovy' , prefix :
prefix )
        zipfileset ( dir : '.' , includes : 'README*' , prefix : prefix )
    }
    Ant.tar ( destfile : "${archiveRoot}.tgz" , compression : 'gzip' ) {
        tarfileset ( dir : buildDirectory , includes : 'lib/gant*.jar' , prefix : prefix )
        tarfileset ( dir : sourceDirectory , includes : 'bin/gant*,bin/install.groovy' , prefix :
prefix , mode : '755' )
        tarfileset ( dir : '.' , includes : 'README*' , prefix : prefix )
    }
    archiveRoot = "${buildDirectory}/gant_src-${gantVersion}"
    Ant.zip ( destfile : "${archiveRoot}.zip" ) {
        zipfileset ( dir : buildDirectory , includes : 'lib/gant*.jar' , prefix : prefix )
        zipfileset ( dir : '.' , includes : distributionTopLevelFiles.join ( ',' ) , prefix :
prefix )
        distributionDirectories.each { directory -> zipfileset ( dir : directory , prefix :
"${prefix}/${directory}" ) }
    }
    Ant.tar ( destfile : "${archiveRoot}.tgz" , compression : 'gzip' ) {
        tarfileset ( dir : buildDirectory , includes : 'lib/gant*.jar' , prefix : prefix )
        tarfileset ( dir : '.' , includes : distributionTopLevelFiles.join ( ',' ) , prefix :
prefix )
        distributionDirectories.each { directory -> tarfileset ( dir : directory , prefix :
"${prefix}/${directory}" ) }
    }
}

task ( 'default' : 'The default target, currently compile.' ) { compile ( ) }

```

Google Data Support

This page last changed on Sep 25, 2006 by [paulk_asert](#).

The GData module makes using the Google Data APIs easier from within Groovy.

Google supports a general data access protocol [GData](#). They supply a [Java library](#) which wraps the protocol and provides a higher level API. Groovy programs can make use of this library "as is". However, it's not very Groovy! The GData module provides a couple of Categories which make it a lot easier to manipulate the Google data.

Here's an example of reading events from Google Calendar and then adding an event to the calendar:

```
import com.google.gdata.client.*
import com.google.gdata.client.calendar.*
import com.google.gdata.data.*
import com.google.gdata.data.extensions.*
import com.google.gdata.util.*

import groovy.google.gdata.GDataCategory
import org.codehaus.groovy.runtime.TimeCategory

def myId = System.properties.id
def myPassword = System.properties.pass
def feedUrl = "http://www.google.com/calendar/feeds/$myId/private/full"

use (TimeCategory, GDataCategory) {
    def myService = new CalendarService("codehausGroovy-groovyExampleApp-1")

    myService.userCredentials = [myId, myPassword]

    //
    // List existing entries
    //

    //
    // Get at most 20 events in the period starting 1 week ago and ending 4 weeks in the
    future
    //
    myService.getFeed(feedUrl, 1.week.ago, 4.weeks.from.today, 20).entries.each {entry ->
        entry.times.each {time ->
            println "${entry.title.text} From: ${time.startTime.toUiString()} To:
${(time.endTime.toUiString())}"
        }
    }

    //
    // Get at most 20 events in the period starting 1 year ago lasting 2 years
    //
    myService.getFeed(feedUrl, 1.year.ago, 2.years, 20).entries.each {entry ->
        entry.times.each {time ->
            println "${entry.title.text} From: ${time.startTime.toUiString()} To:
${(time.endTime.toUiString())}"
        }
    }

    //
    // Add an entry
    //

    // Use standard groovy magic to set the properties after construction
    def me = new Person(name: "John Wilson", email: "tugwilson@gmail.com", uri:
"http://eek.ook.org")

    //
    // Need special magic in the GDataCategory to do this
    //
    // title and content are treated as plain text. If you want XHTML or XML then pass a
```

```
closure or a
  // Buildable object and it will run it in a builder context
  //
  // Note that we can't use title and content in the Catagory as they are already properties
of the class.
  // Later I'll create a custom MetaClass for EventEntry which will let us use these names.
Until then we'll mangle them
  //
  // author can be a single Person or a list of Person
  //
  // time can be a single When or a list of them
  //
  def newEntry = new EventEntry(title1: "This is a test event", content1: "this is some
content", author: me,
                                time: new When(start: 1.hour.from.now, end:
2.hours.from.now))

  myService.insert(feedUrl, newEntry)
}
```

Gram

This page last changed on Sep 25, 2006 by [paulk_asert](#).

Gram is a simple xdoclet-like tool for processing doclet tags or Java 5 annotations in source code or bytecode and auto-generating files, data or resources.

Gram = Groovy + [JAM](#). JAM does all the hard work of abstracting away the details between annotations and doclet tags and handling Java 1.4 and 5 compliance. Groovy takes care of the scripting, code generation & templating. Gram is the little tidy bit of code in between.

The sources can be found here : [Gram](#)

Using Gram

You can use the Gram class as a main() and run it from your IDE if you wish. There is a GramTask as well for using it inside Ant.

Often since JAM depends on Sun's doclet stuff, you can have issues running the GramTask inside Maven and sometimes Ant. So I tend to run the Gram command line tool from inside an Ant build. e.g.

```
<java classname="org.codehaus.gram.Gram" fork="true">
  <classpath refid="tool.classpath"/>

  <!-- the directory where the source code lives -->
  <arg value="src/java"/>

  <!-- the groovy script to run to generate stuff -->
  <arg value="src/script/MyGram.groovy"/>
</java>
```

Example script

Here's a simple example which just lists all the hibernate persistent classes in your source code

```
def persistentClasses = classes.findAll { it.getAnnotation("hibernate.class") != null }
println "Found ${persistentClasses.size()} instances out of ${classes.size()}"

persistentClasses.each { c ->
    println c.simpleName

    for (p in c.properties) {
        println "  property: ${p.simpleName}"
    }
}
```

Jar Dependencies

Gram depends on:

- The Groovy 'all' jar (groovy-all-*.jar)
- JAM from the [Annogen](#) project
- and potentially: xml-apis.1.02b.jar and Sun's tools.jar

Articles

You might find some more documentation in the form of blog posts by Andres Almiray:

- [Getting started with Gram](#)
- [Going further with Gram](#)

Groovy Jabber-RPC

This page last changed on Apr 18, 2007 by [tug](#).

Groovy Jabber-RPC

[Jabber-RPC](#)

allows you to make XML-RPC calls using the Jabber protocol. Groovy has a Jabber-RPC implementation which allows you to create a local Jabber-RPC server and to make calls on remote Jabber-RPC servers. Jabber servers are widely available and very easy to set up and run. The Google GTalk service uses Jabber and the Groovy Jabber-RPC package works over GTalk. We use the excellent

[Smack](#)

Jabber library from Jive Software to handle the protocol details.

The Server

It's really easy to set up a server which provides a set of remotely callable functions.

1. Create a server object

```
import groovy.net.xmlrpc.*
import org.jivesoftware.smack.XMPPConnection

def server = new JabberRPCServer()
```

2. Add some methods

```
server.echo = {return it} // the closure is now named "echo" and is remotely callable
```

3. Start the server

```
def serverConnection = new XMPPConnection("talk.example.org", 5222, "example.org")
serverConnection.login("myServerId", "myServerPassword") // logging in as
myServerId@example.org
server.startServer(serverConnection)
```

4. You're done!

The Client

It's pretty easy to make the remote calls too

1. Create a proxy object to represent the remote server

```
def clientConnection = new XMPPConnection("talk.example.org", 5222, "example.org")
    clientConnection.login("myClientId", "myClientPassword") // logging in as
myClientId@example.orgm
    def serverProxy = new JabberRPCServerProxy(clientConnection, "myServerId")
```

2. Call the remote method via the proxy

```
println severProxy.echo("Hello World!")
```

3. As long as myClientId@example.org and myServerId@example.org are buddies then the call will be made and the result returned

Groovy Monkey

This page last changed on Sep 25, 2006 by [paulk_asert](#).

Groovy Monkey is a dynamic scripting tool for the Eclipse Platform that enables you to automate tasks, explore the Eclipse API and engage in rapid prototyping. In fact, I think that if you are working on automating tasks in Eclipse or doing Plugin development in general, this tool is one for you. Groovy Monkey can allow you to try out code and do rapid prototyping without the overhead of deploying a plugin or creating a separate runtime instance.

Groovy Monkey is based on the Eclipse Jobs API, which enables you to monitor the progress in the platform seamlessly and allows you to write your scripts so that users can cancel them midway. Groovy Monkey is also based on the Bean Scripting Framework ([BSF](#)) so that you can write your Groovy Monkey scripts in a number of languages (particularly Groovy). In fact you can write in Groovy, Beanshell, Ruby or Python. The project update site is located at the Groovy-Monkey SourceForge site (update sites: [Eclipse v3.2](#) or [Eclipse v3.1.2](#)). Direct download of Groovy Monkey directly goto http://sourceforge.net/project/showfiles.php?group_id=168501

Requirements

Eclipse Version compatibility

- ✔ Eclipse 3.1 : working [update site](#)
- ✔ Eclipse 3.2 : working [update site](#)

Java Version compatibility

- ✘ 1.4
- ✔ 5.0
- ✔ 6.0

Addition one: metadata keywords

LANG metadata keyword

First, there is a new metadata keyword called LANG, which as is implied, determines what scripting language you wish to use. Here is an example of an Groovy Monkey base example ported to Groovy:

```
/*
 * Menu: Find System Prints > Groovy
 * Kudos: Bjorn Freeman-Benson & Ward Cunningham & James E. Ervin
 * LANG: Groovy
 * Job: UIJob
 * License: EPL 1.0
 */

def files = resources.filesMatching(".*\\.java")
for( file in files )
{
```



```
file.removeMyTasks( metadata.path() )
for( line in file.lines )
{
    if( line.string.trim().contains( 'System.out.print' ) )
    {
        line.addMyTask( metadata.path(), line.string.trim() )
    }
}
}
window.getActivePage().showView( 'org.eclipse.ui.views.TaskList' )
```

Notice the LANG tag, that is all there is to that. There is also a New Groovy Monkey Script wizard available that has the legal values in pulldown menus.

Job metadata keyword

The Job metadata tag allows you to specify what kind of Eclipse Job that your Groovy Monkey script will be run in. By default it is set to Job, but UIJob and WorkspaceJob are also available. In Eclipse it is best to run almost all of your code from outside the UI Thread so UIJob is not recommended. To enable you to access UI elements from within your script there is a Runner DOM that enables your script to pass a Runnable object that can be called from the `asyncExec()` or `syncExec()` methods. For Groovy the JFace DOM allows you to pass a Closure directly to be invoked from either `asyncExec()` or `syncExec()`.

Exec-Mode metadata keyword

The Exec-Mode metadata keyword allows you to specify whether the script should be run in the background (default) or foreground. The foreground mode has Eclipse directly pop up a modal dialog box that shows the user the progress of the script, the background node does not.

Include metadata keyword

The Include metadata keyword allows you to specify a resource in your workspace and to directly add it to the classloader of your Groovy Monkey script. Examples would obviously include jar files or directories.

Include-Bundle metadata keyword

The Include-Bundle metadata keyword allows you to have an installed bundle be directly added to the classloader of your Groovy Monkey script.

Addition two: Outline view

Secondly, the outline view is populated showing the binding variable names and types with their publicly available methods and fields. This can be useful since the DOMs are loaded on your eclipse ide as plugins and not in your workspace view. Even if you were to load in the DOMs into your workspace, there is still a great deal of switching that must be done.

You can double click on a type in the outline view and have it open the source directly in your editor, if you have included external plugins in your Java search path.

There is also an "Installed DOMs" view that shows the installed DOM plugins currently in your Eclipse workbench. The editor also includes a right click command to display a dialog that lists the and will install available DOMs to your script.

Addition three: Groovy SWT and Launch Manager DOMs

Thirdly, there are new DOMs that are located on the update site that include direct access to a console for output, enable you to script your launch configurations together and a wrapper for the Groovy SWT project as a DOM.

Here is an example of a script, copied from the examples given in Groovy-SWT, ported into Groovy Monkey. The Groovy-SWT DOM is now included by default when you have the net.sf.groovyMonkey.groovy fragment installed. The net.sf.groovyMonkey.groovy fragment contains Groovy Monkey's support for the Groovy language.

```
/*
 * Menu: Test SWT
 * Kudos: James E. Ervin
 * License: EPL 1.0
 * Job: UIJob
 */

def subapp = jface.shell( window.getShell() )
{
    gridLayout()
    group( text:'Groovy SWT', background:[255, 255, 255] )
    {
        gridLayout()
        label( text:"groove fun !" ,background:[255, 255, 255] )
        label( text:"Email: ckl@dacelo.nl", background:[255, 255, 255] )
    }
}
subapp.pack()
subapp.open()
```

Here is an example of a script that uses the Launch Configuration Manager DOM along with the JFace/SWT DOM and the Console output DOM. It prints out the list of all your available launch configurations and allows you to select which ones you wish to string together.

```
/*
 * Menu: Launch Manager
 * Kudos: James E. Ervin
 * License: EPL 1.0
 * LANG: Groovy
 * Job: UIJob
 * DOM: http://groovy-monkey.sourceforge.net/update/net.sf.groovyMonkey.dom
 */
import org.eclipse.swt.SWT

def configurations = launchManager.manager().getLaunchConfigurations()
def selected = []
shell = jface.shell( text: 'Select desired configurations:', location: [ 100, 100 ] )
{
    gridLayout()
    table = table( toolTipText: "Select configurations to execute",
style:'check,border,v_scroll,h_scroll,single' )
    {
        gridLayout()
        gridData( horizontalAlignment: SWT.FILL, verticalAlignment: SWT.FILL,
grabExcessHorizontalSpace: true,
grabExcessVerticalSpace: true, heightHint: 400 )
        for( config in configurations )
```

```

        {
            tableItem().setText( "${config.name}" )
        }
    }
    composite()
    {
        GridLayout( numColumns: 2 )
        button( text: 'run', background: [ 0, 255, 255 ] )
        {
            onEvent( type: 'Selection', closure:
            {
                for( item in table.items )
                {
                    if( !item.checked )
                        continue
                    selected.add( item.text )
                }
                shell.close()
            } )
        }
        button( text: "cancel", background: [ 0, 255, 255 ] )
        {
            onEvent( type: 'Selection', closure:
            {
                selected.clear()
                shell.close()
            } )
        }
    }
}
shell.pack()
shell.open()
while( !shell.isDisposed() )
{
    if( !shell.display.readAndDispatch() )
        shell.display.sleep()
}
selected.each
{
    out.println "${it}"
}

launchManager.launch( 'launch test', selected )

```

Groovy SOAP

This page last changed on Feb 07, 2007 by [galleon](#).

Introduction

[SOAP](#)

is a lightweight protocol intended for exchanging structured information in a decentralized, distributed environment. Groovy has a SOAP implementation based on

[Xfire](#)

which allows you to create a SOAP server and/or make calls to remote SOAP servers using Groovy.

Installation

You just need to download [this](#) jar file in your `${user.home}/.groovy/lib` directory. This jar file embeds all the dependencies.

Getting Started

The Server

You can develop your web service using a groovy script and/or a groovy class. The following two groovy files are valid for building a web-service.

1. MathService.groovy

```
public class MathService {
    double add(double arg0, double arg1) {
        return (arg0 + arg1)
    }
    double square(double arg0) {
        return (arg0 * arg0)
    }
}
```

2. You can also using something more Groovy

```
double add(double arg0, double arg1) {
    return (arg0 + arg1)
}
double square(double arg0) {
    return (arg0 * arg0)
}
```

```
}
```

3. Then the easy part ... no need for comments

```
import groovy.net.soap.SoapServer

def server = new SoapServer("localhost", 6980)

server.setNode("MathService")

server.start()
```

That's all !

The Client

1. Oh ... you want to test it ... two more lines.

```
import groovy.net.soap.SoapClient

def proxy = new SoapClient("http://localhost:6980/MathServiceInterface?wsdl")

def result = proxy.add(1.0, 2.0)
assert (result == 3.0)

result = proxy.square(3.0)
assert (result == 9.0)
```

2. You're done!

Custom Data Types

This example shows how to use custom data types with Groovy SOAP. The code can be downloaded from [here](#).

The Server

The `PersonService.groovy` script contains the service implementation and the custom data type (`Person`).

```
class Person {
    int id
    String firstname
    String lastname
}

Person findPerson(int id) {
    return new Person(id:id, firstname:'First', lastname:'Last')
```

`Server.groovy` is equivalent to the previous example.

```
import groovy.net.soap.SoapServer;
```

```
def server = new SoapServer("localhost", 6980);
server.setNode("PersonService");
server.start();
```

For each class compiled by the groovy compiler a `metaClass` property is added to the bytecode. This property must be excluded from being mapped by XFire, otherwise an error will be reported when trying to obtain the WSDL document from <http://localhost:6980/PersonServiceInterface?wsdl>. The reason is that XFire cannot map `groovy.lang.MetaClass`. To ignore the `metaClass` property a custom type mapping must be defined (for details refer to [Aegis Binding](#)).

```
<?xml version="1.0" encoding="UTF-8"?>
<mappings xmlns:sample="http://DefaultNamespace">
  <mapping name="sample:Person">
    <property name="metaClass" ignore="true"/>
  </mapping>
</mappings>
```

However, if you compile custom data types from Java the bytecode won't contain a `metaClass` property and, hence, there is no need to define a custom mapping.

The Client

```
import groovy.net.soap.SoapClient

def proxy = new SoapClient('http://localhost:6980/PersonServiceInterface?wsdl')
def person = proxy.findPerson(12)
println 'Person (' + person.id + ') = ' +
    person.firstname + ' ' + person.lastname
```

More Information

Current limitations (and workaround)

1. No authentication (see JIRA issue 1457)
2. No proxy support (see JIRA issue 1458)
3. Numeric values are represented as strings in custom data types and arrays.
4. Custom data types cannot be processed on client side when using the Groovy SOAP module with the current groovy-1.0 release.
5. It looks like the XFire dynamic client does not support complex datatypes. This may be a concern if you need for example to transfer an Image as a byte array. The workaround I use is to transform this in a String and transfer that String - As this is a bit painful I am investigating moving to the regular XFire client. Here is a little program demo-ing this (look at this "disco age" image - Is Groovy that old ?

The client (ImageClient.groovy)

```
import groovy.swing.SwingBuilder
```

```

import groovy.net.soap.SoapClient
import javax.swing.ImageIcon
import org.apache.commons.codec.binary.Base64

proxy = new SoapClient("http://localhost:6980/ImageServiceInterface?WSDL")

// get the string, transform it to a byte array and decode this array
b64 = new Base64()
bbytes = b64.decode(proxy.getImage().getBytes())

swing = new groovy.swing.SwingBuilder()

// this is regular SwingBuilder stuff
il = swing.label(icon:new ImageIcon(bbytes))
frame = swing.frame(title:'Groovy logo',
defaultCloseOperation:javax.swing.WindowConstants.DISPOSE_ON_CLOSE) {
    panel(){
        widget(il)
    }
}
frame.pack()
frame.show()

```

The (ugly) server part embedding the image which is Base64 encoded (ImageServer.groovy):

```

import groovy.net.soap.SoapServer

def server = new SoapServer("localhost", 6980)
server.setNode("ImageService")
server.start()

```

and the missing and secret part is [here](#).

Demos with public web services

There exist a lot of web-services available for testing. One which is pretty easy to evaluate is the currency rate calculator from [webservicex.net](#).

Here is a small swing sample that demonstrate the use of the service. Enjoy !

```

import groovy.swing.SwingBuilder
import groovy.net.soap.SoapClient

proxy = new SoapClient("http://www.webservicex.net/CurrencyConvertor.asmx?WSDL")

def currency = ['USD', 'EUR', 'CAD', 'GBP', 'AUD']
def rate = 0.0

swing = new SwingBuilder()

refresh = swing.action(
    name:'Refresh',
    closure:this.&refreshText,
    mnemonic:'R'
)

frame = swing.frame(title:'Currency Demo') {
    panel {
        label 'Currency rate from '
        comboBox(id:'from', items:currency)
        label ' to '
        comboBox(id:'to', items:currency)
        label ' is '
        textField(id:'currency', columns:10, rate.toString())
        button(text:'Go !', action:refresh)
    }
}

```

```
    }  
  }  
  frame.pack()  
  frame.show()  
  
  def refreshText(event) {  
    rate = proxy.ConversionRate(swing.from.getSelectedItemAt(), swing.to.getSelectedItemAt())  
    swing.currency.text = rate  
  }  
}
```

And here is the result:



GroovySWT

This page last changed on Nov 14, 2006 by [paulk_asert](#).

GroovySWT is a wrapper around SWT, the eclipse Standard Widget Toolkit. It allows you to easily write Eclipse [SWT](#) applications by using Groovy's *builder* mechanism.

Here is some SWT code using native Groovy:

```
import org.eclipse.swt.SWT
import org.eclipse.swt.widgets.*
import org.eclipse.swt.layout.RowLayout as Layout

def display = new Display()
def shell = new Shell(display)

shell.layout = new Layout(SWT.VERTICAL)

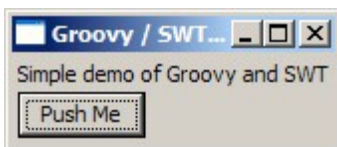
shell.text = 'Groovy / SWT Test'

def label = new Label(shell, SWT.NONE)
label.text = 'Simple demo of Groovy and SWT'
shell.defaultButton = new Button(shell, SWT.PUSH)
shell.defaultButton.text = '  Push Me  '

shell.pack()
shell.open()

while (!shell.disposed) {
    if (!shell.display.readAndDispatch()) shell.display.sleep()
}
```

When you run this (see below for setup details), the result looks like:



Here is the same example using SwtBuilder - note that this example does more because it actually prints some text 'Hello' to standard output when you press the button:

```
import org.eclipse.swt.SWT
import org.eclipse.swt.widgets.*

def swt = new groovy.swt.SwtBuilder()
def shell = swt.shell(text:'Groovy / SWT Test') {
    rowLayout()
    label(style:"none", text:'Simple demo of Groovy and SWT')
    button(style:"push", text:'  Push Me  ') {
        onEvent(type:"Selection", closure:{ println "Hello" })
    }
}

shell.pack()
shell.open()

while (!shell.disposed) {
    if (!shell.display.readAndDispatch()) shell.display.sleep()
}
```

Here is another example which explicitly creates a script class and assumes *guiBuilder* is passed in via a binding:

```
package com.dacelo.guidedsales.ui

class About extends Script {
    run( ) {
        def subapp = guiBuilder.shell( parent ) {
            GridLayout()
            group( text:"Groovy SWT", background:[255, 255, 255] ) {
                GridLayout()
                label( text:"groove fun !" ,background:[255, 255, 255] )
                label( text:"Email: ckl@dacelo.nl", background:[255, 255, 255] )
            }
        }
        subapp.pack()
        subapp.open()
    }
}
```

Further information

The sources (and README.txt telling you how to set up the libraries and dll's) can be found here:

- [groovy-swt](#)

The jar file compiled against Eclipse SDK 3.2.1 jars can be found attached:

- [groovy-swt.jar](#)

GSP

This page last changed on Sep 25, 2006 by [paulk_asert](#).

GSP are not maintained as a standalone module. But it has been forked and reintegrated in [Grails](#).

GSP means GroovyServer Pages, which is similar to JSP (JavaServer Pages).

GSP Module Project has started originally by Troy Heninger.

Troy's GroovyPages project page is <http://www.investortech.com/emp/troy/groovypages.htm>

The original sources of GSP module 1.1 can be found at Groovy's [SVN](#) repository.

There is also a new GSP project page: <https://gsp.dev.java.net/>

Sample GSP: AttributeTest.gsp

```
<%
    if (session.counter == null)
        session.counter = 1
    else
        session.counter++

    session.setAttribute("id", "tmpID")
    session.setAttribute("uid", "userID")

    request.x = 123
    application.x = 500

    if (application.counter == null)
        application.counter = 1
    else
        application.counter++

%>

application.counter = ${application.counter} <br>
session.counter = ${session.counter} <br>
session.id = ${session.id} <br>
session.uid = ${session.uid} <br>
session.getAttribute('id') = ${session.getAttribute('id')} <br>
request.x = ${request.x} <br>
(application.x == null ?) = ${application.x == null} <br>
application.x = ${application.x} <br>
```

web.xml

```
<servlet>
    <servlet-name>GSP</servlet-name>
    <servlet-class>groovy.modules.pages.GroovyPages</servlet-class>
    <init-param>
        <param-name>encoding</param-name>
        <param-value>ISO-8859-1</param-value>
    </init-param>
    <init-param>
        <param-name>debug</param-name>
```

```
        <param-value>0</param-value>
    </init-param>
</servlet>

<servlet-mapping>
    <servlet-name>GSP</servlet-name>
    <url-pattern>*.jsp</url-pattern>
</servlet-mapping>
</servlet>
```

GSQL

This page last changed on Feb 16, 2007 by [jpvasquez](#).

GSQL supports easier access to databases using Groovy.

Groovy supports a few neat ways to work with SQL more easily and to make SQL more Groovy. You can perform queries and SQL statements, passing in variables easily with proper handling of statements, connections and exception handling thanks to closures.

```
import groovy.sql.Sql

def foo = 'cheese'
def sql = Sql.newInstance("jdbc:mysql://localhost:3306/mydb", "user",
                        "pswd", "com.mysql.jdbc.Driver")

sql.eachRow("select * from FOOD where type=${foo}") {
    println "Gromit likes ${it.name}"
}
```

In the above example, you can refer to the various columns by name, using the property syntax on the row variable (e.g. `it.name`) or you can refer to the columns by their index (e.g. `it0`) For example

```
import groovy.sql.Sql

def foo = 'cheese'
def sql = Sql.newInstance("jdbc:mysql://localhost:3306/mydb", "user",
                        "pswd", "com.mysql.jdbc.Driver")

def answer = 0
sql.eachRow("select count(*) from FOOD where type=${foo}") { row ->
    answer = row[0]
}
assert answer > 0
```

Or you can create a `DataSet` which allows you to query SQL using familiar closure syntax so that the same query could work easily on in memory objects or via SQL. e.g.

```
import groovy.sql.Sql

def sql = Sql.newInstance("jdbc:mysql://localhost:3306/mydb", "user",
                        "pswd", "com.mysql.jdbc.Driver")

def food = sql.dataSet('FOOD')
def cheese = food.findAll { it.type == 'cheese' }
cheese.each { println "Eat ${it.name}" }
```

The source code can be found here :

- [GSQL](#)

Examples

Here's an example of using Groovy SQL along with [GroovyMarkup](#) .

```

import groovy.sql.Sql
import groovy.xml.MarkupBuilder

def sql = Sql.newInstance("jdbc:mysql://localhost:3306/mydb", "user",
                        "pswd", "com.mysql.jdbc.Driver")

// lets output some XML builder
// could be SAX / StAX / DOM / TrAX / text etc
def xml = new MarkupBuilder()

def ignore = 'James'
sql.eachRow("select * from person where firstname != ${ignore}") { person ->
    // lets process each row by emitting some markup
    xml.customer(id:person.id, type:'Customer', name:person.firstname + " " + person.lastname)
}

```

This could generate, dynamically something like

```

<customers>
  <customer id="123" type="Customer" foo="whatever">
    <role>partner</role>
    <name>James</name>
    <location id="5" name="London"/>
  </customer>
</customers>

```

There's an example

[test case which demonstrates](#) all of these query mechanisms in action.

Stored procedure support

```

import java.sql.Connection
import java.sql.DriverManager
import javax.sql.DataSource
import groovy.sql.Sql
import oracle.jdbc.driver.OracleTypes

driver = oracle.jdbc.driver.OracleDriver
Connection conn =
DriverManager.getConnection('jdbc:oracle:thin:sirtest/sirtest@duck.aplpi.lan:1521:orcl');

/*
 *
 * Here we call a procedural block with a closure.
 * ${Sql.INTEGER} and ${Sql.VARCHAR} are out parameters
 * which are passed to the closure.
 */
Sql sql = new Sql(conn);
def a="foo";
String foo = "x";
println "${a}=${a}"
undefinedVar = null
println ""
--Simple demonstration of call with closure.
--Closure is called once with all returned values.
"""
sql.call("begin ${Sql.INTEGER}:=20; ${Sql.VARCHAR}:='hello world';end;"){answer,string ->
println "number=[${answer}] string=[${string}]"
println "answer is a ${answer.class}";
println "string is a ${string.class}";
answer += 1;
println "now number=${answer}"
println ""[${string.replaceAll("o","O")}]""
}

```

```

/*
 * Here we execute a procedural block. The block returns four out
 * parameters, two of which are cursors. We use Sql.resultSet function
 * to indicate that the cursors should be returned as GroovyResultSet.
 *
 *
 */
println ""--next we see multiple return values including two ResultSets
--(ResultSets become GroovyResultSets)
--Note the GroovyResultSet.eachRow() function!!
""

def tableClosure = {println "table:${it.table_name}"};
println("tableClosure is a ${tableClosure.class}");
String owner = 'SIRTEST';

sql.call("""declare
type crsr is ref cursor;
tables crsr;
objects crsr;
begin
select count(*) into ${Sql.INTEGER} from all_tables where owner= ${owner} ;
open tables for select * from all_tables where owner= ${owner} ;
${Sql.resultSet OracleTypes.CURSOR} := tables;
select count(*) into ${Sql.INTEGER} from all_objects where owner= ${owner} ;
open objects for select * from all_objects where owner= ${owner};
${Sql.resultSet OracleTypes.CURSOR} := objects;
end;
""")
){t,user_tables,o,user_objects ->
    println "found ${t} tables from a total of ${o} objects"
    // eachRow is a new method on GroovyResultSet
    user_tables.eachRow(){x ->println "table:${x.table_name}"
        user_objects.eachRow(){println "object:${it.object_name}"
    }

/*
 * Determine if we have the stored procedure 'fred' needed
 * for the next test.
 *
 */
Integer procLines = 0
sql.eachRow("select count(*) lines from user_source where name='FRED' and
type='FUNCTION'"){procLines = it.lines}

if(procLines ==0){
print ""
--to demonstrate a function accepting an inout parameter
--and returning a value, create the following function in your schema
create or replace function fred(foo in out varchar2) return number is
begin
foo:='howdy doody';
return 99;
end;
""

}else{
/*
 * Here is a call to a function, passing in inout parameter.
 * The function also returns a value.
 */
println "Next call demonstrates a function accepting inout parameter and returning a value"
sql.call("{ ${Sql.INTEGER} = call fred(${Sql.inout(Sql.VARCHAR(foo))}) }") {answer,string ->
println "returned number=[${answer}] inout string coming back=[${string}]"
}

println "--Same again, but this time passing a null inout parameter"
sql.call("{ ${Sql.INTEGER} = call fred(${Sql.inout(Sql.VARCHAR(undefinedVar))}) }") {answer,string -> println "returned number=[${answer}] inout string coming back=[${string}]"
    answer = answer + 1;
    println "Checked can increment returned number, now number=${answer}"
    println ""[${string.replaceAll("o","O")}]""
}
}

```

```

}

/*
 * Finally a handy function to tell Sql to expand a variable in the
 * GString rather than passing the value as a parameter.
 */
["user_tables","all_tables"].each(){table ->
    sql.eachRow("select count(*) nrows from ${Sql.expand table}"){println "${table} has
    ${it.nrows} rows"}
}

```

SqlGeneratorTest Example:

```

/**
 * Test to verify valid construction of default DDL
 *
 * @author <a href="mailto:jeremy.rayner@bigfoot.com">Jeremy Rayner</a>
 * @version $Revision: 1.2 $
 */
package org.javanicus.gsql

import java.io.*

class SqlGeneratorTest extends GroovyTestCase {
    @Property database
    @Property sqlGenerator

    void setUp() {
        def typeMap = new TypeMap()
        def build = new RelationalBuilder(typeMap)
        def sqlGenerator = new SqlGenerator(typeMap, System.getProperty( "line.separator", "\n"
    ))

        def database = build.database(name:'genealogy') {
            table(name:'event') {
                column(name:'event_id', type:'integer', size:10, primaryKey:true, required:true)
                column(name:'description', type:'varchar', size:30)
            }
            table(name:'individual') {
                column(name:'individual_id', type:'integer', size:10, required:true,
primaryKey:true, autoIncrement:true)
                column(name:'surname', type:'varchar', size:15, required:true)
                column(name:'event_id', type:'integer', size:10)
                foreignKey(foreignTable:'event') {
                    reference(local:'event_id',foreign:'event_id')
                }
                index(name:'surname_index') {
                    indexColumn(name:'surname')
                }
            }
        }

    }

    void testGenerateDDL() {
        def testWriter = new PrintWriter(new FileOutputStream("SqlGeneratorTest.sql"))
        sqlGenerator.writer = testWriter
        sqlGenerator.createDatabase(database,true)
        testWriter.flush()
    }
}

```


Native Launcher

This page last changed on Feb 21, 2007 by [akaranta](#).

The groovy native launcher is a native program for launching groovy scripts. It compiles to an executable binary file, e.g. groovy.exe on windows. Note that you still need to have groovy and jre or jdk installed, i.e. the native launcher is a native executable replacement for the startup scripts (groovy.bat, groovy.sh).

Status

The native launcher should support any platform and any jdk / jre (≥ 1.4). If you find something that is not supported, please post a JIRA enhancement request and support will be added.

At the moment, the following platforms have been tested:

- Windows (XP, Vista)
- linux (SuSE, Ubuntu) on x86
- solaris on sparc
- OS-X

At the moment, the following jdks / jres have been tested

- several versions of sun jre / jdk (from 1.4, 1.5 and 1.6 serieses)
- jrockit (on windows)

Known issues

- Paths are not converted on cygwin, so you have to use windows style paths when invoking scripts
- On OS-X automatic detection of the executable location does not work. This means you have to set GROOVY_HOME

Compiling

The binaries are compiled w/ the provided [rant](#) script. Just type
rant

On Windows you can either compile w/ ms cl compiler + ms link from normal windows command prompt or gcc from cygwin or msys. On cygwin, you currently have to use the rant version from svn head, and run rant w/ the script rant/trunk/run_rant as the present rant release does not work w/ cygwin.

Usage

To use the native launcher, you need to either place the executable in the bin directory of groovy installation OR set the GROOVY_HOME environment variable to point to your groovy installation. If you

do not use `-jh` / `--javahome` option, `JAVA_HOME` needs to be set also.

The launcher primarily tries to find the groovy installation by seeing whether it is sitting in the bin directory of one. If not, it resorts to using `GROOVY_HOME` environment variable. Note that this means that `GROOVY_HOME` environment variable does not need to be set to be able to run groovy.

Parameters

The native launcher accepts all the same parameters as the `.bat` / shell script launchers, and a few others on top of that. For details, type

```
groovy -h
```

JVM parameters

Any options not recognized as options to groovy are passed on to the jvm, so you can e.g. do

```
groovy -Xmx250m myscript.groovy
```

The `-client` (default) and `-server` options to designate the type of jvm to use are also supported, so you can do

```
groovy -Xmx250m -server myscript.groovy
```

Note that no aliases like `-hotspot`, `-jrockit` etc. are accepted - it's either `-client` or `-server`

You can freely mix jvm parameters and groovy parameters. E.g. in the following `-d` is param to groovy and `-Dmy.prop=foo` / `-Xmx200m` are params to the jvm:

```
groovy -Dmy.prop=foo -d -Xmx200m myscript.groovy
```

JAVA_OPTS

The environment variable `JAVA_OPTS` that the `.bat`/shell script launchers use is ignored.

groovy.exe and groovyw.exe on Windows

Similarly to `java.exe` and `javaw.exe` on a jdk, the build process produces `groovy.exe` and `groovyw.exe` on windows. The difference is the same as w/ `java.exe` and `javaw.exe` - `groovy.exe` requires a console and will launch one if it is not started in a console, whereas `groovyw.exe` has no console (and is usually used to start apps w/ their own gui or that run on the background).

Pre-compiled binaries

There are precompiled binaries for windows attached to this page (go to the bottom of the page, click "View" and then click on the "Attachments" tab). They are not guaranteed to be completely up to date with the sources in svn head, but they should work. Hopefully we will have precompiled binaries for all supported platforms in the future.

[groovy.exe](#)
[groovyw.exe](#)

Windows file association

If you want to run your groovy scripts on windows so that they seem like any other commands (i.e. if you have `myscript.groovy` on your PATH, you can just type `myscript`), do as follows:

- add `.groovy` to PATHEXT environment variable
- make changes in windows registry as follows
- run `regedit.exe`
- create a new key `HKEY_CLASSES_ROOT\.groovy` and give it the value `groovyFile`
- create `HKEY_CLASSES_ROOT\groovyFile`
- under that, create `HKEY_CLASSES_ROOT\groovyFile\Shell` and give it value `open`
- under that, create `HKEY_CLASSES_ROOT\groovyFile\Shell\open\command` and give it value (adjust according to your groovy location) `"c:\programs\groovy-1.0\bin\groovy.exe" "%1" %*`

Yes, it would be nicer to have an installer do this. =)

Why?

Why have a native launcher, why aren't the startup scripts (`groovy.bat`, `groovy.sh`) sufficient? Here are some reasons:

- it solves an open bug : return value of groovy (on windows) is always 0 no matter what happens in the executed script (even if you call `System.exit(1)`). Granted, this could be solved by editing the launch scripts also.
- it is slightly faster than the corresponding `.bat` / shell script
- you can mix jvm params and groovy params, thus making it easier and more natural to e.g. reserve more memory for the started jvm.
- the process will be called "groovy", not "java". Cosmetic, yes, but still nice. =)
- fixes the problems there have been w/ the `.bat` launcher and paths w/ whitespace

Also, the launcher has been written so that the source can be used to easily create a native launcher for any Java program.

How it works

Essentially the launcher does the same thing that the normal java launcher (`java` executable) does - it dynamically loads the dynamic library containing the jvm and hands the execution over to it. It does not start a separate process (i.e. it does not call the `java` executable).

Help wanted

If you have expertise with any of the following and want to help, please email me at antti dot karanta (at) iki dot fi:

- Cygwin c api
- more specifically: how to successfully load and use the win <-> posix path conversion functions when loading the cygwin1.dll from a non-cygwin app
- os-x c programming
- more specifically: how to get the path to the current executable

Process

This page last changed on Sep 25, 2006 by [paulk_asert](#).

Process provides a shell-like capability for handling external processes.

Process has also been called Groosh, for Groovy Shell. It is a shell *à la unix* written in groovy.

More information: [src](#)

An example :

```
def gsh = new com.baulsupp.groovy.groosh.Groosh();
def c = gsh.cat('test_scripts/blah.txt').toStdOut();
```

Another example :

```
def gsh = new com.baulsupp.groovy.groosh.Groosh();

def f = gsh.find('.', '-name', '*.java', '-ls');
def total = 0;
def lines = gsh.grid { values,w |
    def x = values[2,4,6,10];
    def s = x.join(' ');
    w.println(s);
    def total += Integer.parseInt(values[6]);
};

f.pipeTo(lines);
lines.toStdOut();

System.out.println("Total: " + total);
```

XMLRPC

This page last changed on Nov 09, 2006 by [hansamann](#).

What is the XMLRPC module?

This is a module which allows you to create a local XML-RPC server and/or to make calls on remote XML-RPC servers.

What is XML-RPC?

[XML-RPC](#) is a spec and a set of implementations that allow software running on disparate operating systems, running in different environments to make procedure calls over the Internet. It uses HTTP as the transport and XML as the encoding. XML-RPC is designed to be as simple as possible, while allowing complex data structures to be transmitted, processed and returned.

Using XMLRPC

Here is an example:

The Server

It's really easy to set up a server which provides a set of remotely callable functions.

1. Create a server object

```
import groovy.net.xmlrpc.*
import java.net.ServerSocket

def server = new XMLRPCServer()
```

2. Add some methods

```
server.echo = {return it} // the closure is now named "echo" and is remotely callable
```

3. Start the server

```
def serverSocket = new ServerSocket() // Open a server socket on a free port
server.startServer(serverSocket) // Start the XML-RPC server listening on the server
socket
```

4. You're done!

The Client

It's pretty easy to make the remote calls too

1. Create a proxy object to represent the remote server

```
def serverProxy = new XMLRPCServerProxy("http://localhost:${serverSocket.getLocalPort()}")
```

2. Call the remote method via the proxy

```
println severProxy.echo("Hello World!")
```

3. That's all you need

More information

The sources can be found here : [XML-RPC](#). For a binary download, go to the [distribution folder](#).

Sample scripts :

- [Confluence Example](#) showing how to download a secured Confluence page.

Project Information

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Some useful project information:

- [Contributing](#)
- [Events](#)
- [Mailing Lists](#)
- [News](#)
- [Related Projects](#)
- [Release Process](#)
- [Success Stories](#)
- [User Groups](#)

Contributing

This page last changed on Sep 24, 2006 by [paulk_asert](#).

There are many ways you can help make Groovy a better piece of software - and we can use all the help we can get 😊 Please dive in and help!

Try surfing the documentation - if something is confusing or not clear, let us know - or better still fix it for us 😊. All of this website is maintained in [a wiki](#), so please go right ahead and fix things if they are wrong or contribute new documentation.

Download the code & try it out and see what you think. Browse the source code.
Got an itch to scratch, want to tune some operation or add some feature?

Want to do some hacking on Groovy? Try surfing the [issue tracker](#) for open issues or features that need to be implemented, take ownership of an issue and try to fix it.

If you'd rather a more gentle introduction to coding on the Groovy project, how about you look at the [test coverage report](#) and help us get it even more green by supplying more test cases to get us closer to 100% coverage.

Getting in touch

There are various ways of communicating with the Groovy community.

- subscribe to the [mailing lists](#) and take part in any conversations
- pop by on [IRC](#) and say hi
- add some comments to the [wiki](#)
- blog about it and hopefully folks are subscribed to your blog 😊

If you find a bug or problem

Please raise a new issue in our [issue tracker](#)

If you can create a JUnit test case (either via Groovy or Java code) then your issue is more likely to be resolved quicker.

e.g. take a look at some of the [existing unit tests cases](#), find one and modify it to try reproduce your problem.

Then we can add your issue to CVS and then we'll know when its really fixed and we can ensure that the problem stays fixed in future releases.

Submitting patches

We gladly accept patches if you can find ways to improve, tune or fix Groovy in some way.

Most IDEs can create nice patches now very easily. If you're a command line person try the following to create the patch

```
Unable to find source-code formatter for language: bash. Available languages are:  
actionscript, html, java, javascript, none, sql, xhtml, xml
```

```
diff -u Main.java.orig Main.java >> patchfile.txt
```

or

```
Unable to find source-code formatter for language: bash. Available languages are:  
actionscript, html, java, javascript, none, sql, xhtml, xml
```

```
cvs diff -u Main.java >> patchfile.txt
```

Once you've created a patch the best way to submit it is to raise a new issue in the issue tracker (see below) and maybe send us a mail on the [developer list](#) letting us know about the patch.

Using the issue tracker

Before you can raise an issue in the issue tracker you need to register with it. This is quick & painless.

If you want to have a go at fixing an issue you need to be in the list of groovy-developers on the issue tracker. To join the group, please mail the groovy-dev mail list with the email address you used to register with the issue tracker and we'll add you to the group.

Events

This page last changed on Apr 26, 2007 by [tof](#).

Upcoming Groovy events 2007

type	location	featuring	date	topic
conference	London, UK	The Groovy Community + Everyone!	May 30th - June 1st 2007	The Grails eXchange 2007
talk	Wiesbaden, Germany	Dierk König	Apr 23-27 2007	Einsatz-Patterns für Skriptsprachen in Java JAX 2007
talk	Wiesbaden, Germany	Dierk König	Apr 23-27 2007	Dynamische Programmierung mit Groovy JAX 2007
talk	Omaha, USA	Scott Hickey	Apr 18 2007	Integrating a Dynamic Programming Language into a Java Project at Infotec
talk	Omaha, USA	Scott Hickey	Apr 17 2007	Introduction to Groovy at Infotec
talk	Omaha, USA	Scott Hickey	Mar 25 2007	The Groovy Eclipse Plugin at Greater Nebraska Software Symposium
talk	Omaha, USA	Scott Hickey and Jim McGill	Mar 24 2007	Real World Groovy at Greater Nebraska Software Symposium
talk	Paris, France	Guillaume Laforge	March 21st 2007	Java Scripting: One VM, Many Languages at Sun's TechDays
talk	London, UK	Guillaume Laforge	March 15th 2007	Grails: Spring & Hibernate development reinvented at QCon
tutorial	London, UK	Guillaume Laforge & John Wilson	March 13th 2007	Domain-Specific Languages in Groovy at QCon
workshop	London, UK	Graeme Rocher	March 15th 2007	Groovy & Grails

				one day workshop at Sun Tech Days
--	--	--	--	--

Historical Groovy events 2006

type	location	featuring	date	topic
workshop	Paris, France	Numerous Committers	Jan 29/30 2007	Groovy Developer Conference
talk	Munich, Germany	Dierk König	Jan 25th 2007	Groovy - agile, dynamic programming for the Java platform at OOP 2007
talk	Paris, France	Guillaume Laforge	January 18th	Grails introduction at OSS-GTP
talk	Berlin, Germany	Christof Vollrath	December 27th	Groovy talk: Java wird Groovy (pdf, video) at 23C3
talk	St. Louis MO, USA	Jeff Brown	December 14th	Groovy presentation at the December St. Louis Java SIG meeting. Presentation by Jeff Brown, Principal Software Engineer with Object Computing Inc.
talk	Hollywood, Florida, USA	Guillaume Laforge	December, 9th	The Holy Grails of Web Framework at the Spring Experience
talk	Hollywood, Florida, USA	Guillaume Laforge with Rod Johnson	December, 8th	Using Dynamic Languages with Spring at the Spring Experience , talk with Rod Johnson
one-day tutorial	Frankfurt/Main Germany	Marc Guillemot, Dierk König	November 30th	Canoo WebTest including how to write such tests with Groovy at iX Better Software
one-day tutorial	Frankfurt/Main Germany	Dierk König, Stefan Roock, Bernd Schiffer	November 27th	Groovy: Java's dynamic friend at iX Better Software

conference track	Munich, Germany	Dierk König, Sven Haiges, Peter Roßbach	November 6-10	Groovy Track with four events at W-JAX
session	Portland, Oregon, USA	Marc Guillemot, Dierk König	October 22-26	Advanced testing with WebTest and Groovy at OOPSLA 2006
meeting	St. Louis MO, USA	Jeff Brown	September 14th	Groovy and Grails at the September St. Louis Java SIG meeting. Presentation by Jeff Brown, Principal Software Engineer with Object Computing Inc.
meeting	London, UK	community	July 27th	First London Groovy and Grails User Group meeting at skillsmatter
half-day tutorial	Minneapolis, Minnesota, USA	Paul King	July 26th	Agile Testing of Web Applications using WebTest including Groovy usage at Agile 2006
seminar	London, UK	Graeme Rocher, Dierk König	July 13th	Groovy and Grails at skillsmatter
talk	Stuttgart, Germany	Dierk König, Bernd Schiffer	July 6th	Groovy intro at Java forum Stuttgart
round table	Versailles, France	Guillaume Laforge	June 29th	Xwiki, Hibernate, Groovy: The French Java OpenSource Vitality and Round Table - JavaOne 2006: Ask The Experts with James Gosling at JavaDay 2006
talk	Adelaide, Australia	Peter Kelly	June 19th	GRAILS; the "other" code quest at Adelaide

				Australia JUG
talk	Salt Lake City, Utah, USA	Dr. Venkat Subramaniam	June 17th	Groovy for Java Programmers at No Fluff Just Stuff
talk	Salt Lake City, Utah, USA	Dr. Venkat Subramaniam	June 17th	Get Groovier with Grails at No Fluff Just Stuff
talk	Salt Lake City, Utah, USA	Scott Davis	June 16th	Groovy - Greasing the Wheels of Java at No Fluff Just Stuff
talks	San Francisco, CA, USA	Guillaume Laforge, Tugdual Grall, Graeme Rocher, Rod Cope	June 16-19	multiple events at Java One
talk	Calgary, Alberta, Canada	Scott Davis	June 14th	Groovy - Greasing the Wheels of Java at Calgary JUG
talk	?	Dr. Venkat Subramaniam	June 5th	Groovy for Java Developers at No Fluff Just Stuff
talk	Houston, TX, USA	Scott Davis	May 31st	Groovy - Greasing the Wheels of Java at Houston JUG
talk	Austin, TX, USA	Scott Davis	May 30th	Groovy - Greasing the Wheels of Java at Austin JUG
talk	Wiesbaden, Germany	Dierk König	May 11th	Groovy intro at JAX
talk	Brisbane, Australia	Paul King, Rob Manthey	March 13th	Groovy and Grails Intro at the March QLD meeting of AJUG

Mailing Lists

This page last changed on Aug 02, 2006 by [paulk_asert](#).

Here are the public mailing lists that have been set up for the project. In order to subscribe/unsubscribe you first need to get a special link from http://xircles.codehaus.org/manage_email. Once you have got this link you can manage your subscriptions by going to the Groovy project page <http://xircles.codehaus.org/projects/groovy>.

<code>announce@groovy.codehaus.org</code>	is a low volume list for announcements about new releases or major news
<code>dev@groovy.codehaus.org</code>	is a medium volume list useful for those interested in ongoing developments
<code>jsr@groovy.codehaus.org</code>	is a low volume list discussing standardisation of the language through the JCP
<code>scm@groovy.codehaus.org</code>	is a high volume list that logs commits and issues
<code>user@groovy.codehaus.org</code>	is a high volume list is for questions and general discussion about Groovy

You can find a great archive support on [Nabble](#).

News

This page last changed on Mar 05, 2007 by [mittie](#).

In addition to the official Groovy news below, you may also want to check out

- the Groovy news provider <http://aboutgroovy.com>
- the Groovy blog aggregator <http://groovyblogs.org>

Both of them were written in Grails (and thus Groovy)!

The Groovy News

 [Thursday, April 26, 2007](#)

[Groovy wins first prize at JAX 2007 innovation award](#)

Last changed: Apr 26, 2007 15:24 by [Guillaume Laforge](#)

[JAX](#) is the **most important Java conference in Germany**. Every year, the organizers are running a [contest](#) to select the **most innovative and creative projects**. From [over 40 proposals](#), the jury selected only [ten nominees](#). Although great projects were selected, like the Matisse GUI builder in NetBeans, or the [Nuxeo](#) Enterprise Content Management solution, **Groovy won the first prize!** It is a great honor and a huge pleasure for us to receive such a prize, especially knowing the cool projects we were competing with, or the [past winners](#) like the Spring framework.

[Dierk König](#), author of the best-selling "[Groovy in Action](#)" book, received the prize in the name of the Groovy community, after having presented several sessions on Groovy at this conference. Dierk took a [picture of the prize](#) if you want to see what it looks like.

This award proves how innovative, creative and influential the Groovy project is for the Java community. After a **1.0 release** this year, and a **book**, with IDE makers working on **IDE plugin support** for the language, with many **companies betting on Groovy** for writing business rules or for scripting their products, with dedicated [news sites](#) and [feed aggregators](#), with [dedicated conferences](#) and tracks, and with over [10 sessions](#) about [Groovy](#) and [Grails](#) at the upcoming [JavaOne](#), Groovy stands out of the crowd and proves it's a very **successful and mature project**.

I would like to seize this opportunity to thank all the Groovy committers and contributors who helped develop this project, as well as the whole Groovy community without which Groovy wouldn't be as great and as cool as it is today. This award is really to all of you, and you're all part of this incredible success.

Update: JAX now lists the winners and has got [some pictures](#) of Dierk receiving the award

Posted at 26 Apr @ 1:56 AM by  [Guillaume Laforge](#) |  [3 comments](#)

 [Sunday, March 25, 2007](#)

[Groovy Series about Regular Expressions available!](#)

Last changed: Mar 25, 2007 14:08 by [Sven Haiges](#)

The next part of the [Groovy Series](#) is available, this time Dierk König and Sven Haiges talk about Regular Expressions. As always, this episode is complemented with a few code snippets at [snipplr.com](#). If you don't want to miss an episode, subscribe via the [Grails Podcast](#) RSS Feed:

<http://hansamann.podspot.de/rss>;

Posted at 25 Mar @ 2:08 PM by  [Sven Haiges](#) |  [0 comments](#)

 [Monday, March 12, 2007](#)

[Community resources, conferences and IDE support](#)

Last changed: Mar 12, 2007 05:23 by [Guillaume Laforge](#)

As always, lots of great things are happening in the [Groovy](#) and [Grails](#) community. If you'd like to stay up-to-date with the news, but if you don't want to spend the whole day reading our high-traffic [mailing-lists](#), you should certainly consider subscribing to one of these two resources:

- [AboutGroovy](#): The community portal news site about everything Groovy and Grails, with frequent news items, podcast interviews, pointers to important resources.
- [GroovyBlogs](#): A JavaBlog-like news agregator agregating the Groovy and Grails mailing-lists feeds, and many feeds from famous bloggers spreading the Groovy and Grails love.

Both of these resources have been developed in Grails! [GroovyBlogs](#) has even been developed in under 24 hours by Glen Smith!

Conferences

I also wanted to say a few words about upcoming conference events.

- A preliminary search on [JavaOne](#)'s online [catalog](#) shows no less than 8 sessions mentioning Groovy! It's already two more sessions than last year's JavaOne! Of higher importance to me, of course, are the two sessions I'm involved with:
 - **TS-1742: Cool things you can do with the Groovy programming language**, with Guillaume Alléon and Dierk Koenig.
 - **BOF-6133: Grails: Spring + Hibernate development re-invented**, with Graeme Rocher.

So don't forget to come to JavaOne and hear about the latest news about Groovy and Grails.

- Now, for a shorter-term aspect, let me mention I'll be at [QCon](#) this week, in London. I'll be happy to present two sessions:
 - [Implementing Domain-Specific Languages in Groovy](#): John Wilson and myself will be explaining how to create DSLs with the help of Groovy. That's an area where Groovy particularly shines, thanks to its maleable syntax and its natural expressivity.
 - [Grails: Spring + Hibernate development re-invented](#): As Graeme Rocher will be at Sun's TechDays in London, he couldn't do the two sessions in parallel, so I'm replacing Graeme, and will be explaining how Grails simplifies the development of Web applications.
- [Sun TechDays in Paris](#): on March 20th/21st, I'll be on stage at Sun's Parisian TechDays worldwide tour to speak about Groovy as an [alternative language for the JVM](#). Like last year, James Gosling will be present! And I still recall the pleasure I felt when [Gosling told me he'd used Groovy on a couple of internal projects at Sun](#) and said he enjoyed it a lot! That's also what he has written in his foreword of our book: [Groovy in Action](#). Speaking of "GinA", I also encourage you to [read Slashdot's review](#).
- Last but not least, the much awaited [Grails eXchange conference](#) will take place in London at the end of May: a dedicated conference to Groovy and Grails! This is the first event of this kind, but more are to be expected, both in the US and in Europe! An incredible line of renown speakers have already signed in: Rod Johnson, Joe Walker, Rob Harrop, Rod Cope, Dierk Koenig, Joe Walnes, etc... This is your best opportunity to meet all the guys who make Groovy and Grails, and to hear the

latest tricks from famous Java champions.

Groovy IDE Plugins

Some additional Groovy news: the complaint we often hear about is the lack of tooling support. Groovy has had basic plugins for all the major IDEs and text editors, but this is not sufficient. Fortunately, IDE support is high on our list for 2007, and I can tell you there are some great things to come on that front:

- First of all, the [Eclipse plugin](#) is making great progress, and code-completion is not very far. You should read Ed's blog to see [some nice screenshots](#) of the completion he's working on this month.
- Some guys at Sun are also investigating how to develop and [Grails IDE for NetBeans](#). It could be based on the stagnant Coyote Groovy plugin, and would provide wizards for Grails artifacts, as well as all the Groovy support that's needed.
- My [favorite Java IDE](#) is not forgotten either, since [JetBrains](#) is investigating how to retrieve the [GroovyJ](#) plugin and to make it work as good as they made their JavaScript or Ruby integrations.

So you can expect a very high and good support for Groovy and Grails in the mainstream IDEs! As I said, a lot is happening in the Groovy and Grails community, it's hard to follow everything. 2007 is really the year of Groovy and Grails!

Posted at 12 Mar @ 5:14 AM by  [Guillaume Laforge](#) |  [0 comments](#)

 [Thursday, March 1, 2007](#)

[First Episode of the Groovy Series Podcast available](#)

For all new to Groovy, the Groovy Series Podcast might be what you are looking for. Dierk König, the lead author of Groovy in Action and Sven Haiges talk about Groovy Code. The first episode is about Groovy GStrings, if interested check out the [Groovy Series](#) wiki page. Please note that the Groovy Series is part of the Grails Podcast, so by subscribing to the Podcast RSS feed, you will also get the latest Grails Podcast episodes delivered right into your podcatcher. Enjoy!

Posted at 01 Mar @ 3:21 AM by  [Sven Haiges](#) |  [0 comments](#)

 [Friday, January 26, 2007](#)

[Win a free copy of Groovy in Action at the release party contest!](#)

This year started with two important events: the availability of the Groovy in Action book and the final release of Groovy 1.0. Both events will be celebrated with a global release party on January 29th. The idea is to have numerous parties with Groovy enthusiasts all over the planet: Paris, London, Berlin, Munich, Jamaica, Uruguay, and so on. Make sure to find the [party near you](#).

Pictures of this event will be uploaded to [flickr with groovyparty tag](#).

Now the best part. Manning promotes this event with running the following contest:

Send Manning your Groovy photos from Global Groovy 1.0 day and win!

Download a cover image of [Groovy in Action](#), print it out and take it to your party on January 29th. Photo must show our poster, clearly indicate the location of the party, and have at least 2 people in the photo.

Any person who sends in a photo that fulfills the easy requirements will receive a **40% off coupon** good for any Manning title (good for up to \$100 purchase).

The **top 5 photos** (based on some Groovy theme) will get a **free Groovy in Action** print edition.

Photos must be sent as .jpg files to mkt [at] manning [dot] com. One entry per contestant, one prize per entry. Names and emails must be included with photo submission. Entries must be received by February 5, 2007.

Questions: Visit [Manning](#) and look for the Global Groovy 1.0 banner in the right hand column.

So, everybody: don't hesitate to invite your friends organize your party!
Dierk

Posted at 26 Jan @ 4:58 PM by  [Dierk Koenig](#) |  [0 comments](#)

Read more News on the [Groovy Blog](#)

Syndicate this site via [RSS](#)

Related Projects

This page last changed on Mar 10, 2007 by [glaforge](#).

This page lists projects using Groovy in some way. Please add your project to this page.

Lightweight containers, J2EE & AOP

- [Spring](#) has [Groovy Spring](#)
- [NanoContainer](#) is a script front-end for PicoContainer.
- [PicoContainer](#) has [Groovy Pico](#). here's an [example test case](#)
- [ServiceMix](#) is an open source JBI / ESB and has full [Groovy support](#)
- [OpenEJB](#) which has a Groovy telnet shell for querying EJBs while the server's live 😊
- [GAP](#) using Groovy [dynAop](#) and Pico
- The Turbine [Fulcrum Groovy Service](#) executes Groovy scripts managed by the Fulcrum ResourceManager Service. It provides the following features:
 - caching of Groovy scripts to improve performance
 - thread-safe execution of compiled Groovy scripts
 - seamless integration with the existing Avalon infrastructure.
- [1060 NetKernel](#) has [Groovy support](#) for creating scripted services and service orchestration.

Blog/Wiki, CMS, Portal projects

- [SnipSnap](#) has some nice Groovy support allowing to admins to write [GSP](#) pages.
- [XWiki](#) also comes with [GSP](#) support and has some nice examples of using it, e.g. [live RegEx testing](#).
- [biscuit](#) is an all-groovy wiki made by Groovy committer Jeremy Rayner.
- [blojsom](#)
- [WidgetWeb](#)
- [eXo Platform](#)

Web frameworks

- [NanoWeb](#)
- [RIFE](#)
- [Simple](#) Advanced Groovy templating, provides a lightweight version of Struts Tiles
- [Groovy Tapestry](#)
- [GvTags](#) Template engine with tag lib support for Groovy and JSP tag library

Testing Tools

- [Canoo WebTest](#) allows specifying Test Steps scripted in Groovy, bundling a series of Tests Steps with the MacroStepBuilder, and creating a whole WebTest using the AntBuilder. see [GroovyWebTest](#)

Web Service Tools

- [soapui](#) Has a Groovy test step. The Groovy Script step allows you to specify an arbitrary Groovy script during the execution of a TestCase. The script has full access to the soapui object model and can thus perform a variety of tasks. Read more: [Groovy Scripts](#)

Other

- [GroovyRules](#) is a JSR-94 compliant lightweight rules engine that permits defining rules in Groovy
- [PLEAC-Groovy](#) is an implementation of the Solutions of the Perl Cookbook in the Groovy language.
- [FreeMind](#) is a mindmapping tool that supports [scripting mindmaps with Groovy](#). Furthermore, the Groovy compiler can produce a visual representation of Groovy code as a FreeMind *.mm file. Start the compiler with the -Dantlr.ast=mindmap option.
- [Funkee](#) is a Groovy Scripting Host that shows a nice little smiley on your desktop that you can click to open a Groovy source code editor, or for running Groovy scripts, as well as other scripting languages.
- [GAQ](#) is a lightweight framework for developing, scheduling, running and reviewing automated tasks. It combines the scripting ease of Groovy, the power of Ant, and the cross platform scheduling of Quartz.
- [Luxor XUL](#) is an XUL language extension that comes with [Groovy Support](#).
- [Hierarchical Inherited Rule-Interpreted XML](#) is a dynamic XML Engine that creates dynamic DOMs built on dynamic rules and expressions where Groovy is available to be used as the expression interpreter.

Release Process

This page last changed on Sep 24, 2006 by [paulk_asert](#).

- let folks know a release is about to occur. Maybe on #groovy let people know or mail the mail list.
- get a nice clean CVS checkout
- make sure you've got Maven 1.0.2 or later installed
- update the version in project.xml to the next version number & check it in
- you need to go into the modules/xmlrpc/project.xml and update the version of groovy to the one we're about to release
- add the release version to the project.xml's versions
- label it as something like GROOVY_9_9_beta_9

Then in groovy/groovy-core type

```
maven groovy:release
```

If there is no new documentation then type

```
maven site:deploy javadoc:deploy
```

- check that the files at <http://dist.codehaus.org/groovy/> look OK
- now change the version number in the project.xml file to be nextReleaseNumber-SNAPSHOT
- you probably need to scp the groovy-all-*.jar file to user@beaver.codehaus.org:/dist/groovy/jars as the release doesn't do this 😞
- update JIRA to inform it that a release has been done so that the change log is updated and any pending issues transfer over to the next release
- maybe create a new JIRA release name for associating pending issues against
- mail the dev/user lists
- blog it!
- have a beer!

build.properties

In order to make a release, you might also have to define some properties in your build.properties file in groovy-core like that:

```
# potentially define the ssh/scp tools you're using on your platform
#maven.ssh.executable=ssh
#maven.scp.executable=scp
#maven.site.deploy.method=ssh

# define your username, private ssh key path, and your passphrase
maven.repo.codehaus.username=xxx
maven.repo.codehaus.privatekey=xxx
maven.repo.codehaus.passphrase=xxx
maven.username=xxx
```


Success Stories

This page last changed on Jan 05, 2007 by raffaele.castagno@gmail.com.

This page contains Success Stories from groovy users. A Success Story should contain information about the company, the project, the number of people involved, and eventually a link the homepage of the project or company. It would be nice to include statements about how groovy impacted on the company.

It would also be nice to include companies "know or suspected" to use groovy, providing evidences of this (articles, statements, etc).

We use Groovy!

Company:
Project:
Description:
Link:;

Seems they use Groovy...

Company:
Project:
Description:
Link:

User Groups

This page last changed on Jan 08, 2007 by [hansamann](#).

The first user group so far is the

- [London Groovy and Grails User Group](#)

The first German user group so far is the

- [Special Interest Group \(SIG\) "Groovy" in der JUGS \(Java User Group Stuttgart\)](#)

There are plans to open a second German User Group in Munich, we will use this Wiki page to inform you about first dates. So far this is the plan:

- proposed meeting space is Actionality, Schellingstraße 45, Munich. Exit the underground station "Universität" and walk down the "Schellingstraße" to get there. Open for other places in Munich.
- propose schedule: once a month, evening from 18:00 to 19:00 or open end - we still have to agree on exakt dates
- Topics would include anything around Groovy: Groovy discussions (Features), Web Frameworks using Groovy (Grails, Aero, Rife), anything you want to talk about

Getting Started Guide

This page last changed on Sep 27, 2006 by paulk_asert.

- [Beginners Tutorial](#)
 - [Tutorial 1 - Getting started](#)
 - [Tutorial 2 - Code as data, or closures](#)
 - [Tutorial 3 - Classes and Objects](#)
 - [Tutorial 4 - Regular expressions basics](#)
 - [Tutorial 5 - Capturing regex groups](#)
 - [Tutorial 6 - Groovy SQL](#)
- [Design Patterns with Groovy](#)
 - [Visitor Pattern](#)
- [Differences from Java](#)
- [Differences from Ruby](#)
- [Download](#)
- [Feature Overview](#)
 - [Ant Scripting](#)
 - [Groovlets](#)
 - [Groovy Beans](#)
 - [Groovy Templates](#)
 - [GroovyMarkup](#)
- [For those new to both Java and Groovy](#)
 - [Blocks, Closures, and Functions](#)
 - [Characters in Groovy](#)
 - [Expandos, Classes, and Categories](#)
 - [Groovy BigDecimal Math](#)
 - [Groovy Collections Indepth](#)
 - [Groovy Floating Point Math](#)
 - [Groovy Integer Math](#)
 - [Java Reflection in Groovy](#)
 - [Maps and SortedMaps](#)
 - [Object Arrays](#)
 - [Using the Proxy Meta Class in depth](#)
- [Installing Groovy](#)
- [Quick Start](#)
- [Running](#)

Beginners Tutorial

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Welcome on board the Groovy flight. Before proceeding through the content of this tutorial, please make sure to fasten your seat belt, before we take off to higher levels of grooviness...

This page is intended to get you started with Groovy, following a trail of a few tutorial labs on various topics mainly oriented towards typical use of scripting languages for data crunching or text manipulation.

Graham Miller, a Groovy aficionado, has been teaching a class of business on data crunching. And he was kind enough to contribute back to the Groovy project this great set of educational material to help you learn Groovy, using some nice examples to massage, summarize and analyze data – a task for which Groovy is a quite good fit.

The topics covered are about Groovy basics, text parsing, regular expressions, SQL, and web-scraping:

- [Getting started](#)
- [Code as data](#)
- [Classes and Objects](#)
- [Regular Expressions](#)
- [Capturing groups](#)
- [Groovy SQL](#)

If you are a Java developer

- you might want to check on the [Differences from Java](#)
- also there are a few [Things to remember](#)

Tutorial 1 - Getting started

This page last changed on Jan 12, 2007 by [ichan](#).

Getting Started

Setting up your Java environment

Groovy requires Java, so you need to have a version available (1.4 or greater is required). Here are the steps if you don't already have Java installed:

- Get the latest Java distribution from the <http://java.sun.com> website.
- Run the installer.
- Set the JAVA_HOME environment variables. On Windows, follow these steps:
 - Open the System control panel
 - Click the Advanced tab
 - Click the Environment Variables button
 - Add a new System variable with the name JAVA_HOME and the value of the directory Java was installed in (mine is C:\Program Files\Java\jdk1.5.0_04)
 - Optionally add %JAVA_HOME%\bin to your system path(Note: as an alternative to setting a system environment variable, you can create yourself a '.bat' or '.cmd' file which sets the variable. You then need to run that batch file in any console window in which you wish to run Java and double clicking on '.bat' or '.cmd' files containing Java invocation instructions won't work. If you are unsure about what this means, follow the earlier instructions.)

Setting up your Groovy environment

- Get a copy of the Groovy distribution from the [website](#), and copy it to some place on your hard drive.
- Unzip the groovy archive to some logical place on your hard drive, I have mine in C:\dev\groovy-1.0-jsr-06
- Set the GROOVY_HOME environment variables. On Windows, follow these steps:
 - Add a new System variable with the name GROOVY_HOME and the value of the directory groovy was installed in (mine is C:\dev\groovy-1.0-jsr-06)
 - Start a command prompt, and type "set" and hit return to see that your environment variables were set correctly.
- Optionally add %GROOVY_HOME%\bin to your system path
- Try opening groovyConsole.bat by double clicking on the icon in the bin directory of the Groovy distribution. If it doesn't work, open a command prompt, and change to the bin directory and run it from there to see what the error message is.

Setting up optional jar files

You may wish to obtain optional jar files, either corresponding to Groovy modules (see module documentation for details) or corresponding to other Java classes you wish to make use of from Groovy.

Some possibilities are listed below:

Name	From	Description
jtds-version.jar	http://jtds.sourceforge.net	Database driver for SQL Server and/or Sybase
hsqldb-version.jar	http://www.hsqldb.org/	Database driver for HSQLDB, a 100% Java database

The recommended way for making Groovy be aware of your additional jar files is to place them in a predefined location. Your Groovy install should include a file called `groovy-starter.conf`. Within that file, make sure a line such as

```
load ${user.home}/.groovy/lib/*
```

is not commented out. The `user.home` system property is set by your operating system. (Mine is `C:\Document and Settings\paul`. Now simply place your jar files into the `.groovy/lib` directory. (Note: as an alternative, you can set up a `CLASSPATH` variable and make sure it mentions all of your additional jar files, otherwise Groovy works fine with an empty or no `CLASSPATH` variable.)

Hello, World

In the top part of the window of the `groovyConsole`, type the following

```
println "Hello, World!"
```

And then type <CTRL-R>.

Notice that the text gets printed out in the OS console window (the black one behind the `groovyConsole` window) and the bottom part of the `groovyConsole` says:

```
groovy> println "Hello, World!"
null
```

The line starting with "groovy>" is just the text of what the console processed. The "null" is what the expression "evaluated to". Turns out the expression to print out a message doesn't have any "value" so the `groovyConsole` printed "null".

Next try something with an actual value. Replace the text in the console with:

```
123+45*67
```

or your favorite arithmetic expression, and then type <CTRL-R> (I'm going to stop telling you to hit <CTRL-R>, I think you get the idea). Now the "value" printed at the bottom of the `groovyConsole` has more meaning.

Variables

You can assign values to variables for later use. Try the following:

```
x = 1
println x

x = new java.util.Date()
println x

x = -3.1499392
println x

x = false
println x

x = "Hi"
println x
```

Lists and Maps

The Groovy language has built-in support for two important data types, lists and maps (Lists can be operated as arrays in Java language). Lists are used to store ordered collections of data. For example an integer list of your favorite integers might look like this:

```
myList = [1776, -1, 33, 99, 0, 928734928763]
```

You can access a given item in the list with square bracket notation (indexes start at 0):

```
println myList[0]
```

Should result in this output:

```
1776
```

You can get the length of the list with the "size" method:

```
println myList.size()
```

Should print out:

```
6
```

But generally you shouldn't need the length, because unlike Java, the preferred method to loop over all the elements in an list is to use the "each" method, which is described below in the "Code as Data" section.

Another native data structure is called a map. A map is used to store "associative arrays" or "dictionaries". That is unordered collections of heterogeneous, named data. For example, let's say we wanted to store names with IQ scores we might have:

```
scores = [ "Brett":100, "Pete":"Did not finish", "Andrew":86.87934 ]
```

Note that each of the values stored in the map is of a different type. Brett's is an integer, Pete's is a string, and Andrew's is a floating point number. We can access the values in a map in two main ways:

```
println scores["Pete"]  
println scores.Pete
```

Should produce the output:

```
Did not finish  
Did not finish
```

To add data to a map, the syntax is similar to adding values to a list. For example, if Pete re-took the IQ test and got a 3, we might:

```
scores["Pete"] = 3
```

Then later when we get the value back out, it will be 3.

```
println scores["Pete"]
```

should print out 3.

Also as an aside, you can create an empty map or an empty list with the following:

```
emptyMap = [:]  
emptyList = []
```

To make sure the lists are empty, you can run the following lines:

```
println emptyMap.size()  
println emptyList.size()
```

Should print a size of 0 for the List and the Map.

Conditional Execution

One of the most important features of any programming language is the ability to execute different code under different conditions. The simplest way to do this is to use the "if" construct. For example:

```

amPM = Calendar.getInstance().get(Calendar.AM_PM)
if (amPM == Calendar.AM)
{
    println("Good morning")
} else {
    println("Good evening")
}

```

Don't worry too much about the first line, it's just some code to determine whether it is currently before noon or after. The rest of the code executes as follows: first it evaluates the expression in the parentheses, then depending on whether the result is `""true""` or `""false""` it executes the first or the second code block. See the section below on boolean expressions.

Note that the `"else"` block is not required, but the `"then"` block is:

```

amPM = Calendar.getInstance().get(Calendar.AM_PM)
if (amPM == Calendar.AM)
{
    println("Have another cup of coffee.")
}

```

Boolean Expressions

There is a special data type in most programming languages that is used to represent truth values, `""true""` and `""false""`. The simplest boolean expression are simply those words. Boolean values can be stored in variables, just like any other data type:

```

myBooleanVariable = true

```

A more complex boolean expression uses one of the boolean operators:

```

* ==
* !=
* >
* >=
* <
* <=

```

Most of those are probably pretty intuitive. The equality operator is `""==""` to distinguish from the assignment operator `""=""`. The opposite of equality is the `""!=""` operator, that is `"not equal"`

So some examples:

```

titanicBoxOffice = 1234600000
titanicDirector = "James Cameron"

trueLiesBoxOffice = 219000000
trueLiesDirector = "James Cameron"

returnOfTheKingBoxOffice = 752200000
returnOfTheKingDirector = "Peter Jackson"

theTwoTowersBoxOffice = 581200000

```



```

theTwoTowersDirector = "PeterJackson"

titanicBoxOffice > returnOfTheKingBoxOffice // evaluates to true
titanicBoxOffice >= returnOfTheKingBoxOffice // evaluates to true
titanicBoxOffice >= titanicBoxOffice // evaluates to true
titanicBoxOffice > titanicBoxOffice // evaluates to false
titanicBoxOffice + trueLiesBoxOffice < returnOfTheKingBoxOffice + theTwoTowersBoxOffice //
evaluates to false

titanicDirector > returnOfTheKingDirector // evaluates to false, because "J" is before "P"
titanicDirector < returnOfTheKingDirector // evaluates to true
titanicDirector >= "James Cameron" // evaluates to true

```

Boolean expressions are especially useful when used in conjunction with the "if" construct. For example:

```

if (titanicBoxOffice + trueLiesBoxOffice > returnOfTheKingBoxOffice + theTwoTowersBoxOffice)
{
    println(titanicDirector + " is a better director than " + returnOfTheKingDirector)
}

```

An especially useful test is to test whether a variable or expression is null (has no value). For example let's say we want to see whether a given key is in a map:

```

suvMap = ["Acura MDX":"$36,700", "Ford Explorer":"$26,845"]
if (suvMap["Hummer H3"] != null)
{
    println("A Hummer H3 will set you back "+suvMap["Hummer H3"]);
}

```

Generally null is used to indicate the lack of a value in some location.

Debugging and Troubleshooting Tips

- Print out the class of a variable that you're interested in with `myVar.getClass()`. Then look up the documentation for that class.
- If you're having trouble with a complex expression, pare it down to a simpler expression and evaluate that. Then build up to your more complex expression.
- Try restarting the `groovyConsole` (this will clear out all the variables so you can start over).
- Look for the topic you're interested in in the Groovy [User Guide](#)

If you are a Java developer

- you might want to check on the [Differences from Java](#)
- also there are a few [Things to remember](#)

Tutorial 2 - Code as data, or closures

This page last changed on Nov 19, 2006 by [mcspanky](#).

Closures

One of the things that makes Groovy different than most compiled languages is that you can create functions that are first class objects. That is you can define a chunk of code and then pass it around as if it were a string or an integer. Check out the following code:

```
square = { it * it }
```

The curly braces around the expression "it * it" tells the Groovy compiler to treat this expression as code. In the software world, this is called a "closure". In this case, the designator "it" refers to whatever value is given to the function. Then this compiled function is assigned to the variable "square" much like those above. So now we can do something like this:

```
square(9)
```

and get the value 81.

This is not very interesting until we find that we can pass this function "square" around as a value. There are some built in functions that take a function like this as an argument. One example is the "collect" method on arrays. Try this:

```
[ 1, 2, 3, 4 ].collect(square)
```

This expression says, create an array with the values 1,2,3 and 4, then call the "collect" method, passing in the closure we defined above. The collect method runs through each item in the array, calls the closure on the item, then puts the result in a new array, resulting in:

```
[ 1, 4, 9, 16 ]
```

For more methods you can call with closures as arguments, see the [Groovy GDK documentation](#).

By default closures take 1 parameter called "it", you can also create closures with named parameters. For example the method Map.each() can take a closure with two variables, to which it binds the key and associated value:

```
printMapClosure = { key, value -> println key + "=" + value }  
[ "yue" : "wu", "lane" : "burks", "sudha" : "saseethiaseeleethialeselan" ]  
.each(printMapClosure)
```

Produces:

```
yue=wu
lane=burks
sudha=saseethiasseeleethialeselan
```

More Closure Examples

Here are a few more closure examples. This first one shows a couple of things. First, the closure is interacting with a variable outside itself. That is, the closure's purpose is to put together the parts of a stock order held in the array `orderParts`, by adding (appending) it to the variable `fullString`. The variable `fullString` is not in the closure. The second thing that is different about this example is that the closure is "anonymous", meaning that it is not given a name, and is defined in the place where the `each` method is called.

```
fullString = ""
orderParts = ["BUY", 200, "Hot Dogs", "1"]
orderParts.each {
    fullString += it + " "
}

println fullString
```

You can probably guess what this prints out.

The next example is another anonymous closure, this time, summing up the values stored in a map.

```
myMap = ["asdf": 1 , "qwer" : 2, "sdfg" : 10]

result = 0
myMap.keySet().each( { result+= myMap[it] } )
println result
```

Dealing with Files

Reading data from files is relatively simple. First create a text file, and call it `myfile.txt`. It doesn't matter what's in it, just type some random text into it and save it on your C: drive in the `\temp` directory. Then type the following code in the `groovyConsole`:

```
myFileDirectory = "C:\\temp\\"
myFileName = "myfile.txt"
myFile = new File(myFileDirectory + myFileName)

printFileLine = { println "File line: " + it }

myFile.eachLine( printFileLine )
```

This should print out every line in the file prefixed with "File line: ". The first two lines of the code simply declare variables to specify where the file is located. The variable names don't have any special significance, and as you can see, all we do is combine them when we use them. Note that because the backslash character has special meaning in groovy, you have to use two of them to tell it that you "really" mean a backslash.

The next line that starts "myFile =" creates a new File object. An object is simply a collection of related methods and data. For example, a file object might have data describing its location, in this case "C:\temp\myfile.txt", and maybe a method to delete the file if it exists. In this case the only method we are going to use is the eachLine method, which we call in the last line of code. The line before that is a simple closure definition, that you have seen several times by this point.

Dealing with strings

Strings in Groovy have all the same functionality of Java strings. That is, a Groovy string is just a Java string with a few extra things added to it. Because of that, we can refer to the [Java documentation for the String class](#) to find out some of the interesting things we can do with it. For example, look in the section entitled "Method Summary" at the description for the "split" method. This method does something very useful, which is to split a string based on a regular expression. We will talk more about regular expressions later, but for now the only thing you have to know is that the simplest regular expression is a single character. So let's say that we want to split up the components of the date "2005-07-04", so that we can add one to the year to get the date of next fourth of July. We might:

```
stringDate = "2005-07-04"
dateArray = stringDate.split("-")
year = dateArray[0].toInteger()
year = year + 1
newDate = year + "-" + dateArray[1] + "-" + dateArray[2]
```

This code brings together a bunch of things we have talked about before. There are two new things, first is the use of the split method on a String. Second is the call of toInteger() on a String. This call to toInteger simply tells Groovy that you want to treat that data as a number rather than a String. See what happens if you run the same code without ".toInteger()" at the end of the third line.

Another thing you might notice is that toInteger is not listed in the Java documentation for string. That is because it is one of the extra features that Groovy has added to Strings. You can also take a look at the documentation for the [Groovy extensions to Java objects](#).

Tutorial 3 - Classes and Objects

This page last changed on Apr 24, 2006 by [paulk_asert](#).

Classes and Objects

- Objects are collections of related code and data
- Everything in Java and Groovy can be considered an object
- A class is a higher level description of an object.
 - For example a 10-Q is a specification developed by the SEC and can be thought of as a "Class". A quarterly report issued by **IBM** for Q2 2005 can be thought of as an object of the class 10-Q.
- Documentation for java classes can be found [here](#)
- Documentation for Groovy extensions to Java classes can be found [here](#)

Tutorial 4 - Regular expressions basics

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Regular Expressions

Regular expressions are the Swiss Army knife of text processing. They provide the programmer the ability to match and extract **patterns** from strings. The simplest example of a regular expression is a string of letters and numbers. And the simplest expression involving a regular expression uses the `==~` operator. So for example to match Dan Quayle's spelling of 'potato':

```
"potatoe" ==~ /potatoe/
```

If you put that in the groovyConsole and run it, it will evaluate to true. There are a couple of things to notice. First is the `==` `~` operator, which is similar to the `==` operator, but matches patterns instead of computing exact equality. Second is that the regular expression is enclosed in `/`'s. This tells groovy (and also anyone else reading your code) that this is a regular expression and not just a string.

But let's say that we also wanted to match the correct spelling, we could add a `'?'` after the `'e'` to say that the `e` is optional. The following will still evaluate to true.

```
"potatoe" ==~ /potatoe?/
```

And the correct spelling will also match:

```
"potato" ==~ /potatoe?/
```

But anything else will not match:

```
"motato" ==~ /potatoe?/
```

So this is how you define a simple boolean expression involving a regular expression. But let's get a little bit more tricky. Let's define a method that tests a regular expression. So for example, let's write some code to match Pete Wisniewski's last name:

```
def checkSpelling(spellingAttempt, spellingRegularExpression)
{
    if (spellingAttempt ==~ spellingRegularExpression)
    {
        println("Congratulations, you spelled it correctly.")
    } else {
        println("Sorry, try again.")
    }
}

theRegularExpression = /Wisniewski/
checkSpelling("Wisniewski", theRegularExpression)
```

```
checkSpelling("Wisnewski", theRegularExpression)
```

There are a couple of new things we have done here. First is that we have defined a function (actually a method, but I'll use the two words interchangeably). A function is a collection of code similar to a closure. Functions always have names, whereas closures can be "anonymous". Once we define this function we can use it over and over later.

In this function the **if** statement in bold tests to see if the parameter `spellingAttempt` matches the regular expression given to the function by using the **`==~`** operator.

Now let's get a little bit more tricky. Let's say we also want to match the string if the name does not have the 'w' in the middle, we might:

```
theRegularExpression = /Wisniew?ski/  
checkSpelling("Wisniewski", theRegularExpression)  
checkSpelling("Wisnieski", theRegularExpression)  
checkSpelling("Wisniewewski", theRegularExpression)
```

The single **`?`** that was added to the `spellingRegularExpression` says that the item directly before it (the character 'w') is optional. Try running this code with different spellings in the variable **`spellingAttempt`** to prove to yourself that the only two spellings accepted are now "Wisniewski" and "Wisnieski". (Note that you'll have to leave the definition of `checkSpelling` at the top of your `groovyConsole`)

The **`*?*`** is one of the characters that have special meaning in the world of regular expressions. You should probably assume that any punctuation has special meaning.

Now let's also make it accept the spelling if "ie" in the middle is transposed. Consider the following:

```
theRegularExpression = /Wisn(ie|ei)w?ski/  
checkSpelling("Wisniewski", theRegularExpression)  
checkSpelling("Wisnieski", theRegularExpression)  
checkSpelling("Wisniewewski", theRegularExpression)
```

Once again, play around with the spelling. There should be only four spellings that work, "Wisniewski", "Wisneiowski", "Wisnieski" and "Wisneiowski". The bar character **`|`** says that either the thing to the left or the thing to the right is acceptable, in this case "ie" or "ei". The parentheses are simply there to mark the beginning and end of the interesting section.

One last interesting feature is the ability to specify a group of characters all of which are ok. This is done using square brackets **`*[]*`**. Try the following regular expressions with various misspellings of Pete's last name:

```
theRegularExpression = /Wis[abcd]niewski/ // requires one of 'a', 'b', 'c' or 'd'  
theRegularExpression = /Wis[abcd]?niewski/ // will allow one of 'a', 'b', 'c' or 'd', but not  
required (like above)  
theRegularExpression = /Wis[a-zA-Z]niewski/ // requires one of any upper\_- or lower-case letter  
theRegularExpression = /Wis[^abcd]niewski/ // requires one of any character that is ''not''  
'a', 'b', 'c' or 'd'
```

The last one warrants some explanation. If the first character in the square brackets is a **`*^*`** then it means anything but the characters specified in the brackets.

The operators

So now that you have a sense for how regular expressions work, here are the operators that you will find helpful, and what they do:

Regular Expression Operators

a?	matches 0 or 1 occurrence of *a*	'a' or empty string
a*	matches 0 or more occurrences of *a*	empty string or 'a', 'aa', 'aaa', etc
a+	matches 1 or more occurrences of *a*	'a', 'aa', 'aaa', etc
a b	match *a* or *b*	'a' or 'b' -
.	match any single character	'a', 'q', 'l', '_', '+', etc
[woeirjsd]	match any of the named characters	'w', 'o', 'e', 'i', 'r', 'j', 's', 'd'
[1-9]	match any of the characters in the range	'1', '2', '3', '4', '5', '6', '7', '8', '9'
[^13579]	match any characters not named	even digits, or any other character
(ie)	group an expression (for use with other operators)	'ie'
^a	match an *a* at the beginning of a line	'a'
a\$	match an *a* at the end of a line	'a'

There are a couple of other things you should know. If you want to use one of the operators above to mean the actual character, like you want to match a question mark, you need to put a '\ ' in front of it. For example:

```
// evaluates to true, and will for anything ending in a question mark (that doesn't have a question mark in it)
"How tall is Angelina Jolie?" =~ /^[^?]+\?/
```

This is your first really ugly regular expression. (The frequent use of these in PERL is one of the reasons it is considered a "write only" language). By the way, google knows how tall [she is|<http://www.google.com/search?hl=en&q=how+tall+is+angelina+jolie&btnG=Google+Search>]. The only way to understand expressions like this is to pick it apart:

/	[^?]	+	?	/
begin expression	any character other than '?'	more than one of those	a question mark	end expression

So the use of the \ in front of the ? makes it refer to an actual question mark.

Tutorial 5 - Capturing regex groups

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Capture groups

One of the most useful features of Groovy is the ability to use regular expressions to "capture" data out of a regular expression. Let's say for example we wanted to extract the location data of Liverpool, England from the following data:

```
locationData = "Liverpool, England: 53° 25? 0? N 3° 0? 0?"
```

We could use the `split()` function of string and then go through and strip out the comma between Liverpool and England, and all the special location characters. Or we could do it all in one step with a regular expression. The syntax for doing this is a little bit strange. First, we have to define a regular expression, putting anything we are interested in in parentheses.

```
myRegularExpression = /([a-zA-Z]+), ([a-zA-Z]+): ([0-9]+). ([0-9]+). ([0-9]+). ([A-Z])
([0-9]+). ([0-9]+). ([0-9]+)./
```

Next, we have to define a "matcher" which is done using the `=~` operator:

```
matcher = ( locationData =~ myRegularExpression )
```

The variable `matcher` contains a `java.util.regex.Matcher` as enhanced by groovy. You can access your data just as you would in Java from a `Matcher` object. A groovier way to get your data is to use the `matcher` as if it were an array--a two dimensional array, to be exact. A two dimensional array is simply an array of arrays. In this case the first "dimension" of the array corresponds to each match of the regular expression to the string. With this example, the regular expression only matches once, so there is only one element in the first dimension of the two-dimensional array. So consider the following code:

```
matcher[0]
```

That expression should evaluate to:

```
["Liverpool, England: 53° 25? 0? N 3° 0? 0?", "Liverpool", "England", "53", "25", "0", "N",
"3", "0", "0"]
```

And then we use the second dimension of the array to access the capture groups that we're interested in:

```
if (matcher.matches()) {
    println(matcher.getCount()+ " occurrence of the regular expression was found in the
string.");
    println(matcher[0][1] + " is in the " + matcher[0][6] + " hemisphere. (According to: "
+ matcher[0][0] + ")")
}
```

Notice that the extra benefit that we get from using regular expressions is that we can see if the data is well-formed. That is if **locationData** contained the string "Could not find location data for Lima, Peru", the if statement would not execute.

Non-matching Groups

Sometimes it is desirable to group an expression without marking it as a capture group. You can do this by enclosing the expression in parentheses with `?:` as the first two characters. For example if we wanted to reformat the names of some people, ignoring middle names if any, we might:

```
names = [
    "Graham James Edward Miller",
    "Andrew Gregory Macintyre"
]

printClosure = {
    matcher = (it =~ /(.*?)(?: .+)+ (.*)/); // notice the non-matching group in the middle
    if (matcher.matches())
        println(matcher[0][2]+", "+matcher[0][1]);
}
names.each(printClosure);
```

Should output:

```
Miller, Graham
Macintyre, Andrew
```

That way, we always know that the last name is the second matcher group.

Replacement

One of the simpler but more useful things you can do with regular expressions is to replace the matching part of a string. You do that using the `replaceFirst()` and `replaceAll()` functions on `java.util.regex.Matcher` (this is the type of object you get when you do something like `myMatcher = ("a" += /b/);`).

So let's say we want to replace all occurrences of Harry Potter's name so that we can resell J.K. Rowlings books as Tanya Grotter novels (yes, someone tried this, Google it if you don't believe me).

```
excerpt = "At school, Harry had no one. Everybody knew that Dudley's gang hated that odd Harry Potter "+
    "in his baggy old clothes and broken glasses, and nobody liked to disagree with Dudley's gang.";
matcher = (excerpt =~ /Harry Potter/);
excerpt = matcher.replaceAll("Tanya Grotter");

matcher = (excerpt =~ /Harry/);
excerpt = matcher.replaceAll("Tanya");
println("Publish it! "+excerpt);
```

In this case, we do it in two steps, one for Harry Potter's full name, one for just his first name.

Reluctant Operators

The operators `?`, `+`, and `*` are by default "greedy". That is, they attempt to match as much of the input as possible. Sometimes this is not what we want. Consider the following list of fifth century popes:

```
popesArray = [  
    "Pope Anastasius I 399-401",  
    "Pope Innocent I 401-417",  
    "Pope Zosimus 417-418",  
    "Pope Boniface I 418-422",  
    "Pope Celestine I 422-432",  
    "Pope Sixtus III 432-440",  
    "Pope Leo I the Great 440-461",  
    "Pope Hilarius 461-468",  
    "Pope Simplicius 468-483",  
    "Pope Felix III 483-492",  
    "Pope Gelasius I 492-496",  
    "Pope Anastasius II 496-498",  
    "Pope Symmachus 498-514"  
]
```

A first attempt at a regular expression to parse out the name (without the sequence number or modifier) and years of each pope might be as follows:

```
/Pope (.*)?(?: .*)? ([0-9]+)-([0-9]+)/
```

Which splits up as:

/	Pope	(.*)	(?: .*)?	([0-9]+)	-	([0-9]+)	/
begin expression	Pope	capture some characters	non-capture group: space and some characters	capture a number	-	capture a number	end expression

We hope that then the first capture group would just be the name of the pope in each example, but as it turns out, it captures too much of the input. For example the first pope breaks up as follows:

/	Pope	(.*)	(?: .*)?	([0-9]+)	-	([0-9]+)	/
begin expression	Pope	Anastasius I		399	-	401	end expression

Clearly the first capture group is capturing too much of the input. We only want it to capture *Anastasius*, and the modifiers should be captured by the second capture group. Another way to put this is that the first capture group should capture as little of the input as possible to still allow a match. In this case it would be everything until the next space. Java regular expressions allow us to do this using "reluctant" versions of the `*`, `+` and `?` operators. In order to make one of these operators reluctant, simply add a `?` after it (to make `*?`, `+?` and `??`). So our new regular expression would be:

```
/Pope (.*)?(?: .*)? ([0-9]+)-([0-9]+)/
```

So now let's look at our new regular expression with the most difficult of the inputs, the one before Pope

Hilarius (a real jokester), breaks up as follows:

/	Pope	(.*)?	(?: .*)?	([0-9]+)	-	([0-9]+)	/
begin expression	Pope	Leo	I the Great	440	-	461	end expression

Which is what we want.

So to test this out, we would use the code:

```
popesArray = [
  "Pope Anastasius I 399-401",
  "Pope Innocent I 401-417",
  "Pope Zosimus 417-418",
  "Pope Boniface I 418-422",
  "Pope Celestine I 422-432",
  "Pope Sixtus III 432-440",
  "Pope Leo I the Great 440-461",
  "Pope Hilarius 461-468",
  "Pope Simplicius 468-483",
  "Pope Felix III 483-492",
  "Pope Gelasius I 492-496",
  "Pope Anastasius II 496-498",
  "Pope Symmachus 498-514"
]

myClosure = {
  myMatcher = (it =~ /Pope (.*)?(?: .*)? ([0-9]+)-([0-9]+)/);
  if (myMatcher.matches())
    println(myMatcher[0][1]+": "+myMatcher[0][2]+" to "+myMatcher[0][3]);
}

popesArray.each(myClosure);
```

Try this code with the original regular expression as well to see the broken output.

Tutorial 6 - Groovy SQL

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Groovy SQL

This section some content from this [GroovySQL article](#), by Andrew Glover. If some of the references to JDBC don't make sense, don't worry. There is one new language construct that is used below, which is the inclusion of variables in string definitions. For example try the following:

```
piEstimate = 3;
println("Pi is about ${piEstimate}");
println("Pi is closer to ${22/7}");
```

As you can see, in a string literal, Groovy interprets anything inside `${}` as a groovy expression.

This feature is used extensively below.

Performing a simple query

Your first Groovy SQL code consists of three lines.

```
import groovy.sql.Sql
sql = Sql.newInstance("jdbc:jtds:sqlserver://serverName/dbName-CLASS;domain=domainName",
"username",
"password", "net.sourceforge.jtds.jdbc.Driver")
sql.eachRow("select * from tableName", { println it.id + " -- ${it.firstName} --" } );
```

The first line is a Java import. It simply tells Groovy the full name of the Sql object. The second line creates a new connection to the SQL database, and stores the connection in the variable sql.

This code is written for a jTDS connection to a MS SQL Server database. You will need to adjust all the parameters to newInstance to connect to your database, especially **username** and **password**.

Finally the third line calls the eachRow method of sql, passing in two arguments, the first being the query string, the second being a closure to print out some values.

Notice that in the closure the fields of "it" are accessed in two different ways. The first is as a simple field reference, accessing the id field of it. The second is the included Groovy expression mentioned above.

So the output from a row might look like:

```
001 -- Lane --
```

Doing more complex queries

The previous examples are fairly simple, but GroovySql is just as solid when it comes to more complex data manipulation queries such as insert, update, and delete queries. For these, you wouldn't necessarily want to use closures, so Groovy's Sql object provides the `execute` and `executeUpdate` methods instead. These methods are reminiscent of the normal JDBC statement class, which has an `execute` and an `executeUpdate` method as well.

Here you see a simple insert that uses variable substitution again with the `${}` syntax. This code simply inserts a new row into the people table.

```
firstName = "yue"
lastName = "wu"
sql.execute("insert into people (firstName, lastName) "+
    " values ('${firstName}', '${lastName}')")
```

Note that in this example you have to put quotes around any string data in the insert statement. This is generally not a great way to do things (think about what happens if your data contains a quote character). A better way to do the same thing is to use prepared statements as follows:

```
firstName = "yue"
lastName = "wu"
sql.execute("insert into people (firstName, lastName) "+
    " values (?,?)", [firstName, lastName])
```

The data that you want to insert is replaced with `"?"` in the insert statement, and then the values are passed in as an array of data items. Updates are much the same in that they utilize the `executeUpdate` method. Notice, too, that in Listing 8 the `executeUpdate` method takes a list of values that will be matched to the corresponding `?` elements in the query.

```
comment = "Lazy bum"
sql.executeUpdate("update people set comment = ? where id=002", [comment])
```

Deletes are essentially the same as inserts, except, of course, that the query's syntax is different.

```
sql.execute("delete from word where word_id = ?" , [5])
```

Design Patterns with Groovy

This page last changed on Mar 26, 2007 by [blackdrag](#).

- [Visitor Pattern](#)

Visitor Pattern

This page last changed on Mar 26, 2007 by [blackdrag](#).

The visitor pattern is of these known, but not often used patterns. I think this is strange, as it is really a nice thing.

What is it used for?

Basically it used to iterate over a tree structure where each node might be of a different type and an iterator has to react to these types different.

Example

```
interface Visitor {
    public void visit(NodeType1 n1);
    public void visit(NodeType2 n2);
}

interface Visitable {
    public void accept(Visitor visitor);
}

class NodeType1 implements Visitable {
    Visitable[] children = new Visitable[0];
    public void accept(Visitor visitor) {
        visitor.visit(this);
        for(int i = 0; i < children.length; ++i) {
            children[i].accept(visitor);
        }
    }
}

class NodeType2 implements Visitable {
    Visitable[] children = new Visitable[0];
    public void accept(Visitor visitor) {
        visitor.visit(this);
        for(int i = 0; i < children.length; ++i) {
            children[i].accept(visitor);
        }
    }
}

public class NodeType1Counter implements Visitor {
    int count = 0;
    public void visit(NodeType1 n1) {
        count++;
    }
    public void visit(NodeType2 n2){}
}
```

If we now use NodeType1Counter on a tree like this:

```
NodeType1 root = new NodeType1()
root.children = new Visitable[2];
root.children[0] = new NodeType1();
root.children[1] = new NodeType2();
```

Then we have one NodeType1 object as root and one of the children is also a NodeType1 instance. The

other child is a NodeType2 instance. That means using NodeType1Cpunter here should count 2 NodeType1 objects.

Why to use this

As you can see here very good we have a visitor that has a state while the tree of objects is not changed. That's pretty useful in different areas, for example you could have a visitor counting all node types, or how many different types are used, or you could use methods special to the node to gather information about the tree and much more.

What happens if we add a new type?

In this case we have to do much work.. we have to change Visitor to accept the new type, we have to write the new type itself of course and we have to change every Visitor we have already implemented. After very few changes you will modify all your Visitors to extend a default implementation of the visitor, so you don't need to change every Visitor each time you add a new type.

What if we want to have different iteration patterns?

Then you have a problem. since the node describes how to iterate, you have no influence and stop iteration at a point or change the order. so maybe we should change this a little to this:

```
interface Visitor {
    public void visit(NodeType1 n1);
    public void visit(NodeType2 n2);
}

class DefaultVisitor implements Visitor{
    public void visit(NodeType1 n1) {
        for(int i = 0; i < n1.children.length; ++i) {
            n1.children[i].accept(visitor);
        }
    }
    public void visit(NodeType2 n2) {
        for(int i = 0; i < n2.children.length; ++i) {
            n2.children[i].accept(visitor);
        }
    }
}

interface Visitable {
    public void accept(Visitor visitor);
}

class NodeType1 implements Visitable {
    Visitable[] children = new Visitable[0];
    public void accept(Visitor visitor) {
        visitor.visit(this);
    }
}

class NodeType2 implements Visitable {
    Visitable[] children = new Visitable[0];
    public void accept(Visitor visitor) {
        visitor.visit(this);
    }
}
```

```

public class NodeType1Counter extends DefaultVisitor {
    int count = 0;
    public void visit(NodeType1 n1) {
        count++;
        super.visit(n1);
    }
}

```

Some small changes but with big effect... the visitor is now recursive and tells me how to iterate. The implementation in the Nodes is minimized to `visitor.visit(this);`, `DefaultVisitor` is now able to catch the new types, we can stop iteration by not delegating to `super`. Of course the big disadvantage now is that it is no longer iterative, but you can't get all the benefits.

Make it Groovy

The question now is how to make that a bit more Groovy. Didn't you find this `visitor.visit(this);` strange? Why is it there? The answer is to simulate double dispatch. In Java the compile time type is used, so when I `visitor.visit(children[i]);` then the compiler won't be able to find the correct method, because `Visitor` does not contain a method `visit(Visitable)`. And even if it would, we would like to visit the more special methods with `NodeType1` or `NodeType2`.

Now Groovy is not using the static type, Groovy uses the runtime type. This means I could do `visitor.visit(children[i])` directly. Hmm.. since we minimized the `accept` method to just do the double dispatch part and since the runtime type system of Groovy will already cover that.. do we need the `accept` method? I think you can guess that I would answer no. But we can do more. We had the disadvantage of not knowing how to handle unknown tree elements. We had to extend the interface `Visitor` for that, resulting in changes to `DefaultVisitor` and then we have the task to provide a useful default like iterating the node or not doing anything at all. Now with Groovy we can catch that case by adding a `visit(Visitable)` method that does nothing. that would be the same in Java btw.

But don't let us stop here... do we need the `Visitor` interface? If we don't have the `accept` method, then we don't need the `Visitor` interface at all. So the new code would be:

```

class DefaultVisitor {
    void visit(NodeType1 n1) {
        n1.children.each { visit(it) }
    }
    void visit(NodeType2 n2) {
        n2.children.each { visit(it) }
    }
    void visit(Visitable v) {}
}

interface Visitable {}

class NodeType1 implements Visitable {
    Visitable[] children = []
}

class NodeType2 implements Visitable {
    Visitable[] children = []
}

public class NodeType1Counter extends DefaultVisitor {
    int count = 0;
    public void visit(NodeType1 n1) {
        count++
        super.visit(n1)
    }
}

```

```
}
```

Looks like we saved a few lines of code here. But we made more. The Visitable nodes now do not refer to any Visitor class or interface. For me this is the best level of separation you could get here. But do we really need to stop here? No. Let us change the Visitable interface a little and let it return the children we want to visit next. This allows us a general iteration method.

```
class DefaultVisitor {
    void visit(Visitable v) {
        doIteration(v)
    }
    doIteration(Visitable v) {
        v.children.each { visit(it) }
    }
}

interface Visitable {
    Visitable[] getChildren()
}

class NodeType1 implements Visitable {
    Visitable[] children = []
}

class NodeType2 implements Visitable {
    Visitable[] children = []
}

public class NodeType1Counter extends DefaultVisitor {
    int count = 0
    public void visit(NodeType1 n1) {
        count++
        super.visit(n1)
    }
}
```

DefaultVisitor now looks a bit different. I added a doIteration method that will get the children it should iterate over and then call visit on each element. Per default this will call visit(Visitable) which then iterates over the children of this child. I changed Visitable to ensure that any node will be able to return children (even if empty). I didn't have to change the NodeType1 and NodeType2 class, because the way the children filed was defined already made them a property, which means Groovy is so nice to generate a get method for us. No the really interesting part is NodeType1Counter, it is interesting because we have not changed it. super.visit(n1) will now call visit(Visitable) which will call doIterate which will start the next level of iteration. So no change. But visit(it) will call visit(NodeType1) if it is of type NodeType1. In fact we don't need the doIterate method, we could do that in visit(Visitable) too, but I thought this variant is better, because it allows us to write a new Visitor that overwrites visit(Visitable) for error cases which of course means we must not do super.visit(n1) but doIterate(n1).

Summary

In the end we got ~40% less code, a robust and stable architecture and we completely removed the Visitor from the Visitable. I heard about visitor implementations based on Reflection to get a more generic version. Well, with this you see there is really no need to do such thing. If we add new types we don't need to change anything. It is said that the visitor pattern doesn't fit extreme programming techniques very well because you need to make changes to so many classes all the time. I think I proved that this is because of Java not because the pattern is bad or something.

There are variants of the Visitor pattern, like the acyclic visitor pattern, that tries to solve the problem of

adding new node types with special visitors. I don't like that very much, it works with casts, catches the `ClassCastException` and other nasty things. In the end it tries to solve something we don't even get with the Groovy version.

One more thing... `NodeType1Counter` could be implemented in Java as well. Groovy will recognize the visit methods and call them as needed because `DefaultVisitor` is still Groovy and does all the magic.

Differences from Java

This page last changed on Mar 29, 2007 by [pledbrook](#).

Groovy tries to be as natural as possible for Java developers. We've tried to follow the principle of least surprise when designing Groovy, particularly for developers learning Groovy who've come from a Java background.

Here we list all the major differences between Java and Groovy.

Default imports

All these packages and classes are imported by default, i.e. you do not have to use an explicit `import` statement to use them:

- `java.io.*`
- `java.lang.*`
- `java.math.BigDecimal`
- `java.math.BigInteger`
- `java.net.*`
- `java.util.*`
- `groovy.lang.*`
- `groovy.util.*`

Common gotchas

Here we list the common things you might trip over if you're a Java developer starting to use Groovy.

- `==` means equals on all types. In Java there's a wierd part of the syntax where `==` means equality for primitive types and `===` means identity for objects. Since we're using autoboxing this would be very confusing for Java developers (since `x == 5` would be mostly false if `x` was 5 😊). So for simplicity `==` means `equals()` in Groovy. If you really need the identity, you can use the method `"is"` like `foo.is(bar)`. This does not work on null, but you can still use `==` here: `foo==null`.
- `in` is a keyword. So don't use it as a variable name.
- When declaring array you can't write

```
int[] a = {1,2,3};
```

you need to write

```
int[] a = [1,2,3]
```

- If you were used to write a for loop which looked like

```
for (int i =0; i < len; i++)
```

in groovy you need to write

```
for (i in 0..len-1)
```

or

```
for (i in 0..<len)
```

Things to be aware of

- semicolon is optional. Use them if you like (though you must use them to put several statements on one line).
- the return keyword is optional.
- you can use the *this* keyword inside static methods (which refers to this class).
- methods and classes are public by default.
- protected in Groovy is the equivalent of both package-protected and protected in Java. i.e. you can have friends in the same package - or derived classes can also see protected members.
- inner classes are not supported at the moment. In most cases you can use [closures](#) instead.
- the throws clause in method heads is not checked by the Groovy compiler, because there is no difference between checked and unchecked exceptions.

Uncommon Gotchas

Java programmers are used to semicolons terminating statements and not having [closures](#). Also there are instance initializers in class definitions. So you might see something like:

```
class Trial {  
    private final Thing thing = new Thing ( ) ;  
    { thing.doSomething ( ) ; }  
}
```

Many Groovy programmers eschew the use of semicolons as distracting and redundant (though others use them all the time - it's a matter of coding style). A situation that leads to difficulties is writing the above in Groovy as:

```
class Trial {  
    private final thing = new Thing ( )  
    { thing.doSomething ( ) }  
}
```

This will probably be a compile error!

The issue here is that in this situation the newline is not a statement terminator so the following block is treated as a [closures](#) that is a parameter to the Thing constructor. Bizarre to many, but true. If you want to use instance initializers in this sort of way, it is effectively mandatory to have a semicolon:

```
class Trial {
    private final thing = new Thing ( ) ; {
        thing.doSomething ( )
    }
}
```

This way the block following the initialized definition is clearly an instance initializer.

New features added to Groovy not available in Java

- [closures](#)
- native

[syntax](#) for lists and maps

- [GroovyMarkup](#) and GPath support
- native support for [regular expressions](#)
- polymorphic

[iteration](#) and powerful

[switch statement](#)

- dynamic and static typing is supported - so you can omit the type declarations on methods, fields and variables
- you can embed expressions inside [strings](#)
- lots of new helper methods added to the [JDK](#)
- simpler syntax for writing

[beans](#) for both properties and adding event listeners

- [safe navigation](#) using the ?. operator, e.g. "variable?.field" and "variable?.method()" - no more nested ifs to check for null clogging up your code

Differences from Ruby

This page last changed on Dec 11, 2006 by [fr33m3n](#).

The core abstract programming model of Ruby and Groovy are very similar: everything is an object, there is a MOP in control of all activity, and closures are the core structuring tool after classes. Ruby uses the Ruby library, Groovy uses the Java library with some additions of its own. This is the biggest difference but it is a huge difference. Syntactically, things like:

```
File.open( 'blah' ) { | file | puts( file.read ) }
```

becomes:

```
println ( new File ( 'blah' ).text )
```

which doesn't show that the Groovy closures syntax is:

```
{ file -> doSomething ( file ) }
```

which is slightly different from Ruby, but does show that sometimes Groovy has a different approach to certain things compared to Ruby. So in moving from Ruby to Groovy, there are gotchas.

Download

This page last changed on Jan 10, 2007 by [blackdrag](#).

Latest Release - v1.0

Download zip: [Binary Release](#) | [Source Release](#)

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Download Javadoc: [Javadoc Jar](#)

You may download other distributions of Groovy from [this site](#).

Once you've download the distribution, please read the [installation instructions](#).

If you prefer to live on the edge, you can also [grab the code from SVN](#).

Feature Overview

This page last changed on Sep 27, 2006 by [paulk_asert](#).

- [Ant Scripting](#)
- [Groovlets](#)
- [Groovy Beans](#)
- [Groovy Templates](#)
- [GroovyMarkup](#)

Ant Scripting

This page last changed on Sep 27, 2006 by [paulk_asert](#).

If ever you've been working with a build.xml or some Jelly script and found yourself a little restricted by all those pointy brackets & found it a bit wierd using XML as a scripting language and wanted something a little cleaner & more straight forward, then maybe Ant scripting with Groovy might be what you're after.

A few articles on the topic:

- [Java world](#)
- [Alphaworks](#)
- [JavaPro](#)

Using [GroovyMarkup](#) inside a Groovy script can make the scripting of Ant tasks really easy; allowing a real scripting language to be used for programming constructs (variables, methods, loops, logical branching , classes etc). It still looks like a neat concise version of Ant's XML without all those pointy brackets; though you can mix and match this markup inside your script.

Here's [an example](#) which in one simple concise file we have a JUnit test case that demonstrates the use of Ant inside Groovy along with testing that it actually works along with a demo of iterating through an Ant FileSet.

Notice that normal variables can be used to pass state into the Ant tasks and that Groovy code can be embedded anywhere in the markup.

```
package groovy.util

import java.io.File

class AntTest extends GroovyTestCase {

    void testAnt() {
        def ant = new AntBuilder()

        // lets just call one task
        ant.echo("hello")

        // here"s an example of a block of Ant inside GroovyMarkup
        ant.sequential {
            echo("inside sequential")

            myDir = "target/AntTest/"

            mkdir(dir:myDir)
            copy(todir:myDir) {
                fileset(dir:"src/test") {
                    include(name:"**/*.groovy")
                }
            }

            echo("done")
        }

        // now lets do some normal Groovy again
        file = new File("target/AntTest/groovy/util/AntTest.groovy")
        assert file.exists()
    }

    void testFileIteration() {
        def ant = new AntBuilder()

        // lets create a scanner of filesets
```

```

        scanner = ant.fileScanner {
            fileset(dir:"src/test") {
                include(name:"**/Ant*.groovy")
            }
        }

        // now lets iterate over
        def found = false
        for (f in scanner) {
            println("Found file ${f}")

            found = true

            assert f instanceof File
            assert f.name.endsWith(".groovy")
        }
        assert found
    }

    void testJUnitTask() {
        def ant = new AntBuilder()

        ant.junit {
            test(name:'groovy.util.SomethingThatDoesNotExist')
        }
    }

    void testPathBuilding() {
        def ant = new AntBuilder()

        value = ant.path {
            fileset(dir:"xdocs") {
                include(name:"*.wiki")
            }
        }

        assert value != null

        println "Found path of type ${value.class.name}"
        println value
    }

    void testTaskContainerAddTaskIsCalled() {
        def ant = new AntBuilder()
        def taskContainer = ant.parallel(){ // "Parallel" serves as a sample TaskContainer
            ant.echo() // "Echo" without message to keep tests silent
        }
        // not very elegant, but the easiest way to get the ant internals...
        assert taskContainer.dump() =~
'nestedTasks=\\[org.apache.tools.ant.taskdefs.Echo@\\w+\\]'
    }

    void testTaskContainerExecutionSequence() {
        def ant = new AntBuilder()
        SpoofTaskContainer.getSpoof().length = 0
        def PATH = 'task.path'
        ant.path(id:PATH){ant.pathelement(location:'classes')}
        ['spoofcontainer':'SpoofTaskContainer', 'spoof':'SpoofTask'].each{ |pair|
            ant.taskdef(name:pair.key, classname:'groovy.util.'+pair.value, classpathref:PATH)
        }
        ant.spoofcontainer(){
            ant.spoof()
        }
        expectedSpoof =
        "SpoofTaskContainer ctor\n"+
        "SpoofTask ctor\n"+
        "in addTask\n"+
        "begin SpoofTaskContainer execute\n"+
        "begin SpoofTask execute\n"+
        "end SpoofTask execute\n"+
        "end SpoofTaskContainer execute\n"
        assertEquals expectedSpoof, SpoofTaskContainer.getSpoof().toString()
    }
}

```

Groovy Ant task

You can also use the [Groovy Ant task](#).

Groovlets

This page last changed on Sep 27, 2006 by [paulk_asert](#).

You can write normal Java servlets in Groovy (i.e. Groovlets).

There is also a [GroovyServlet](#) which automatically compile your .groovy source files, turn them into bytecode, load the Class and cache it until you change the source file.

Here's a simple example to show you the kind of thing you can do from a Groovlet.

Notice the use of implicit variables to access the session, output & request.

```
import java.util.Date

if (session == null) {
    session = request.getSession(true);
}

if (session.counter == null) {
    session.counter = 1
}

println ""
<html>
    <head>
        <title>Groovy Servlet</title>
    </head>
    <body>
        Hello, ${request.remoteHost}: ${session.counter}! ${new Date()}
    </body>
</html>
""
session.counter = session.counter + 1
```

Or, do the same thing using MarkupBuilder:

```
import java.util.Date
import groovy.xml.MarkupBuilder

if (session == null) {
    session = request.getSession(true);
}

if (session.counter == null) {
    session.counter = 1
}

html.html {    // html is implicitly bound to new MarkupBuilder(out)
    head {
        title("Groovy Servlet")
    }
    body {
        p("Hello, ${request.remoteHost}: ${session.counter}! ${new Date()}")
    }
}
session.counter = session.counter + 1
```

Implicit variables

The following variables are ready for use in Groovlets:

variable name	bound to	note
---------------	----------	------

request	ServletRequest	-
response	ServletResponse	-
context	ServletContext	unlike Struts
application	ServletContext	unlike Struts
session	getSession(false)	can be null! see ★ A
out	response.getWriter()	see ★ B
sout	response.getOutputStream()	see ★ B
html	new MarkupBuilder(out)	see ★ B

★ A The session variable is only set, if there was already a session object. See the 'if (session == null)' checks in the examples above.

★ B These variables cannot be re-assigned inside a Groovlet. They are bound on first access, allowing to e.g. calling methods on the 'response' object before using 'out'.

Setting up groovylets

Put the following in your web.xml:

```
<servlet>
  <servlet-name>Groovy</servlet-name>
  <servlet-class>groovy.servlet.GroovyServlet</servlet-class>
</servlet>

<servlet-mapping>
  <servlet-name>Groovy</servlet-name>
  <url-pattern>*.groovy</url-pattern>
</servlet-mapping>
```

Then all the groovy jar files into WEB-INF/lib. You should only need to put the **groovy.jar**, the **antlr.jar** and the **asm.jar**. Or copy the **groovy-all-xyz.jar** into WEB-INF/lib - this *almost* all jar contains the antlr and asm jars.

Now put the .groovy files in, say, the root directory (i.e. where you would put your html files). The groovy servlet takes care of compiling the .groovy files.

So for example using tomcat you could edit tomcat/conf/server.xml like so:

```
<Context path="/groovy" docBase="c:/groovy-servlet"/>
```

Then access it with <http://localhost:8080/groovy/hello.groovy>

Groovy Beans

This page last changed on Dec 20, 2006 by [tug](#).

GroovyBeans are JavaBeans but using a much simpler syntax.

Here's an example:

```
import java.util.Date

class Customer {
    // properties
    Integer id
    String name
    Date dob

    // sample code
    static void main(args) {
        def customer = new Customer(id:1, name:"Gromit", dob:new Date())
        println("Hello ${customer.name}")
    }
}
```

```
Hello Gromit
```

Notice how the properties look just like public fields. You can also set named properties in a bean constructor in Groovy. In Groovy, fields and properties have been merged so that they act and look the same. So, the Groovy code above is equivalent to the following Java code:

```
import java.util.Date;

public class Customer {
    // properties
    private Integer id;
    private String name;
    private Date dob;

    public Integer getId() {
        return this.id;
    }

    public String getName() {
        return this.name;
    }

    public Date getDob() {
        return this.dob;
    }

    public void setId(Integer id) {
        this.id = id;
    }

    public void setName(String name) {
        this.name = name;
    }

    public void setDob(Date dob) {
        this.dob = dob;
    }

    // sample code
    public static void main(String[] args) {
        Customer customer = new Customer();
        customer.setId(1);
        customer.setName("Gromit");
        customer.setDob(new Date());
    }
}
```

```
        println("Hello " + customer.getName());
    }
}
```

Property and field rules

When Groovy is compiled to bytecode, the following rules are used.

- If the name is declared with an access modifier (public, private or protected) then a field is generated.
- A name declared with no access modifier generates a private field with public getter and setter (i.e. a property).
- If a property is declared final the private field is created final and no setter is generated.
- You can declare a property and also declare your own getter or setter.
- If you want a private or protected property you have to provide your own getter and setter which must be declared private or protected.

So, for example, you could create a read only property or a public read-only property with a protected setter like this:

```
class Foo {
    // read only property
    final String name = "John"

    // read only property with public getter and protected setter
    Integer amount
    protected void setAmount(Integer amount) { this.amount = amount }

    // dynamically typed property
    def cheese
}
```

Note that properties need *some* kind of identifier: e.g. a variable type ("String") or untyped using the "def" keyword.

Closures and listeners

Though Groovy doesn't support anonymous inner classes, it is possible to define action listeners inline through the means of closures. So instead of writing in Java:

```
Processor deviceProc = ...
deviceProc.addControllerListener(new ControllerListener() {
    public void controllerUpdate(ControllerEvent ce) {
        ...
    }
})
```

You can do that in Groovy with a closure:

```
// Add a closure for a particular method on the listener interface
```

```
deviceProc.controllerUpdate = { ce -> println "I was just called with event $ce" }
```

Notice how the closure is for a *method* on the listener interface (`controllerUpdate`), and *not for the interface itself* (`ControllerListener`). This technique means that Groovy's listener closures are used like a `ListenerAdapter` where only one method of interest is overridden. Beware: mistakenly misspelling the method name to override or using the interface name instead can be tricky to catch, because Groovy's parser may see this as a property assignment rather than a closure for an event listener.

This mechanism is heavily used in the Swing builder to define event listeners for various components and listeners. The JavaBeans introspector is used to make event listener methods available as properties which can be set with a closure:

The Java Beans introspector (`java.beans.Introspector`) which will look for a `BeanInfo` for your bean or create one using its own naming conventions. (See the Java Beans spec for details of the naming conventions it uses if you don't provide your own `BeanInfo` class). We're not performing any naming conventions ourselves - the standard Java Bean introspector does that for us.

Basically the `BeanInfo` is retrieved for a bean and its [EventSetDescriptors](#) are exposed as properties (assuming there is no clash with regular beans). It's actually the [EventSetDescriptor.getListenerMethods\(\)](#) which is exposed as a writable property which can be assigned to a closure.

Groovy Templates

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Template framework

The template framework in Groovy consists of a `TemplateEngine` abstract base class that engines must implement and a `Template` interface that the resulting templates they generate must implement.

Included with Groovy is the `SimpleTemplateEngine` that allows you to use JSP-like scriptlets (see example below), script, and EL expressions in your template in order to generate parametrized text. Here is an example of using the system:

```
import groovy.text.Template
import groovy.text.SimpleTemplateEngine

def text = 'Dear \"${firstname} ${lastname}\",\nSo nice to meet you in <% print city %>.\nSee you in ${month},\n${signed}'

def binding = ["firstname":"Sam", "lastname":"Pullara", "city":"San Francisco",
"month":"December", "signed":"Groovy-Dev"]

def engine = new SimpleTemplateEngine()
template = engine.createTemplate(text).make(binding)

def result = 'Dear "Sam Pullara",\nSo nice to meet you in San Francisco.\nSee you in December,\nGroovy-Dev'

assert result == template.toString()
```

Though its possible to plug in any kind of template engine dialect, we can share the same API to invoke templates. e.g. we could create a Velocity / FreeMarker flavour `TemplateEngine` implemenation which could reuse `GPath` and auto-recompile to bytecode.

Using TemplateServlet to serve single JSP-like HTML files



Mind the gap! Ehm, meaning the difference between Groovlets and Templates.

The

[TemplateServlet](#) just works the opposite as the [Groovlets](#) ([GroovyServlet](#)) does. Here, your source are HTML (or any other, fancy template files) and the template framework will generate a Groovy script on-the-fly. This script could be saved to a `.groovy` file and the served by `GroovyServlet` (and the `GroovyScriptEngine`), but after generation, the template is evaluated and responded to the client.

Here is a simple example **helloworld.html** file which is not validating and does not have an `head` element. But it demonstrates, how to let Groovy compile and serve your HTML files to web clients. The tag syntax close to JSP and should be easy to read:

```
<html>
  <body>
    <% 3.times { %>
```

```

    Hello World!
<% } %>
<br>
<% if (session != null) { %>
    My session id is ${session.id}
<% } else println "No session created." %>
</body>
</html>

```

The first Groovy block - a for loop - spans the `HelloWorld!` text. Guess what happens? And the second Groovy statement prints the servlet's session id - if there is a session available. The variable `session` is one of some default bound keys. More details reveals the documentation of [ServletBinding](#).

Here is some sample code using <http://jetty.mortbay.org>'s servlet container. Just get the latest Jetty jar and put this excerpt in a main method, organize the imports and start! Note, that the servlet handler also *knows* how to serve *.groovy files and supports dumping:

```

ServletHttpContext context = new ServletHttpContext();

context.setContextPath("/");
context.setResourceBase("."); // current working directory
context.addHandler(new ServletHandler());
context.addHandler(new ResourceHandler());
context.addServlet("Dump!", "/dump/*", "org.mortbay.servlet.Dump");
context.addServlet("GroovyServlet", "*.groovy", "groovy.servlet.GroovyServlet");
context.addServlet("GroovyTemplate", "*.html", "groovy.servlet.TemplateServlet");

HttpServer http = new HttpServer();

http.addListener(new InetAddrPort(1234)); // browse to http://localhost:1234
http.addContext(context);
http.start();

```

Here is a similar **web.xml** example.

```

<web-app>

  <servlet>
    <servlet-name>Groovlet</servlet-name>
    <servlet-class>groovy.servlet.GroovyServlet</servlet-class>
  </servlet>
  <servlet>
    <servlet-name>Template</servlet-name>
    <servlet-class>groovy.servlet.TemplateServlet</servlet-class>
  </servlet>

  <servlet-mapping>
    <servlet-name>Groovlet</servlet-name>
    <url-pattern>*.groovy</url-pattern>
  </servlet-mapping>
  <servlet-mapping>
    <servlet-name>Template</servlet-name>
    <url-pattern>*.html</url-pattern>
  </servlet-mapping>
  <servlet-mapping>
    <servlet-name>Template</servlet-name>
    <url-pattern>*.gsp</url-pattern>
  </servlet-mapping>

</web-app>

```

Further reading

[Article on templating with Groovy templates](#) by Andrew Glover

[Article on templating with Groovlets and TemplateServlets](#) by Andrew Glover

GroovyMarkup

This page last changed on Aug 04, 2006 by [paulk_asert](#).

Note: the following examples are snippets no ready to run examples.

Groovy has native support for various markup languages from XML, HTML, SAX, W3C DOM, Ant tasks, Swing user interfaces and so forth.

This is all accomplished via the following syntax...

```
def someBuilder = new NodeBuilder()

someBuilder.people(kind:'folks', groovy:true) {
  person(x:123, name:'James', cheese:'edam') {
    project(name:'groovy')
    project(name:'geronimo')
  }
  person(x:234, name:'bob', cheese:'cheddar') {
    project(name:'groovy')
    project(name:'drools')
  }
}
```

Whichever kind of builder object is used, the syntax is the same. What the above means is that the someBuilder object has a method called 'people' invoked with 2 parameters...

- a Map of arguments ['kind':'folks', 'groovy':true]
- a Closure object which when invoked will call 2 methods on the builder called 'person', each taking 2 parameters, a map of values and a closure...

So we can easily represent any arbitrary nested markup with ease using a simple concise syntax. No pointy brackets! 😊

What's more is this is native Groovy syntax; so you can mix and match this markup syntax with any other Groovy features (iteration, branching, method calls, variables, expressions etc). e.g.

```
// lets create a form with a label & text field for each property of a bean
def swing = new SwingBuilder()
def widget = swing.frame(title:'My Frame',
defaultCloseOperation:javax.swing.WindowConstants.EXIT_ON_CLOSE) {
  panel() {
    for (entry in someBean) {
      label(text:entry.key)
      textField(text:entry.value)
    }
    button(text:'OK', actionPerformed:{ println("I've been clicked with event ${it}") })
  }
}
widget.show()
```

Trees, DOMs, beans and event processing

The really neat thing about GroovyMarkup is that its just a syntax which maps down to method calls. So it can easily support the building of any arbitrary object structure - so it can build any DOMish model, a bean structure, JMX MBeans, PicoComponents, Swing front ends, Ant tasks etc. What's more since its just

normal method invocations it can naturally map to SAX event processing too.

Out of the box Groovy comes with a few different markup builders you can use :

- NodeBuilder - creates a tree of Node instances which can be easily navigated in Groovy using an XPath-like syntax
- DOMBuilder - creates a W3C DOM document from the markup its given
- SAXBuilder - fires SAX events into a given SAX ContentHandler
- MarkupBuilder - outputs XML / HTML markup to some PrintWriter for things like implementing servlets or code generation
- AntBuilder - fires off Ant tasks using familiar markup for processing build tasks
- SwingBuilder - creates rich Swing user interfaces using a simple markup

Examples

Here's a simple example which shows how you could iterate through some SQL result set and output a dynamic XML document containing the results in a custom format using GroovyMarkup

```
// lets output some XML builder (could be SAX / DOM / TrAX / text)
def xml = new NodeBuilder()
xml.customers() {
    loc = 'London'
    sql.eachRow("select * from customer where location = ${loc}") {
        // lets process each row by emitting some markup
        xml.customer(id:it.id, type:'Customer', foo:someVariable)) {
            role(it.person_role)
            name(it.customer_name)
            location(id:it.location_id, name:it.location_name)
        }
    }
}
```

The interesting thing about the above is that the XML technology used at the other end could be push-event based (SAX) or pull-event based (StAX) or a DOM-ish API (W3C, dom4j, JDOM, EXML, XOM) or some JAXB-ish thing (XMLBeans, Castor) or just beans or just good old text files. e.g. a pull parser could literally pull the data out of the database - or the data could be pushed into data some structure or piped straight to a file using IO or async NIO.

The use of GroovyMarkup means developers can hide the XML plumbing and focus on tackling the real problems we're trying to solve.

To see more examples of using GroovyMarkup try looking at our unit test cases

- [XML unit tests](#)
- [Ant unit tests](#)
- [Swing demos](#)

There is more detail on markup here [Make a builder](#).

For those new to both Java and Groovy

This page last changed on Apr 04, 2007 by [gavingrover](#).

If you don't already know Java, these pages are for you.

The Groovy Math facilities in depth:

[Groovy Integer Math](#) - choose from many types of integers

[Groovy BigDecimal Math](#) - for high-precision decimal math

[Groovy Floating Point Math](#) - for high-speed decimal math

Collections:

[Lists and Sets](#) - convenient notation to group items into a collection

[Object Arrays](#) - fixed-size arrays for faster collections

[Maps and Sorted Maps](#) - convenient notation to assign values to keys **NEW ON 29 MARCH 2007**

[Characters in Groovy](#) **NEW ON 4 APRIL 2007**

Groovy Data Structures:

[Blocks, Closures, and Functions](#)

[Expandos, Classes, and Categories](#)

[Using Interceptors with the ProxyMetaClass](#) - intercept calls to methods

[Java Reflection in Groovy](#) - how to examine and manipulate objects and their fields and methods when their names aren't known at compile time.

Blocks, Closures, and Functions

This page last changed on Mar 23, 2007 by [gavingrover](#).

Want to learn some Groovy, but don't already know Java? This one's for you.

Run these examples inside a script. All code tested using Groovy v1.0.

If you already know Java, you can instead read ["Closures for Java Programmers"](#).

Blocks

We can embed a sequence of statements inside "try", called a "block". Defined variables are only visible within that block, not outside:

```
def a = 'good morning'
try{
    def b = 'greetings', c = 'nice day' //def keyword applies to both 'b' and 'c'

    assert a == 'good morning'
    assert b == 'greetings'
}
assert a == 'good morning'
//println b //a compile error if uncommented: b not visible here
```

Using the "def" keyword is optional because we are inside a script:

```
def c = 5; assert c == 5
d = 6; assert d == 6 //def keyword optional
assert binding.variables.c == null
assert binding.variables.d == 6 //when def not used, variable becomes part of binding.variables
```

But variables without "def" are visible outside the block:

```
try{
    h = 9
    assert binding.variables.h == 9
}
assert h == 9
assert binding.variables.h == 9
```

We can't define a variable (using "def") with the same name as another already visible (ie, another "in scope"):

```
def a = 'island'
//def a = 'snake' //a compile error if uncommented: a already defined
try{
    //def a = 'jewel' //a compile error if uncommented: a already defined
}
```

We can nest blocks:

```
def a = 123; try{ try{ try{ assert a == 123 } } } }
```

Closures

We can assign a sequence of statements that refers to its external context to a variable, then execute it later. It's called a "closure":

```
def a = 'coffee'
def c = {
  def b = 'tea'
  a + ' and ' + b //a refers to the variable a outside the closure, and is remembered by the
closure
}
assert c() == 'coffee and tea' //short for c.call()
```

The closure assigned to the variable (here, c) will remember its context (here, including a) even if that context is not in scope when the closure is called:

```
def c
try{
  def a = 'sugar'
  c = { a } //a closure always returns its only value
}
assert c() == 'sugar'
def d = c //we can also assign the closure to another variable
assert d() == 'sugar'
```

When a closure doesn't explicitly refer to any part of its external context, it's correct name is "lambda block". However, because Groovy implements it in the same way as a closure, it's common to use the same name for both concepts:

```
printFiftySix = { 7; def n = 8; println 7*n } //no external references here
printFiftySix()
```

A closure always returns a value, the result of its last statement:

```
giveSeven = { 7 }; assert giveSeven() == 7 //value of last statement is returned
giveNull = { def a }; assert giveNull() == null //null returned if last statement has no value
```

By putting a closure within another, we can create two instances of it:

```
c = { def e = { 'milk' }; e }
d = c
assert c == d
v1 = c()
v2 = c()
assert v1 != v2
```

Closure Parameters

We can put parameters at the beginning of a closure definition, and pass values in when we call the closure:

```
def toTriple = {n -> n * 3}
assert toTriple.call( 5 ) == 15
```

We can also pass information out using the parameters:

```
def f = { list, value -> list << value }
x = []
f(x, 1); f(x, 2)
assert x == [1, 2]
```

One parameter is always available, called "it", if no explicit parameters are named:

```
c = { it*3 }
assert c( 'run' ) == 'runrunrun'
```

If parameters aren't specified, "it" will still be implicitly defined, but be null:

```
//c = { def it = 789 } //a compile error when uncommented: 'it' already implicitly defined
c = { value1 -> def it = 789; [value1, it] } //works OK because no 'it' among parameters
assert c( 456 ) == [456, 789]
c = {-> def it = 789; it } //zero parameters, not even 'it', so works OK
assert c() == 789
```

Parameters can't have the same name as another variable in scope, except for the implicit parameter 'it':

```
def name= 'cup'
//def c={ name-> println (name) }
//a compile error when uncommented: current scope already contains name 'name'
c= { def d= { 2 * it }; 3 * d(it) }
//'it' refers to immediately-surrounding closure's parameter in each case
assert c(5) == 30
```

If there's already a variable called 'it' in scope, we can access it using owner.it:

```
it= 2; c= { assert it == 3; assert owner.it == 2 }; c(3)
```

We can pass one closure into another as a parameter:

```
toTriple = {n -> n * 3}; runTwice = { a, c -> c( c(a) )}
assert runTwice( 5, toTriple ) == 45
```

There's a shortcut syntax when explicitly defining a closure within another closure call, where that closure is the last or only parameter:

```
def runTwice = { a, c -> c(c(a)) }
```

```

assert runTwice( 5, {it * 3} ) == 45 //usual syntax
assert runTwice( 5 ){it * 3} == 45 //when closure is last param, can put it after the param
list

def runTwiceAndConcat = { c -> c() + c() }
assert runTwiceAndConcat( { 'plate' } ) == 'plateplate' //usual syntax
assert runTwiceAndConcat(){ 'bowl' } == 'bowlbowl' //shortcut form
assert runTwiceAndConcat{ 'mug' } == 'mugmug' //can skip parens altogether if closure is only
param

def runTwoClosures = { a, c1, c2 -> c1(c2(a)) } //when more than one closure as last params
assert runTwoClosures( 5, {it*3}, {it*4} ) == 60 //usual syntax
assert runTwoClosures( 5 ){it*3}{it*4} == 60 //shortcut form

```

We can enquire the number of parameters for a closure, both from inside and outside the closure:

```

c = {x,y,z-> getMaximumNumberOfParameters() }
assert c.getMaximumNumberOfParameters() == 3
assert c(4,5,6) == 3

```

Parameter Defaulting, Currying, and Number-Varying

A closure may have its last parameter/s assigned default value/s:

```

def e = { a, b, c=3, d='a' -> "${a+b+c}$d" }
assert e( 7, 4 ) == '14a'
assert e( 9, 8, 7 ) == '24a' //override default value of 'c'

```

A closure can take a varying number of arguments by prefixing its last parameter with `Object[]`, and accessing them using `each`. (`Object[]` is an example of a 'type', to be explained in another lesson on Typing in Groovy.)

```

def c = { arg, Object[] extras ->
  def list= []
  list<< arg
  extras.each{ list<< it }
  list
}
assert c( 1 ) == [ 1 ]
assert c( 1, 2 ) == [ 1, 2 ]
assert c( 1, 2, 3 ) == [ 1, 2, 3 ]
assert c( 1, 2, 3, 4 ) == [ 1, 2, 3, 4 ]

```

We can also prefix the last parameter of a closure with `Closure[]` to pass in a varying number of other closures, even using the shortcut syntax:

```

def apply = { a, Closure[] cc ->
  (cc as List).inject(a){ flo, it-> it(flo) } //apply the closures nestedly to the initial
  value
}
assert apply(7){it*3}{it+1}{it*3}.toString() == '66'

```

A closure may be copied with its first parameter/s fixed to a constant value/s, using `curry`:

```
def concat = { p1, p2, p3 -> "$p1 $p2 $p3" }
def concatAfterFly = concat.curry( 'fly' )
assert concatAfterFly( 'drive', 'cycle' ) == 'fly drive cycle'
def concatAfterFlySwim = concatAfterFly.curry( 'swim' )
assert concatAfterFlySwim( 'walk' ) == 'fly swim walk'
```

In closures, we can use currying and parameter-count-varying together:

```
def c = { arg, Object[] extras -> arg + ', ' + extras.join(', ') }
def d = c.curry( 1 ) //curry first param only
assert d( 2, 3, 4 ) == '1, 2, 3, 4'
def e = c.curry( 1, 3 ) //curry part of Object[] also
assert e( 5 ) == '1, 3, 5'
def f = e.curry( 5, 7, 9, 11 ) //currying continues on Object
assert f( 13, 15 ) == '1, 3, 5, 7, 9, 11, 13, 15'
```

We can make closures recursive:

```
def gcd; gcd={ m,n-> m%n==0? n: gcd(n,m%n) } //more readable version
assert gcd( 28, 35 ) == 7

gcd={ x={ self,m,n-> m%n==0? n: self(self,n,m%n) }; x.curry(x) }() //more encapsulated version
assert gcd( 28, 35 ) == 7
```

Functions

A function is similar to a closure, though a function can't access defined variables in its surrounding context:

```
a = 32 //def keyword not used for this one
def c = 'there', d = 'yonder'
def f(){
  assert a == 32 //outer 'a' visible because 'def' keyword wasn't used with it
  def c = 'here' //compiles OK because other defined c invisible inside function definition
  //println d //a compile error when uncommented: d not accessible
  c
}
assert f() == 'here' //syntax to invoke a function
```

The def keyword is compulsory when defining functions:

```
def f(){
  a = 1
  c = { 'here, again' }
  c()
}
assert f() == 'here, again'
//g(){ println 'there, again' } //a compile error when uncommented: def keyword required
```

We use a special syntax to assign a function to another variable when using the original definition name:

```
def f(){ 77 } //define function using name 'f'
assert f() == 77
def g = this.&f //special syntax to assign function to another variable
assert g() == 77
```

```
def h = g //don't use special syntax here
assert h() == 77
f = 'something else' //this 'f' is a VARIABLE, not the function NAME
assert f() == 77 //the function name can't be reassigned
```

Unlike blocks and closures, we can't nest functions:

```
def f(){
    //def g1(){ println 'there' } //a compile error when uncommented: can't nest functions
    'here'
}
assert f() == 'here'
try{
    //def g2(){ println 'yonder' } //a compile error when uncommented: can't nest functions
}
c = {
    //def g3(){ println 'outer space' } //a compile error when uncommented: can't nest functions
}
def h(){
    try{ def c = { 'here, again' } } //we can have blocks and closures within functions
}
```

Function Parameters

A function can have parameters, with which we can pass information both in and out:

```
def foo( list, value ){
    list << value
}
x = []
foo(x, 1)
foo(x, 2)
assert x == [1, 2]
```

We can have more than one function of the same name if they each have different numbers of (untyped) parameters. (If we use different 'types' of parameters, we can often have more than one function of the same name and same number of parameters. To be explained in another lesson on Groovy Typing.)

```
def foo(value){ 'v1' }
def foo(list, value){ 'v2' }
assert foo(9) == 'v1'
assert foo([], 1) == 'v2'
```

A function returns a value, unless prefixed by void instead of def, when it always returns null:

```
def f1(){ 7 }; assert f1() == 7 //value of last statement is returned
def f2(){ return 8; 3 }; assert f2() == 8 //return explicitly using return
void f3(){ 10 }; assert f3() == null //null always returned
//void f4(){ return 9 } //a compile error when uncommented: can't use 'return' in a void function
```

Some Similarities with Closures

We can use the shortcut invocation syntax for closure parameters:

```
def f(Closure c){ c() }  
assert f{ 'heehee' } == 'heehee'
```

A function may have its last parameter/s assigned default value/s:

```
def dd( a, b=2 ){ "$a, $b" }  
assert dd( 7, 4 ) == '7, 4'  
assert dd( 9 ) == '9, 2'
```

A function can take a varying number of arguments by prefixing its last argument by `Object[]`, and accessing them using `each`:

```
def c( arg, Object[] extras ){  
  def list= []  
  list<< arg  
  extras.each{ list<< it }  
  list  
}  
assert c( 1 ) == [ 1 ]  
assert c( 1, 2, 3, 4 ) == [ 1, 2, 3, 4 ]
```

We can call a function recursively by referencing its own name:

```
def gcd( m, n ){ if( m%n == 0 )return n; gcd(n,m%n) }  
assert gcd( 28, 35 ) == 7
```


Characters in Groovy

This page last changed on Apr 04, 2007 by [gavingrover](#).

A Character is a single token from the Unicode basic multilingual plane. It can also convert to the lowermost 16 bits of an integer.

```
assert Character.SIZE == 16 && Character.SIZE == Short.SIZE //16 bits in size
assert Character.MIN_VALUE as int == 0x0000
assert Character.MAX_VALUE as int == 0xFFFF
assert Character.TYPE == char //often, we can write 'char' instead
```

Each Unicode character belongs to a certain category, which we can inspect using `getType()`:

```
def categories= [
  'LOWERCASE_LETTER', //unicode category "Ll": a lowercase letter that has an uppercase variant
  'UPPERCASE_LETTER', //Lu: an uppercase letter that has a lowercase variant
  'TITLECASE_LETTER', //Lt: a letter that appears at the start of a word with only the first
letter capitalized
  'MODIFIER_LETTER', //Lm: a special character that is used like a letter
  'OTHER_LETTER', //Lo: a letter or ideograph that does not have lowercase and uppercase
variants

  'NON_SPACING_MARK', //Mn: a character to be combined with another that doesnt take up extra
space (eg accents, umlauts)
  'COMBINING_SPACING_MARK', //Mc: a character to be combined with another that takes up extra
space (vowel signs in the East)
  'ENCLOSING_MARK', //Me: a character that encloses the one it is combined with (eg circle,
square, keycap)

  'SPACE_SEPARATOR', //Zs: a whitespace character that is invisible, but takes up space
  'LINE_SEPARATOR', //Zl: line separator character 0x2028
  'PARAGRAPH_SEPARATOR', //Zp: paragraph separator character 0x2029

  'MATH_SYMBOL', //Sm: any mathematical symbol
  'CURRENCY_SYMBOL', //Sc: any currency sign
  'MODIFIER_SYMBOL', //Sk: a combining character (mark) as a full character on its own
  'OTHER_SYMBOL', //So: various symbols that are not math symbols, currency signs, or combining
characters (eg dingbats, box-drawing)

  'DECIMAL_DIGIT_NUMBER', //Nd: a digit zero through nine in any script except ideographic
scripts
  'LETTER_NUMBER', //Nl: a number that looks like a letter, such as a Roman numeral
  'OTHER_NUMBER', //No: a superscript or subscript digit, or number that's not a digit 0..9
(excluding from ideographic scripts)

  'DASH_PUNCTUATION', //Pd: any kind of hyphen or dash
  'START_PUNCTUATION', //Ps: any kind of opening bracket
  'END_PUNCTUATION', //Pe: any kind of closing bracket
  'INITIAL_QUOTE_PUNCTUATION', //Pi: any kind of opening quote. (may behave like Ps or Pe
depending on usage)
  'FINAL_QUOTE_PUNCTUATION', //Pf: any kind of closing quote. (may behave like Ps or Pe
depending on usage)
  'CONNECTOR_PUNCTUATION', //Pc: a punctuation character such as an underscore that connects
words
  'OTHER_PUNCTUATION', //Po: any kind of punctuation character that is not a dash, bracket,
quote or connector

  'FORMAT', //Cf: invisible formatting indicator
  'CONTROL', //Cc: 65 ISO control characters (0x00..0x1F and 0x7F..0x9F) with non-unicode use
  'PRIVATE_USE', //Co: any code point reserved for private non-unicode use
  'SURROGATE', //Cs: one half of a surrogate pair
  'UNASSIGNED', //Cn: any code point to which no character has been assigned (including
noncharacters)
]

def stats= (0x0000..0xFFFF).groupBy{ Character.getType(it) }
stats.entrySet().sort{ it.value.size }.reverse().each{ cat->
  def keyName= Character.fields.find{ it.get() == cat.key && it.name in categories }.name
```

```
println "$keyName: $cat.value.size"
}
```

The surrogate category is divided into the high surrogates and the low surrogates. A Unicode supplementary character is represented by two Characters, the first from the high surrogates, the second from the low. Integers, known as code points, can also represent all Unicode characters, including supplementary ones. The code point is the same as a Character converted to an integer for basic plane characters, and its values continue from 0x10000 for supplementary characters. The upper 11 bits of the code point Integer must be zeros. Methods accepting only char values treat surrogate characters as undefined characters.

```
assert Character.MIN_HIGH_SURROGATE == 0xD800 && Character.MIN_SURROGATE == 0xD800
assert Character.MAX_HIGH_SURROGATE == 0xDBFF
assert Character.MIN_LOW_SURROGATE == 0xDC00
assert Character.MAX_LOW_SURROGATE == 0xDFFF && Character.MAX_SURROGATE == 0xDFFF
assert Character.isSurrogatePair( Character.MIN_HIGH_SURROGATE, Character.MIN_LOW_SURROGATE )
assert Character.isHighSurrogate( Character.MIN_HIGH_SURROGATE )
assert Character.isLowSurrogate( Character.MIN_LOW_SURROGATE )

assert Character.MIN_CODE_POINT == 0x0000
assert Character.MIN_SUPPLEMENTARY_CODE_POINT == 0x10000 //an integer
assert Character.MAX_CODE_POINT == 0x10FFFF
assert Character.isValidCodePoint( Character.MIN_CODE_POINT )
assert ! Character.isValidCodePoint( Character.MAX_CODE_POINT + 1 )
assert Character.isSupplementaryCodePoint( Character.MIN_SUPPLEMENTARY_CODE_POINT )
assert ! Character.isSupplementaryCodePoint( Character.MIN_SUPPLEMENTARY_CODE_POINT - 1 )

assert Character.charCount(0xFFFF) == 1 //number of Characters needed to represent a certain
integer as a Unicode character
assert Character.charCount(0x10FFFF) == 2

assert Character.isDefined(0xFFFFD)
assert ! Character.isDefined(0xFFFFF) //doesn't include unassigned characters
assert Character.isDefined(0x10000)
```

To convert a Unicode character between a code point and a Character array:

```
def minLowSurr= Character.MIN_LOW_SURROGATE, maxLowSurr= Character.MAX_LOW_SURROGATE,
  minHighSurr= Character.MIN_HIGH_SURROGATE, maxHighSurr= Character.MAX_HIGH_SURROGATE
assert Character.toChars(0xFFFF).collect{ it as int }.toList() == [0xFFFF] //convert integer
into array of Characters
assert Character.toChars(0x10000).collect{ it as int }.toList() == [minHighSurr as int,
minLowSurr as int]
assert Character.toChars(0x10FFFF).collect{ it as int }.toList() == [maxHighSurr as int,
maxLowSurr as int]

def charArray= new char[6] //an array that can only contain Characters
assert Character.toChars(0x10000, charArray, 2) == 2 && charArray.collect{ it as int }.toList()
==
  [0, 0, minHighSurr as int, minLowSurr as int, 0, 0]
charArray= new char[4]
assert Character.toChars(0xFFFF, charArray, 1) == 1 && charArray.collect{ it as int }.toList()
== [0, 0xFFFF, 0, 0]

assert Character.toCodePoint(minHighSurr, minLowSurr) == 0x10000 //converts surrogate pair to
integer representation
```

We can enquire of code points in a char array or string:

```
def minLowSurr= Character.MIN_LOW_SURROGATE, minHighSurr= Character.MIN_HIGH_SURROGATE

def ca1= ['a', 'b', 'c', minHighSurr, minLowSurr, 'e', 'f', 'g'] as char[]
def ca2= ['a', 'b', 'c', 0xFFFF, 'e', 'f', 'g'] as char[]
assert Character.codePointAt(ca1, 3) == 0x10000 //beginning at index 3, look at as many chars
```

```

as needed
assert Character.codePointAt(ca2, 3) == 0xFFFF
assert Character.codePointAt(cal, 3, 4) == minHighSurr //extra parameter limits sequence of
chars to index <4
assert Character.codePointAt(ca2, 3, 4) == 0xFFFF
assert Character.codePointBefore(cal, 4) == minHighSurr
assert Character.codePointBefore(cal, 5) == 0x10000 //if low surrogate, look back more for high
one, and use both
assert Character.codePointBefore(cal, 5, 4) == minLowSurr //extra param limits lookback to
index >=4
assert Character.codePointCount(cal, 1, 5) == 4 //number of code points in a subarray given by
offset 1 and count 5
assert Character.codePointCount(cal, 1, 4) == 3 //lone high surr counted as 1 code point
assert Character.offsetByCodePoints(cal, 0, 6, 1, 3) == 5 //index of cal[0..<6] that's offset
by 3 code points

//versions of these methods exist for strings...
def s1= 'abc'+ minHighSurr + minLowSurr + 'efg'
def s2= 'abcdefg'
assert Character.codePointAt(s1, 3) == 0x10000 //if high surrogate, add on low surrogate
assert Character.codePointAt(s1, 4) == minLowSurr //if low surrogate, use it only
assert Character.codePointAt(s1, 5) == 'e' as int
assert Character.codePointAt(s2, 3) == 'd' as int //enquire code point in string
assert Character.codePointBefore(s1, 4) == minHighSurr
assert Character.codePointBefore(s1, 5) == 0x10000 //if low surrogate, look back more for high
one, and use both
assert Character.codePointCount(s1, 1, 5) == 3 //number of code points in a substring with
indexes >=1 and <5
assert Character.offsetByCodePoints(s1, 1, 3) == 5 //index from 1 that's offset by 3 code
points

```

Every character also has a directionality:

```

def directionalities= [:]
Character.fields.each{ if( it.name =~ /^DIRECTIONALITY_/ ) directionalities[ it.get() ]=
it.name }

def stats= (0x0000..0xFFFF).groupBy{ Character.getDirectionality(it) } //will also work for
supplementary chars
stats.entrySet().sort{ it.value.size }.reverse().each{ dir->
  def keyName= Character.fields.find{ it.get() == dir.key && it.name in
directionalities.values() }.name
  println "$keyName: $dir.value.size"
}

```

Every character is part of a Unicode block:

```

(0x0000..0xFFFF).groupBy{ Character.UnicodeBlock.of( it as char ) }. //basic plane only
entrySet().sort{it.value.size}.reverse().each{ println "$it.key: $it.value.size" }

(0x0000..0x10FFFF).groupBy{ Character.UnicodeBlock.of( it as int ) }. //this one uses
supplementary characters also
entrySet().sort{it.value.size}.reverse().each{ println "$it.key: $it.value.size" }

try{ Character.UnicodeBlock.of( 0x110000 ); assert 0 }catch(e){ assert e instanceof
IllegalArgumentException }

```

Character assists integers using different radixes:

```

assert Character.MIN_RADIX == 2 //the minimum and maximum radixes available for conversion to
and from strings
assert Character.MAX_RADIX == 36 //0 to 9, and A to Z
assert Character.forDigit(12, 16) == 'c' //character representation for a digit in a certain
radix
assert Character.digit('c' as char, 16) == 12 //digit of a character rep'n in a certain radix

```

We can find the Unicode block for a loosely-formatted textual description of it:

```
[ 'BASIC LATIN', 'basic latin', 'BasicLatin', 'baSiC laTiN', 'BaSiC LaTiN', 'BASIC_LATIN',  
'BaSiC_LaTiN' ].  
  each{ assert Character.UnicodeBlock.forName(it).toString() == 'BASIC_LATIN' }
```

Constructing and Using Characters

We can't represent Characters directly in our programs, but must construct them from a string:

```
assert 'a'.class == String  
def c1= 'a' as char, c2= (char)'b' //constructing  
def c3= new Character(c2), c4= c2.charValue() //cloning  
[c1, c2, c3, c4].each{ assert it.class == Character }  
assert c2 == c3 && c1 != c2  
assert c1 < c2 && c1.compareTo(c2) == -1 //comparing works just the same as for numbers  
assert c2.toString().class == String
```

There's a number of Character utility methods, accepting either a code point or a basic-plane character, that test some attribute of the character:

```
def categories= [  
  'digit': { Character.isDigit(it) },  
  'letter': { Character.isLetter(it) },  
  'letter or digit': { Character.isLetterOrDigit(it) },  
  'identifier ignorable': { Character.isIdentifierIgnorable(it) }, //an ignorable character in  
  a Java or Unicode identifier  
  'ISO control': { Character.isISOControl(it) }, //an ISO control character  
  'Java identifier part': { Character.isJavaIdentifierPart(it) }, //be part of a Java  
  identifier as other than the first character  
  'Java identifier start': { Character.isJavaIdentifierStart(it) }, //permissible as the first  
  character in a Java identifier  
  'Unicode identifier part': { Character.isUnicodeIdentifierPart(it) }, //be part of a Unicode  
  identifier other than first character  
  'Unicode identifier start': { Character.isUnicodeIdentifierStart(it) }, //permissible as  
  first character in a Unicode identifier  
  'lower case': { Character.isLowerCase(it) },  
  'upper case': { Character.isUpperCase(it) },  
  'title case': { Character.isTitleCase(it) },  
  'space char': { Character.isSpaceChar(it) }, //a Unicode space character  
  'whitespace': { Character.isWhitespace(it) }, //white space according to Java  
  'mirrored': { Character.isMirrored(it) }, //mirrored according to the Unicode spec  
]  
def stats= [:]  
categories.keySet().each{ stats[it]= 0 }  
(0x0000..0xFFFF).each{ch-> //also works with supplementaries (0x0000..0x10FFFF)  
  categories.each{cat->  
    if( cat.value(ch) ) stats[ cat.key ] += 1  
  }  
}  
stats.entrySet().sort{ it.value }.reverse().each{ println "$it.key: $it.value" }
```

We can use characters instead of numbers in arithmetic operations:

```
assert 'a' as char == 97 && 'd' as char == 100  
assert ('a' as char) + 7 == 104 && 7 + ('a' as char) == 104 //either first or second arg  
assert ('a' as char) + ('d' as char) == 197 //two chars  
assert ('a' as char).plus(7) == ('a' as char) + 7 //alternative method name  
assert ('a' as char) - 27 == 70 && ('a' as char).minus(27) == 70  
assert ('a' as char) * ('d' as char) == 9700 && ('a' as char).multiply('d' as char) == 9700  
assert 450 / ('d' as char) == 4.5 && 450.div('d' as char) == 4.5
```

```
assert 420.intdiv('d' as char) == 4

assert ('a' as char) > 90 && ('a' as char).compareTo(90) == 1
assert 90 < ('a' as char) && 90.compareTo('a' as char) == -1
assert ('a' as char) == ('a' as char) && ('a' as char).compareTo('a' as char) == 0
```

We can auto-increment and -decrement characters:

```
def c= 'p' as char
assert c++ == 'p' as char && c == 'q' as char && c-- == 'q' as char && c == 'p' as char &&
    ++c == 'q' as char && c == 'q' as char && --c == 'p' as char && c == 'p' as char
assert c.next() == 'q' && c.previous() == 'o' && c == 'p'
```

Some miscellaneous methods:

```
assert Character.getNumericValue('6' as char) == 6
assert Character.reverseBytes(0x37ae as char) == 0xae37 as char

assert Character.toUpperCase('a' as char) == 'A' as char
assert Character.toLowerCase('D' as char) == 'd' as char
assert Character.titleCase('a' as char) == 'A' as char
```

Expandos, Classes, and Categories

This page last changed on Mar 22, 2007 by [gavingrover](#).

Accessing Private Variables

Closures and functions can't remember any information defined within themselves between invocations. If we want a closure to remember a variable between invocations, one only it has access to, we can nest the definitions inside a block:

```
def c
try{
  def a= new Random() //only closure c can see this variable; it is private to c
  c= { a.nextInt(100) }
}
100.times{ println c() }
try{ a; assert 0 }catch(e){ assert e instanceof MissingPropertyException } //'a' inaccessible
here
```

We can have more than one closure accessing this private variable:

```
def counterInit, counterIncr, counterDecr, counterShow //common beginning of names to show
common private variable/s
try{
  def count
  counterInit= { count= it }
  counterIncr= { count++ }
  counterDecr= { count-- }
  counterShow= { count }
}
counterInit(0)
counterIncr(); counterIncr(); counterDecr(); counterIncr()
assert counterShow() == 2
```

We can also put all closures accessing common private variables in a map to show they're related:

```
def counter= [:]
try{
  def count= 0
  counter.incr= { count++; (counter.show)() } //we must use map name and nonintuitive parens
  here
  counter.decr= { count--; (counter.show)() }
  counter.show= { count }
}

//intuitive format for closure call doesn't work...
try{ counter.incr(); assert 0 }catch(e){ assert e instanceof MissingMethodException }

//we must call closures in one of these formats...
counter['incr']()
(counter.incr)()
assert (counter.show)() == 2
```

Expando

We can access private variables with an Expando instead. An expando allows us to assign closures to Expando names:

```
def counter= new Expando()
try{
  def count= 0
  counter.incr= { count++; show() } //no need to qualify closure call with expando name
  counter.decr= { count--; show() }
  counter.show= { timesShown++; count }
  counter.timesShown= 0 //we can associate any value, not just closures, to expando keys
}
//we can use intuitive syntax for closure calls...
counter.incr(); counter.incr(); counter.decr(); counter.incr()
assert counter.show() == 2
```

An expando can also be used when common private variables aren't used:

```
def language= new Expando()
language.name= "Groovy"
language.letterValue = {->
  (name as List).inject(0){flo,it->
    flo+= 1+ (it as int) - ( (it in 'a'..'z')?('a' as int):(it in 'A'..'Z')?('A' as int):(1+(it as int)) )
  }
}
assert language.letterValue() == 102
language.name= "Python"
assert language.letterValue() == 98
language.name= "A...b,   c"
assert language.letterValue() == 6
```

Like individual closures, closures in expandos see all external variables all the way to the outermost block. This is not always helpful for large programs as it can limit our choice of names:

```
def a= 7
try{
  //... .. lots of lines and blocks in between ... ..
  def exp= new Expando()
  exp.c= {
    //def a= 2 //does not compile because a is already defined
    //... ..
  }
}
```

For single-argument closures, both standalone and within expandos, we can use the implicit parameter as a map for all variables to ensure they're all valid, though the syntax is not very elegant:

```
def a= 7
try{
  def c= {
    it= [it: it]
    it.a= 2
    it.it + it.a
  }
  assert c(3) == 5
}
```

Static Classes

Just as we can use functions instead of closures to hide names from the surrounding context, so also we can use static classes instead of expandos to hide such external names. We use the static keyword to qualify the individual definitions in a class definition:

```

def a= 7
class Counter{
  //variable within a class is called a field...
  static public count= 0 //count has 'public' keyword, meaning it's visible from outside class

  //function within a class is called a method...
  static incr(){
    count++ //variables defined within class visible from everywhere else inside class
  }
  static decr(){
    //println a //compile error if uncommented because a is outside the class and not visible
    count--
  }
}
Counter.incr(); Counter.incr(); Counter.decr(); 5.times{ Counter.incr() }
assert Counter.count == 6

```

Methods act quite similar to standalone functions. They can take parameters:

```

class Counter{
  static private count = 0 //qualified with private, meaning not visible from outside class
  static incr( n ){ count += n }
  static decr( count ){ this.count -= count } //params can have same name as a field; 'this.'
  prefix accesses field
  static show(){ count }
}
Counter.incr(2); Counter.incr(7); Counter.decr(4); Counter.incr(6)
assert Counter.show() == 11

```

We can have more than one method of the same name if they each have different numbers of parameters. (But see forthcoming tutorial on "Groovy Typing" for exceptions to this rule.)

```

class Counter{
  static private count = 0
  static incr(){ count++ }
  static incr( n ){ count += n }
  static decr(){ count-- }
  static decr( n ){ count -= n }
  static show(){ count }
}
Counter.incr(17); Counter.incr(); Counter.decr(4)
assert Counter.show() == 14

```

//Methods are also similar to other aspects of functions:

```

class U{
  static a(x, Closure c){ c(x) }
  static b( a, b=2 ){ "$a, $b" } //last argument/s assigned default values
  static c( arg, Object[] extras ){ arg + extras.inject(0){ flo, it-> flo+it } }
  static gcd( m, n ){ if( m%n == 0 )return n; gcd(n,m%n) } //recursion by calling own name
}
assert U.a(7){ it*it } == 49 //shorthand passing of closures as parameters
assert U.b(7, 4) == '7, 4'
assert U.b(9) == '9, 2'
assert U.c(1,2,3,4,5) == 15 //varying number of arguments using Object[]
assert U.gcd( 28, 35 ) == 7

```

We can assign each method of a static class to a variable and access it directly similar to how we can with functions:

```

class U{

```



```

    static private a= 11
    static f(n){ a*n }
}
assert U.f(4) == 44
def g= U.&f //special syntax to assign method to variable
assert g(4) == 44
def h = g //don't use special syntax here
assert h(4) == 44

```

When there's no accessibility keyword like 'public' or 'private' in front of a field within a static class, it becomes a property, meaning two extra methods are created:

```

class Counter{
    static count = 0 //property because no accessibility keyword (eg 'public','private')
    static incr( n ){ count += n }
    static decr( n ){ count -= n }
}
Counter.incr(7); Counter.decr(4)
assert Counter.count == 3
assert Counter.getCount() == 3 //extra method for property, called a 'getter'
Counter.setCount(34) //extra method for property, called a 'setter'
assert Counter.getCount() == 34

```

When we access the property value using normal syntax, the 'getter' or 'setter' is also called:

```

class Counter{
    static count= 0 //'count' is a property

    //we can define our own logic for the getter and/or setter...
    static setCount(n){ count= n*2 } //set the value to twice what's supplied
    static getCount(){ 'count: ' + count } //return the value as a String with 'count: ' prepended
}
Counter.setCount(23) //our own 'setCount' method is called here
assert Counter.getCount() == 'count: 46' //our own 'getCount' method is called here
assert Counter.count == 'count: 46' //our own 'getCount' method is also called here
Counter.count= 7
assert Counter.count == 'count: 14' //our own 'setCount' method was also called in previous
line

```

To run some code, called a static initializer, the first time the static class is accessed. We can have more than one static initializer in a class.

```

class Counter{
    static count = 0
    static{ println 'Counter first accessed' } //static initializer
    static incr( n ){ count += n }
    static decr( n ){ count -= n }
}
println 'incrementing...'
Counter.incr(7) //'Counter first accessed' printed here
println 'decrementing...'
Counter.decr(4) //nothing printed

```

Instantiable Classes

We can write instantiable classes, templates from which we can construct many instances, called objects or class instances. We don't use the static keyword before the definitions within the class:

```

class Counter{
  def count = 0 //must use def inside classes if no other keyword before name
  def incr( n ){ count += n }
  def decr( n ){ count -= n }
}
def c1= new Counter() //create a new object from class
c1.incr(2); c1.incr(7); c1.decr(4); c1.incr(6)
assert c1.count == 11

def c2= new Counter() //create another new object from class
c2.incr(5); c2.decr(2)
assert c2.count == 3

```

We can run some code the first time each object instance is constructed. First, the instance initializer/s are run. Next run is the constructor with the same number of arguments as in the calling code.

```

class Counter{
  def count
  { println 'Counter created' } //instance initializer shown by using standalone curlyes
  Counter(){ count= 0 } //instance constructor shown by using class name
  Counter(n){ count= n } //another constructor with a different number of arguments
  def incr( n ){ count += n }
  def decr( n ){ count -= n }
}
c = new Counter() //'Counter created' printed
c.incr(17); c.decr(2)
assert c.count == 15
d = new Counter(2) //'Counter created' printed again
d.incr(12); d.decr(10); d.incr(3)
assert d.count == 7

```

If we don't define any constructors, we can pass values directly to fields within a class by adding them to the constructor call:

```

class Dog{
  def sit
  def number
  def train(){ ([sit()] * number).join(' ') }
}
def d= new Dog( number:3, sit: {'Down boy!'} )
assert d.train() == 'Down boy! Down boy! Down boy!'

```

Methods, properties, and fields on instantiable classes act similarly to those on static classes:

```

class U{
  private timesCalled= 0 //qualified with visibility, therefore a field
  def count = 0 //a property
  def a(x){ x }
  def a(x, Closure c){ c(x) } //more than one method of the same name but each having different
  numbers of parameters
  def b( a, b=2 ){ "$a, $b" } //last argument/s assigned default values
  def c( arg, Object[] extras ){ arg + extras.inject(0){ flo, it-> flo+it } }
  def gcd( m, n ){ if( m%n == 0 )return n; gcd(n,m%n) } //recursion by calling own name
}
def u=new U()
assert u.a(7){ it*it } == 49 //shorthand passing of closures as parameters
assert u.b(7, 4) == '7, 4'
assert u.b(9) == '9, 2'
assert u.c(1,2,3,4,5) == 15 //varying number of arguments using Object[]
assert u.gcd( 28, 35 ) == 7
u.setCount(91)
assert u.getCount() == 91

```

A class can have both static and instantiable parts by using the static keyword on the definitions that are

static and not using it on those that are instantiable:

```
class Dice{
  //here is the static portion of the class...
  static private count //doesn't need a value
  static{ println 'First use'; count = 0 }
  static showCount(){ return count }

  //and here is the instantiable portion...
  def lastThrow
  Dice(){ println 'Instance created'; count++ }

  //static portion can be used by instantiable portion, but not vice versa
  def throww(){
    lastThrow = 1+Math.round(6*Math.random()) //random integer from 1 to 6
    return lastThrow
  }
}
d1 = new Dice() //'First use' then 'Instance created' printed
d2 = new Dice() //'Instance created' printed
println "Dice 1: ${ (1..20).collect{d1.throww()} }"
println "Dice 2: ${ (1..20).collect{d2.throww()} }"
println "Dice 1 last throw: $d1.lastThrow, dice 2 last throw: $d2.lastThrow"
println "Number of dice in play: ${Dice.showCount()}"
```

Categories

When a class has a category method, that is, a static method where the first parameter acts like an instance of the class, we can use an alternative 'category' syntax to call that method:

```
class View{
  def zoom= 1
  def produce(str){ str*zoom }
  static swap(self, that){ //first parameter acts like instance of the class
    def a= self.zoom
    self.zoom= that.zoom
    that.zoom= a
  }
}
def v1= new View(zoom: 5), v2= new View(zoom: 4)
View.swap( v1, v2 ) //usual syntax
assert v1.zoom == 4 && v2.zoom == 5
use(View){ v1.swap( v2 ) } //alternative syntax
assert v1.zoom == 5 && v2.zoom == 4
assert v1.produce('a') == 'aaaaa'
```

We can also use category syntax when the category method/s are in a different class:

```
class View{
  static timesCalled= 0 //unrelated static definition
  def zoom= 1
  def produce(str){ timesCalled++; str*zoom }
}
class Extra{
  static swap(self, that){ //first parameter acts like instance of View class
    def a= self.zoom
    self.zoom= that.zoom
    that.zoom= a
  }
}
def v1= new View(zoom: 5), v2= new View(zoom: 4)
use(Extra){ v1.swap( v2 ) } //alternative syntax with category method in different class
assert v1.zoom == 4 && v2.zoom == 5
assert v1.produce('a') == 'aaaa'
```

Many supplied library classes in Groovy have category methods that can be called using category syntax. (However, most category methods on Numbers, Characters, and Booleans do not work with category syntax in Groovy-1.0)

```
assert String.format('Hello, %1$s.', 42) == 'Hello, 42.'
use(String){
    assert 'Hello, %1$s.'.format(42) == 'Hello, 42.'
}
```

Far more common are supplied library classes having category methods in another utility class, eg, List having utilities in Collections:

```
def list= ['a', 7, 'b', 9, 7, 7, 2.4, 7]
Collections.replaceAll( list, 7, 55 ) //normal syntax
assert list == ['a', 55, 'b', 9, 55, 55, 2.4, 55]

list= ['a', 7, 'b', 9, 7, 7, 2.4, 7]
use(Collections){
    list.replaceAll(7, 55) //category syntax
}
assert list == ['a', 55, 'b', 9, 55, 55, 2.4, 55]
```

We can call category methods inside other category methods:

```
class Extras{
    static f(self, n){ "Hello, $n" }
}
class Extras2{
    static g(self, n){
        Extras.f(self, n)
    }
    static h(self, n){
        def ret
        use(Extras){ ret= self.f(n) } //call Extras.f() as a category method
        ret
    }
}
assert Extras.f(new Extras(), 4) == 'Hello, 4'
assert Extras2.g(new Extras2(), 5) == 'Hello, 5'
assert Extras2.h(new Extras2(), 6) == 'Hello, 6'

class A{ }
def a= new A()
use(Extras){
    assert a.f(14) == 'Hello, 14'
}
use(Extras2){
    assert a.g(15) == 'Hello, 15'
    assert a.h(16) == 'Hello, 16' //call category method within another
}
```

But we can't call category methods inside another category method from the same class:

```
class Extras{
    static f(self, n){ "Hello, $n" }
    static g(self, n){ f(self, n) }
    static h1(self, n){ f(n) } //calling f without first parameter only valid when called within
a category method
    static h2(self, n){
        def ret
        use(Extras){ ret= self.f(n) } //class as category within itself only valid if method wasn't
called using category syntax
        ret
    }
}
```

```

    }
}
assert Extras.f(new Extras(), 4) == 'Hello, 4'
assert Extras.g(new Extras(), 5) == 'Hello, 5'
try{ Extras.h1(new Extras(), 6); assert 0 }catch(e){ assert e instanceof MissingMethodException
}
assert Extras.h2(new Extras(), 7) == 'Hello, 7'

class A{ }
def a= new A()
use(Extras){
    assert a.f(14) == 'Hello, 14'
    assert a.g(15) == 'Hello, 15'
    assert a.h1(16) == 'Hello, 16'
    try{ a.h2(17); assert 0 }catch(e){ assert e instanceof
java.lang.reflect.InvocationTargetException }
}

```

A lot of entities in Groovy are classes, not just the explicit ones we've just learnt about. Numbers, lists, sets, maps, strings, patterns, scripts, closures, functions, and expandos are all implemented under the hood as classes. Classes are the building block of Groovy.

Groovy BigDecimal Math

This page last changed on Mar 08, 2007 by [gavingrover](#).

We can only use base-10 notation to represent decimal numbers, not hexadecimal or octal. Decimals are written with a decimal part and/or an exponent part, each with an optional + -. The leading zero is required.

```
[ 1.23e-23, 4.56, -1.7E1, 98.7e2, -0.27e-54 ].each{ println it } //decimals
assert (-1.23).class == BigDecimal
assert (-1.23g).class == BigDecimal
    //if we use the BigInteger 'g' suffix after a decimal-formatted number, it is a BigDecimal
```

Such BigDecimals are arbitrary-precision signed decimal numbers. They consist of an unscaled infinitely-extendable value and a 32-bit Integer scale. The value of the number represented by it is $(\text{unscaledValue} \times 10^{*(-\text{scale})})$. This means a zero or positive scale is the number of digits to the right of the decimal point; a negative scale is the unscaled value multiplied by ten to the power of the negation of the scale. For example, a scale of -3 means the unscaled value is multiplied by 1000.

We can construct a BigDecimal with a specified scale:

```
assert new BigDecimal( 0, 1 ) == 0.0
assert new BigDecimal( 123, 0 ) == 123
assert new BigDecimal( 123 ) == 123 //default scale is 0
assert new BigDecimal( -123, 0 ) == -123
assert new BigDecimal( 123, -1 ) == 1.23e3
assert new BigDecimal( 12, -3 ) == 12000.0
assert new BigDecimal( 120, 1 ) == 12.0
assert new BigDecimal( 123, 5 ) == 0.00123
assert new BigDecimal( -123, 14 ) == -1.23e-12

assert (2 as BigDecimal).unscaledValue() == 2
assert (2 as BigDecimal).scale() == 0
assert (2 as BigDecimal).scale == 0 //parens optional
assert 2.0.unscaledValue() == 20
assert 2.0.scale == 1
```

All methods and constructors for this class throw `NullPointerException` when passed a null object reference for any input parameter.

We can enquire the scale of a BigDecimal:

```
assert (1234.567).unscaledValue() == 1234567g //returns the unscaled portion of a BigInteger
assert (1234.567).scale() == 3 //returns the scale
```

The precision of a BigDecimal is the number of digits in the unscaled value. The precision of a zero value is 1.

```
assert 7.7.precision() == 2
assert (-7.7).precision() == 2
assert 1.000.precision() == 4
```

We can construct a BigDecimal from a string. The value of the resulting scale must lie between `Integer.MIN_VALUE` and `Integer.MAX_VALUE`, inclusive.

```

assert '23.45'.toBigDecimal() == 23.45
assert new BigDecimal( '23.45' ) == 23.45
assert new BigDecimal( '-32.8e2' ) == -32.8e2
assert new BigDecimal( '+.9E-7' ) == 0.9e-7
assert new BigDecimal( '+7.E+8' ) == 7e8
assert new BigDecimal( '0.0' ) == 0.0
try{ new BigDecimal( ' 23.45' ); assert 0 }catch(e){ assert e instanceof NumberFormatException
} //whitespace in string

```

If we have the String in a char array and are concerned with efficiency, we can supply that array directly to the BigDecimal:

```

def ca1= ['1', '2', '.', '5'] as char[]
assert new BigDecimal( ca1 ) == 12.5
def ca2= [ 'a', 'b', '9', '3', '.', '4', '5', 'x', 'y', 'z' ] as char[]
assert new BigDecimal( ca2, 2, 5 ) == 93.45 //use 5 chars from the array beginning from index 2

```

Formatted Displays

There are some different ways of displaying a BigDecimal:

```

assert 1.2345e7.toString() == '1.2345E+7' //one digit before decimal point, if exponent used
assert 1.2345e7.toPlainString() == '12345000' //no exponent portion
assert 1.2345e7.toEngineeringString() == '12.345E+6' //exponent divisible by 3

```

From Java 5.0, every distinguishable BigDecimal value has a unique string representation as a result of using toString(). If that string representation is converted back to a BigDecimal, then the original value (unscaled-scale pair) will be recovered. This means it can be used as a string representation for exchanging decimal data, or as a key in a HashMap.

```

[ 1.2345e7, 98.76e-3, 0.007, 0.000e4 ].each{
    assert new BigDecimal( it.toString() ) == it
}

```

We can format integers and decimals using patterns with DecimalFormat:

```

import java.text.*
def fmt= new DecimalFormat( '#,##00.0#' )
assert fmt.format( 5.6789d ) == '05.68' //pattern says at least 2 digits before point
assert fmt.format( 12345L ) == '12,345.0' //at least one digit after point, and comma as separator

```

We can explicitly define a text for negative numbers, separating the positive and negative formats with a semicolon. If the negative text is omitted, numbers are prefixed with the negative sign.

```

import java.text.*
assert new DecimalFormat( '#,##0.00;( #,##0.00)' ).format( -56L ) == '(56.00)'
//pattern says parens around negative numbers
assert new DecimalFormat( '#,##0.00' ).format( -56L ) == '-56.00' //same as
'#,##0.00;-#,##0.00'

```

We can format decimal numbers:

```
import java.text.*
assert new DecimalFormat( '0.###E0' ).format( 1234L ) == '1.234E3'
assert new DecimalFormat( '0.###E0;(0.###E0)' ).format( -0.001234 ) == '(1.234E-3)'
assert new DecimalFormat( '00.###E0' ).format( 0.00123 ) == '12.3E-4'
[ 12345: '12.345E3',
  123456: '123.456E3'
].each{ assert new DecimalFormat( '##0.#####E0' ).format( it.key ) == it.value }
// '##0' in pattern means exponent will be a multiple of 3
```

We can change various settings using `DecimalFormatSymbols`:

```
import java.text.*
def dfs= new DecimalFormatSymbols() //use to give a different text for the exponent
assert dfs.zeroDigit == '0' //char used for zero. Different for Arabic, etc
assert dfs.groupingSeparator == ',' //char used for thousands separator. Different for French,
etc
assert dfs.decimalSeparator == '.' //char used for decimal point
assert dfs.digit == '#' //char used for a digit in a pattern
assert dfs.patternSeparator == ';' //char used to separate positive and negative subpatterns in
a pattern
assert dfs.infinity == '#' //char used to represent infinity
assert dfs.minusSign == '-' //char used for minus sign, used if no negative pattern specified
assert dfs.exponentSeparator == 'E' //string used to separate mantissa and exponent

dfs.exponentSeparator= 'x10^'
def fmt= new DecimalFormat( '0.###E0', dfs )
assert fmt.format( 123456 ) == '1.2346x10^5' //uses RoundingMode.HALF_EVEN by default

assert new DecimalFormat().format( Double.POSITIVE_INFINITY ) == '#'
```

We'll look at `DecimalFormats` more in an upcoming tutorial on Internationalization.

Conversions

We can construct a `BigDecimal` from integers:

```
assert new BigDecimal( 45i ).scale == 0
assert new BigDecimal( 45L ).scale == 0
```

If we want to buffer frequently-used `BigDecimal` values for efficiency, we can use the `valueOf()` method:

```
def a= BigDecimal.valueOf( 12L, -3 ); assert a == 12000.0g; assert a.scale == -3
def b= BigDecimal.valueOf( 12L ); assert b == 12.0; assert b.scale == 0 //default scale is 0
assert BigDecimal.ZERO == 0.0 //These commonly-used values are pre-supplied
assert BigDecimal.ONE == 1.0
assert BigDecimal.TEN == 10.0
```

The `BigDecimal` can be converted between the `BigInteger`, `Integer`, `Long`, `Short`, and `Byte` classes. Numbers converted to fixed-size integers may be truncated, or have the opposite sign.

```
assert 123g as BigDecimal == 123.0
assert 45i as BigDecimal == 45.0
assert 73L as BigDecimal == 73.0
assert 73L.toBigDecimal() == 73.0 //alternative syntax

assert 123.456 as BigInteger == 123g //lost information about the precision
assert 123.456.toBigInteger() == 123g //alternative syntax
assert 73.0 as Long == 73g
```



```

assert 73.0 as long == 73g
assert 73.0.toLong() == 73g
assert 73.0.longValue() == 73g //another alternative syntax
assert 45.6789.intValue() == 45g //truncated
assert 259.0.byteValue() == 3 //truncated, only lowest 8 integral bits returned
assert 200.789.byteValue() == -56 //truncated, only lowest 8 integral bits returned, with
opposite sign

```

By appending 'Exact' to the asLong()-style method names, we can ensure an ArithmeticException is thrown if any information would be lost in the conversion:

```

assert 123.0.toBigIntegerExact() == 123g //lost information about the precision
try{ 123.456.toBigIntegerExact(); assert false }catch(e){ assert e instanceof
ArithmeticException }

assert 73.0.longValueExact() == 73g
[ { 73.21.longValueExact() },
  { 45.6789.intValueExact() },
  { 73.21.shortValueExact() },
  { 259.0.byteValueExact() },
  { 200.789.byteValueExact() },
].each{ try{ it(); assert false }catch(e){ assert e instanceof ArithmeticException } }

```

BigDecimal Arithmetic

We can use the same methods and operators on BigDecimal we use with BigInteger:

```

assert 3.4.plus( 3.3 ) == 3.4 + 3.3
assert 3.4.add( 3.3 ) == 3.4 + 3.3 //alternative name for plus
assert 3.4.minus( 2.1 ) == 3.4 - 2.1
assert 3.4.subtract( 2.1 ) == 3.4 - 2.1 //alternative name for minus
assert 3.0.multiply( 3.1 ) == 3.0 * 3.1
assert 3.0.multiply( 3g ) == 3.0 * 3g
assert 7.7.negate() == -7.7 //unary operation/method
assert (-7.7).negate() == -(-7.7)
assert (-7.7).plus() == +(-7.7) //this method provided for symmetry with negate
try{ 3.4.multiply(null); assert 0 }catch(e){ assert e instanceof NullPointerException }
//all BigDecimal methods throw NullPointerException if passed a null

```

The scale resulting from add or subtract is the maximum scale of each operand; that resulting from multiply is the sum of the scales of the operands:

```

def a = 3.414, b = 3.3
assert a.scale() == 3 && b.scale() == 1
assert (a+b).scale() == 3 //max of 3 and 1
assert (a*b).scale() == 4 //sum of 3 and 1

```

For + - and *, a BigDecimal with any integer type converts it to a BigDecimal:

```

assert (123.45g * 789).class == BigDecimal
assert (123.45g * 789L).class == BigDecimal
assert (123.45g * (89 as byte)).class == BigDecimal

```

We can use a MathContext to change the precision of operations involving BigDecimals:

```

def mc= new java.math.MathContext( 3 ) //precision of 3 in all constructors and methods where

```

```
used
assert new BigDecimal( 123456, 0, mc ) == 123000g
assert new BigDecimal( -12345, 14, mc ) == -1.23e-10
assert new BigDecimal( '23.4567', mc ) == 23.5
assert new BigDecimal( ['2', '3', '.', '4', '5', '6', '7'] as char[], mc ) == 23.5
assert new BigDecimal( ['2', '3', '.', '4', '5', '6', '7'] as char[], 1, 5, mc ) == 3.46
assert new BigDecimal( 1234i, mc ) == 1230
assert new BigDecimal( 1234L, mc ) == 1230

assert 3.45678.add( 3.3, mc ) == 6.76
assert 0.0.add( 3.333333, mc ) == 3.33
assert 3.4567.subtract( 2.1, mc ) == 1.36
assert 0.0.subtract( 2.12345, mc ) == -2.12
assert 3.0.multiply( 3.1234, mc ) == 9.37
assert (-7.77777).negate( mc ) == 7.78
assert (-7.77777).plus( mc ) == -7.78 //effect identical to that of round(MathContext) method
```

Division

We can create BigDecimals by dividing integers, both fixed-size and BigInteger, for which the result is a decimal number:

```
assert 7g / 4g == 1.75
assert (-7g) / 4g == -1.75
assert ( 1 / 2 ).class == BigDecimal
assert ( 1L / 2L ).class == BigDecimal
assert ( 1g / 2g ).class == BigDecimal
assert ( 1.5 * 2g ).class == BigDecimal //an expression with a BigDecimal never converts to an integer
assert 1.0.div( 2 ).class == BigDecimal //we can use a method instead of the operator
try{ 17g / 0; assert 0 }catch(e){ assert e instanceof ArithmeticException } //division by 0 not allowed
```

Sometimes, the division can return a recurring number. This leads to a loss of exactness:

```
assert 1/3 == 0.3333333333 //BigDecimals with recurring decimal parts round their result to 10 decimal places...
assert ( (1/3) * 3 ) != 1 //...which leads to inaccuracy in calculations
assert (1/3).precision() == 10
assert 100000/3 == 33333.3333333333 //accuracy before the decimal point is always retained
```

When the scales of both operands in division are quite different, we can lose precision, sometimes even completely:

```
assert (1.0 / 7.0) == 0.1428571429 //instead of "0.142857 with last 6 digits recurring"
assert (1e-5 / 7.0) == 0.0000014286 //precision is 10
assert (1e-9 / 7.0) == 0.0000000001
assert (1e-11 / 7.0) == 0.0 //difference in scale of operands can cause full loss of precision
```

The `ulp()` of a BigDecimal returns the "Units of the Last Place", the difference between the value and next larger having the same number of digits:

```
assert 123.456.ulp() == 0.001 //always 1, but with same scale
assert 123.456.ulp() == (-123.456).ulp()
assert 0.00.ulp() == 0.01
```

Another way of dividing numbers is to use the `divide()` method, different to the `div()` method and `/` operator. The result must be exact when using `divide()`, or an `ArithmeticException` is thrown.

```

assert 1.0.divide( 4.0 ) == 0.25
try{ 1.0.divide( 7.0 ); assert 0 }catch(e){ assert e instanceof ArithmeticException }
    //result must be exact when using divide()

assert 1.234.divide( 4.0 ) == 0.3085
assert 1.05.divide( 1.25 )
assert 1.234.scale() == 3 && 4.0.scale() == 1 && 0.3085.scale() == 4 //scale of result
unpredictable
assert 1.05.scale() == 2 && 1.25.scale() == 2 && 0.84.scale() == 2

```

We can change the precision of divide() by using a MathContext:

```

assert (1.0).divide( 7.0, new java.math.MathContext(12) ) == 0.142857142857 //precision is 12
assert (1.0).divide( 7.0, new java.math.MathContext(10) ) == 0.1428571429
assert (1.0).divide( 7.0, new java.math.MathContext(5) ) == 0.14286
try{ 1.0.divide( 7.0, new java.math.MathContext(0) ); assert 0 }catch(e){ assert e instanceof
ArithmeticException }
    //precision of 0 same as if no MathContext was supplied

```

MathContext Rounding Modes

As well as specifying required precision for operations in a MathContext, we can also specify the rounding behavior for operations discarding excess precision. Each rounding mode indicates how the least significant returned digit of a rounded result is to be calculated.

If fewer digits are returned than the digits needed to represent the exact numerical result, the discarded digits are called "the discarded fraction", regardless their contribution to the value of the number returned. When rounding increases the magnitude of the returned result, it is possible for a new digit position to be created by a carry propagating to a leading 9-digit. For example, the value 999.9 rounding up with three digits precision would become 1000.

We can see the behaviour of rounding operations for all rounding modes:

```

import java.math.MathContext //so we don't have to qualify MathContext with java.math when we
refer to it
import java.math.RoundingMode //ditto

def values= [ +5.5, +2.5, +1.6, +1.1, +1.0, -1.0, -1.1, -1.6, -2.5, -5.5 ]
def results= [
    (RoundingMode.UP): [ 6, 3, 2, 2, 1, -1, -2, -2, -3, -6 ],
    (RoundingMode.DOWN): [ 5, 2, 1, 1, 1, -1, -1, -1, -2, -5 ],
    (RoundingMode.CEILING): [ 6, 3, 2, 2, 1, -1, -1, -1, -2, -5 ],
    (RoundingMode.FLOOR): [ 5, 2, 1, 1, 1, -1, -2, -2, -3, -6 ],
    (RoundingMode.HALF_UP): [ 6, 3, 2, 1, 1, -1, -1, -2, -3, -6 ],
    (RoundingMode.HALF_DOWN): [ 5, 2, 2, 1, 1, -1, -1, -2, -2, -5 ],
    (RoundingMode.HALF_EVEN): [ 6, 2, 2, 1, 1, -1, -1, -2, -2, -6 ],
]

results.keySet().each{ roundMode->
    def mc= new MathContext( 1, roundMode )
    results[ roundMode ].eachWithIndex{ it, i->
        assert new BigDecimal( values[i], mc ) == it
    }
}

def mcu= new MathContext( 1, RoundingMode.UNNECESSARY )
assert new BigDecimal( 1.0, mcu ) == 1
assert new BigDecimal( -1.0, mcu ) == -1
[ +5.5, +2.5, +1.6, +1.1, -1.1, -1.6, -2.5, -5.5 ].each{
    try{ new BigDecimal( it, mcu ); assert 0 }catch(e){ assert e instanceof ArithmeticException }
}

```

We can thus see:

UP rounds away from zero, always incrementing the digit prior to a non-zero discarded fraction.

DOWN rounds towards zero, always truncating.

CEILING rounds towards positive infinity (positive results behave as for UP; negative results, as for DOWN).

FLOOR rounds towards negative infinity (positive results behave as for DOWN; negative results, as for UP).

HALF_UP rounds towards nearest neighbor; if both neighbors are equidistant, rounds as for UP. (The rounding mode commonly taught in US schools.)

HALF_DOWN rounds towards nearest neighbor; if both neighbors are equidistant, rounds as for DOWN.

HALF_EVEN rounds towards the nearest neighbor; if both neighbors are equidistant, rounds towards the even neighbor. (Known as "banker's rounding.")

UNNECESSARY asserts that the operation has an exact result; if there's an inexact result, throws an ArithmeticException.

There are some default rounding modes supplied for use:

```
import java.math.* //imports all such classes, including both MathContext and RoundingMode

MathContext.UNLIMITED //for unlimited precision arithmetic (precision=0 roundingMode=HALF_UP)
MathContext.DECIMAL32 //for "IEEE 754R" Decimal32 format (precision=7 roundingMode=HALF_EVEN)
MathContext.DECIMAL64 //Decimal64 format (precision=16 roundingMode=HALF_EVEN)
MathContext.DECIMAL128 //Decimal128 format (precision=34 roundingMode=HALF_EVEN)

assert MathContext.DECIMAL32.precision == 7
assert MathContext.DECIMAL32.roundingMode == RoundingMode.HALF_EVEN //precision and
roundingMode are properties
assert new BigDecimal( 123456789, 0, MathContext.DECIMAL32 ) == 123456800g
```

Other constructors for MathContext are:

```
import java.math.*

def mc1= new MathContext( 3 ) //by default, uses RoundingMode.HALF_UP rounding mode
assert mc1.roundingMode == RoundingMode.HALF_UP

def mc2= new MathContext( 3, RoundingMode.HALF_UP )
assert mc2.toString() == 'precision=3 roundingMode=HALF_UP'
def mc3= new MathContext( mc2.toString() ) //we can initialize a MathContext from another's
string
assert mc3.precision == 3
assert mc3.roundingMode == RoundingMode.HALF_UP
```

The rounding mode setting of a MathContext object with a precision setting of 0 is not used and thus irrelevant.

Cloning BigDecimals but with different scale

We can create a new BigDecimal with the same overall value as but a different scale to an existing one:

```
import java.math.*

def num= 2.2500
assert num.scale == 4 && num.unscaledValue() == 22500
def num2= num.setScale(5)
assert num2 == 2.25000 && num2.scale == 5 && num2.unscaledValue() == 225000
//usual use of changing scale is to increase the scale
```

```

def num3= num.setScale(3)
assert num3 == 2.25000 && num3.scale == 3 && num3.unscaledValue() == 2250

assert num.setScale(2) == 2.25 //only BigDecimal returned from method call has changed scale...
assert num.scale == 4 //...while original BigDecimal still has old scale...
num.scale= 3 //...so there's no point using the allowable property syntax
assert num.scale == 4

try{
    num.setScale(1) //we can't change the value when we reduce the scale...
    assert false
}catch(e){ assert e instanceof ArithmeticException }
assert 1.125.setScale(2, RoundingMode.HALF_UP) == 1.13 //...unless we use a rounding mode
assert 1.125.setScale(2, BigDecimal.ROUND_HALF_UP) == 1.13 //pre-Java-5.0 syntax

```

These 8 BigDecimal static fields are older pre-Java-5.0 equivalents for the values in the RoundingMode enum:

```

BigDecimal.ROUND_UP
BigDecimal.ROUND_DOWN
BigDecimal.ROUND_CEILING
BigDecimal.ROUND_FLOOR
BigDecimal.ROUND_HALF_UP
BigDecimal.ROUND_HALF_DOWN
BigDecimal.ROUND_HALF_EVEN
BigDecimal.ROUND_UNNECESSARY

```

There's two methods that let us convert such older names to the newer RoundingMode constants (enums):

```

import java.math.RoundingMode
assert RoundingMode.valueOf( 'HALF_UP' ) == RoundingMode.HALF_UP
assert RoundingMode.valueOf( BigDecimal.ROUND_HALF_DOWN ) == RoundingMode.HALF_DOWN

```

Further operations

For the other arithmetic operations, we also usually have the choice of supplying a MathContext or not.

There's two main ways to raise a number to a power. Using `**` and `power()` returns a fixed-size floating-point number, which we'll look at in the next topic on Groovy Floating-Point Math.

```

assert (4.5**3).class == Double
assert 4.5.power(3).class == Double //using equivalent method instead

```

We can raise a BigDecimal to the power using the `pow()` method instead, which always returns an exact BigDecimal. However, this method will be very slow for high exponents. The result can sometimes differ from the rounded result by more than one ulp (unit in the last place).

```

assert 4.5.pow(3) == 91.125 //pow() is different to power()
assert (-4.5).pow(3) == -91.125
assert 4.5.pow(0) == 1.0
assert 0.0.pow(0) == 1.0
try{ 4.5.pow(-1); assert 0 }catch(e){ assert e instanceof ArithmeticException } //exponent must
be integer >=0
try{ 1.1.pow(10000000000); assert 0 }catch(e){ assert e instanceof ArithmeticException }
//exponent too high for Java 5.0

```

```
//println( 1.1.pow(999999999) ) //warning: this runs for a VERY LONG time when uncommented
```

When we supply a MathContext, the "ANSI X3.274-1996" algorithm is used:

```
import java.math.MathContext
assert 4.5.pow( 3, new MathContext(4) ) == 91.13 //can supply a MathContext
assert 4.5.pow( -1, new MathContext(10) ) //negative exponents allowed when MathContext
supplied
try{ 4.5.pow( -1, new MathContext(0) ); assert 0 }catch(e){ assert e instanceof
ArithmeticException }
//ArithmeticException thrown if mc.precision == 0 and n < 0
try{ 4.5.pow( 123, new MathContext(2) ); assert 0 }catch(e){ assert e instanceof
ArithmeticException }
//ArithmeticException thrown if mc.precision > 0 and n has more than mc.precision decimal
digits
```

Instead of giving a precision via the MathContext, we can give the desired scale directly:

```
import java.math.RoundingMode
assert 25.497.divide( 123.4567, 5, RoundingMode.UP ) == 0.20653 //specify desired scale of 4,
and rounding mode UP
assert 25.497.divide( 123.4567, 5, BigDecimal.ROUND_UP ) == 0.20653 //cater for pre-Java-5.0
syntax
assert 25.497.divide( 123.4567, RoundingMode.UP ) == 0.207 //if no scale given, use same one
as dividend (here, 25.497)
assert 25.497.divide( 123.4567, BigDecimal.ROUND_UP ) == 0.207
```

We can divide to an integral quotient, and/or find the remainder. (The preferred scale of the integral quotient is the dividend's less the divisor's.)

```
import java.math.* //import all classes prefixed with java.math, so we don't need to specify
them individually
mc= new MathContext( 9, RoundingMode.HALF_UP )
assert 25.5.divide( 2.4, mc ) == 10.625

assert 25.5.divideToIntegralValue( 2.4 ) == 10 //rounding mode always DOWN...
assert 25.5.remainder( 2.4 ) == 1.5
assert 25.5.divideToIntegralValue( 2.4, mc ) == 10 //...even when a MathContext says otherwise
assert 25.5.remainder( 2.4, mc ) == 1.5
assert (-25.5).divideToIntegralValue( 2.4, mc ) == -10
assert (-25.5).remainder( 2.4, mc ) == -1.5

try{ 25.5.divideToIntegralValue( 0 ); assert 0 }catch(e){ assert e instanceof
ArithmeticException }
try{ 25.5.remainder( 0 ); assert 0 }catch(e){ assert e instanceof ArithmeticException }

assert 25.525.remainder( 2.345, new MathContext(1) ) == 2.075
//MathContext's precision only affects quotient calculation; remainder always exact so may
have more decimal digits

[ [25.5, 2.4], [-27.1, 3.3] ].each{ x, y->
  assert x.remainder( y ) == x.subtract( x.divideToIntegralValue( y ).multiply( y ) )
}

try{
  2552.0.divideToIntegralValue( 2.4, new MathContext(2) )
  assert 0
}catch(e){ assert e instanceof ArithmeticException }
//throw if result needs more decimal digits than supplied MathContext's precision

try{
  2552.0.remainder( 2.4, new MathContext(2) )
  assert 0
}catch(e){ assert e instanceof ArithmeticException }
//throw if implicit divideToIntegralValue() result needs more decimal digits than supplied
MathContext's precision
```

```
def qr= 25.5.divideAndRemainder( 2.4 )
assert qr[0] == 10 && qr[1] == 1.5 //same results as divideToIntegralValue() and remainder(),
but more efficient
```

We can find the absolute value of a BigDecimal:

```
import java.math.*
assert 7.89.abs() == 7.89 //same scale if no MathContext
assert (-7.89).abs() == 7.89
assert (-7.89).abs( new MathContext(2) ) == 7.9
```

The round() operation only has a version with a MathContext parameter. Its action is identical to that of the plus(MathContext) method.

```
assert 7.89.round( new MathContext(2) ) == 7.9
assert 7.89.round( new MathContext(0) ) == 7.89 //no rounding if precision is 0
```

Operations without a MathContext

Not all BigDecimal operations have a MathContext.

Auto-incrementing and -decrementing work on BigDecimals:

```
def a= 12.315
a++
assert a == 13.315
--a
assert a == 12.315
```

The signum method:

```
assert 2.34.signum() == 1
assert (-2.34).signum() == -1
assert 0.0.signum() == 0
```

As with integers, we can compare BigDecimals:

```
assert (2.50 <=> 2.5) == 0 && 2.50.compareTo(2.5) == 0
assert (-3.45 <=> 1.23) == -1 && (-3.45).compareTo(1.23) == -1
assert (1.23 <=> -0.12) == 1 && 1.23.compareTo(-0.12) == 1
assert (1.23 > -0.12) && 1.23.compareTo(-0.12) > 0
```

The equals() method and == operator are different for BigDecimals. (So we must be careful if we use BigDecimal objects as elements in a SortedSet or keys in a SortedMap, since BigDecimal's natural ordering is inconsistent with equals().)

```
assert ! ( 2.00.equals(2.0) ) //considers whether both unscaledValue and scale are equal
assert 2.00 == 2.0 //only considers the sequence of the two numbers on a line
assert 0.0 == -0.0 && 0.0.equals( -0.0 )
```

We can find the minimum and maximum of two BigDecimals:

```
assert (-2.0).min( 7.3 ) == -2.0
assert 3.5.max( 4.2 ) == 4.2
```

We can move the decimal point to the left or right:

```
import java.math.*
def num= 123.456
assert num.scale == 3
def mpl= num.movePointLeft( 2 )
assert mpl.scale == 5 //scale should be max( number.scale + movement, 0 )
assert mpl == 1.23456
def mpr= num.movePointRight( 4 )
assert mpr.scale == 0 //scale should be max( number.scale - movement, 0 )
assert mpr == 1234560
assert( 3.456.movePointLeft(2) == 0.03456 )
[ -2, -1, 0, 1, 2 ].each{
  assert 123.456.movePointLeft( it ) == 123.456.movePointRight( -it )
}
try{ //throw ArithmeticException if scale will overflow on moving decimal point
  new BigDecimal( 123456, 128*256*256*256 - 1 ).movePointLeft( 1 )
  assert 0
}catch(e){ assert e instanceof ArithmeticException }
```

Another method for moving the decimal point, but by consistent change to the scale:

```
import java.math.*
def num= 123.456
assert num.scale == 3
def mpl= num.scaleByPowerOfTen( 16 )
assert mpl == 1.23456e18
assert mpl.scale == -13 //num.scale - 16
```

We can strip trailing zeros:

```
assert 45.607000.stripTrailingZeros() == 45.607
assert 600.0.stripTrailingZeros() == 6e2
assert new BigDecimal( 6000, 1 ).stripTrailingZeros() == new BigDecimal( 6, -2 )
```


Groovy Collections Indepth

This page last changed on Mar 27, 2007 by [gavingrover](#).

Lists

A list is an ordered collection of objects:

```
def list = [5, 6, 7, 8]
assert list.size() == 4
list = [5, 6, 7, 7, 6, 7, 9, -1] //duplicates allowed
assert [ 1, 2.5, 2.5f, 2.5d, 'hello', 7g, null, 9 as byte ] //objects can be of different types
assert list.class == ArrayList //the specific kind of list being used

assert list[2] == 7 //indexing starts at 0
assert list.getAt(2) == 7 //equivalent method to []
assert list.get(2) == 7 //alternative method

assert [1,2,3,4,5][-1] == 5 //use negative indices to count from the end
assert [1,2,3,4,5][-2] == 4
assert [1,2,3,4,5].getAt(-2) == 4 //getAt() available with negative index, but not get()
try{ [1,2,3,4,5].get(-2); assert 0 }catch(e){ assert e instanceof
ArrayIndexOutOfBoundsException }

list[2] = 9
assert list == [5, 6, 9, 8, ] //trailing comma OK
list.putAt(2, 10) //equivalent method to [] when value being changed
assert list == [5, 6, 10, 8]
assert list.set(2, 11) == 10 //alternative method that returns old value
assert list == [5, 6, 11, 8]
```

Lists can be evaluated as a boolean value:

```
assert ! [] //an empty list evaluates as false
assert [1] && ['a'] && [0] && [0.0] && [false] && [null]
//all other lists, irrespective of contents, evaluate as true
```

We can use [] to assign a new empty list and << to append items to it:

```
def list = []; assert list.size() == 0
list << 5; assert list.size() == 1
list << 7 << 'i' << 11; assert list == [5, 7, 'i', 11]
list << ['m', 'o']; assert list == [5, 7, 'i', 11, ['m', 'o']]
assert ( [1,2] << 3 << [4,5] << 6 ) == [1,2,3, [4, 5], 6] //first item in chain of << is target
list
assert ([1,2,3] << 4) == ([1,2,3].leftShift(4)) //using this method is equivalent to using <<
```

We can add to a list in many ways:

```
assert [1,2] + 3 + [4,5] + 6 == [1, 2, 3, 4, 5, 6]
assert [1,2].plus(3).plus([4,5]).plus(6) == [1, 2, 3, 4, 5, 6] //equivalent method for +
def a = [1,2,3]; a += 4; a += [5,6]; assert a == [1,2,3,4,5,6]
assert [1, *[222, 333], 456] == [1, 222, 333, 456]
assert [ *[1,2,3] ] == [1,2,3]
assert [ 1, [2,3,[4,5],6], 7, [8,9] ].flatten() == [1, 2, 3, 4, 5, 6, 7, 8, 9]

def list= [1,2]
list.add(3) //alternative method name
list.addAll([5,4]) //alternative method name
assert list == [1,2,3,5,4]
```

```
def list= [1,2]
list.add(1,3) //add 3 just before index 1
assert list == [1,3,2]
list.addAll(2,[5,4]) //add [5,4] just before index 2
assert list == [1,3,5,4,2]

list = ['a', 'b', 'z', 'e', 'u', 'v', 'g']
list[8] = 'x'
assert list == ['a', 'b', 'z', 'e', 'u', 'v', 'g', null, 'x'] //nulls inserted if required
```

We can use the each and eachWithIndex methods to execute code on each item in a list:

```
[1, 2, 3].each{ println "Item: $it" }
['a', 'b', 'c'].eachWithIndex{ it, i -> println "$i: $it" }
```

We can construct a list using another's elements as a template:

```
def list1= ['a','b','c']
def list2 = new ArrayList( list1 ) //construct a new list, seeded with the same items as in list1
assert list2 == list1 // == checks that each corresponding element is the same
def list3 = list1.clone()
assert list3 == list1
```

We can perform a closure on each item of a list and return the result:

```
assert [1, 2, 3].collect{ it * 2 } == [2, 4, 6] //simple call gives single result
assert [1, 2, 3]*.multiply(2) == [1, 2, 3].collect{ it.multiply(2) } //shortcut syntax instead of collect

def list= []
assert [1, 2, 3].collect( list ){ it * 2 } == [2, 4, 6] //this style of call gives two identical results
assert list == [2, 4, 6]
```

Other methods on a list return a value:

```
assert [1, 2, 3].find{ it > 1 } == 2
assert [1, 2, 3].findAll{ it > 1 } == [2, 3]
assert ['a','b','c','d','e'].indexOf{ it in ['c','e','g'] } == 2 //find first item that satisfies closure
assert [1, 2, 3].every{ it < 5 }
assert ! [1, 2, 3].every{ it < 3 }
assert [1, 2, 3].any{ it > 2 }
assert ! [1, 2, 3].any{ it > 3 }

assert [1,2,3,4,5,6].sum() == 21
assert ['a','b','c','d','e'].sum{ it=='a'?1: it=='b'?2: it=='c'?3: it=='d'?4: it=='e'?5: 0 } == 15

assert [1, 2, 3].join('-') == '1-2-3'
assert [1, 2, 3].inject('counting: '){ str, item -> str + item } == 'counting: 123'
assert [1, 2, 3].inject(0){ count, item -> count + item } == 6
```

We can find the maximum and minimum in a collection:

```
def list= [9, 4, 2, 10, 5]
assert list.max() == 10
```

```

assert list.min() == 2
assert Collections.max( list ) == 10
assert Collections.min( list ) == 2
assert ['x', 'y', 'a', 'z'].min() == 'a' //we can also compare single characters

def list2= ['abc', 'z', 'xyzuvw', 'Hello', '321']
assert list2.max{ it.size() } == 'xyzuvw' //we can use a closure to spec the sorting behaviour
assert list2.min{ it.size() } == 'z'

```

We can use a "Comparator" to define the comparing behaviour:

```

def mc= [compare:{a,b-> a.equals(b)? 0: a<b? -1: 1}] as Comparator //this syntax to be
explained in a later tutorial
def list= [7,4,9,-6,-1,11,2,3,-9,5,-13]
assert list.max( mc ) == 11
assert list.min( mc ) == -13
assert Collections.max( list, mc ) == 11
assert Collections.min( list, mc ) == -13

def mc2= [ compare: {a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ] as Comparator
//we should always ensure a.equals(b) returns 0, whatever else we do, to avoid inconsistent
behaviour in many contexts
assert list.max( mc2 ) == -13
assert list.min( mc2 ) == -1
assert list.max{a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } == -13
assert list.min{a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } == -1

```

We can remove elements from a list by referring to the element/s to be removed:

```

assert ['a','b','c','b','b'] - 'c' == ['a','b','b','b'] //remove 'c', and return resulting list
assert ['a','b','c','b','b'] - 'b' == ['a','c'] //remove all 'b', and return resulting list
assert ['a','b','c','b','b'] - ['b','c'] == ['a'] //remove all 'b' and 'c', and return
resulting list
assert ['a','b','c','b','b'].minus('b') == ['a','c'] //equivalent method name for -
assert ['a','b','c','b','b'].minus( ['b','c'] ) == ['a']
def list= [1,2,3,4,3,2,1]
list -= 3
assert list == [1,2,4,2,1] //use -= to remove 3, permanently
assert ( list -= [2,4] ) == [1,1] //remove 2's and 4's, permanently

```

We can remove an element by referring to its index:

```

def list= [1,2,3,4,5,6,2,2,1]
assert list.remove(2) == 3 //remove the third element, and return it
assert list == [1,2,4,5,6,2,2,1]

```

We can remove the first occurrence of an element from a list:

```

def list= ['a','b','c','b','b']
assert list.remove('c') //remove 'c', and return true because element removed
assert list.remove('b') //remove first 'b', and return true because element removed
assert ! list.remove('z') //return false because no elements removed
assert list == ['a','b','b']

```

We can clear a list of all elements:

```

def list= ['a',2,'c',4]
list.clear()
assert list == []

```

We can pop the last item from a list, and use the list as a simple stack:

```
def stack= [1,2,4,6]
stack << 7
assert stack == [1,2,4,6,7]
assert stack.pop() == 7
assert stack == [1,2,4,6]
```

Other useful operators and methods:

```
assert 'a' in ['a','b','c']
assert ['a','b','c'].contains('a')
assert [1,3,4].containsAll([1,4])

assert [].isEmpty()
assert [1,2,3,3,3,3,4,5].count(3) == 4

assert [1,2,4,6,8,10,12].intersect([1,3,6,9,12]) == [1,6,12]

assert [1,2,3].disjoint( [4,6,9] )
assert ! [1,2,3].disjoint( [2,4,6] )
assert Collections.disjoint( [1,2,3], [4,6,9] ) //alternative method name
```

There's various ways of sorting:

```
assert [6,3,9,2,7,1,5].sort() == [1,2,3,5,6,7,9]

def list= ['abc', 'z', 'xyzuvw', 'Hello', '321']
assert list.sort{ it.size() } == ['z', 'abc', '321', 'Hello', 'xyzuvw']

def list2= [7,4,-6,-1,11,2,3,-9,5,-13]
assert list2.sort{a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ==
    [-1, 2, 3, 4, 5, -6, 7, -9, 11, -13]
def mc= [ compare: {a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ] as Comparator
assert list2.sort(mc) == [-1, 2, 3, 4, 5, -6, 7, -9, 11, -13]

def list3= [6,-3,9,2,-7,1,5]
Collections.sort(list3)
assert list3 == [-7,-3,1,2,5,6,9]
Collections.sort(list3, mc)
assert list3 == [1,2,-3,5,6,-7,9]
```

We can repeat a list or element:

```
assert [1,2,3] * 3 == [1,2,3,1,2,3,1,2,3]
assert [1,2,3].multiply(2) == [1,2,3,1,2,3]
assert Collections.nCopies( 3, 'b' ) == ['b', 'b', 'b'] //nCopies works differently
assert Collections.nCopies( 2, [1,2] ) == [ [1,2], [1,2] ] //not [1,2,1,2]
```

We can find the first or last index of items in a list:

```
assert ['a','b','c','d','c','d'].indexOf('c') == 2 //index returned
assert ['a','b','c','d','c','d'].indexOf('z') == -1 //index -1 means value not in list
assert ['a','b','c','d','c','d'].lastIndexOf('c') == 4
```

Some very common methods are:

```
def list= [], list2= []
[1,2,3,4,5].each{ list << it*2 }
assert list == [2,4,6,8,10]
[1,2,3,4,5].eachWithIndex{item, index-> list2 << item * index } //closure supplied must have 2
params
assert list2 == [0,2,6,12,20]
```

A list may contain itself, but equals() may not always be consistent. Consider this:

```
def list, list2, list3
list= [1, 2, list, 4]
list2= [1, 2, list2, 4]
assert list.equals(list2)
list3= [1, 2, list, 4]
assert ! list.equals(list3)
```

Ranges and List-Slicing

Ranges are consecutive lists of sequential values like Integers, and can be used just like a List:

```
assert 5..8 == [5,6,7,8] //includes both values
assert 5..<8 == [5, 6, 7] //excludes specified top value
```

They can also be used with single-character strings:

```
assert ('a'..'d') == ['a','b','c','d']
```

Ranges are handy with the each method:

```
def n=0
(1..10).each{ n += it }
assert n == 55
```

We can define lists using a range or ranges within a list. This is called slicing:

```
assert [*3..5] == [3,4,5]
assert [ 1, *3..5, 7, *9..<12 ] == [1,3,4,5,7,9,10,11]
```

Lists can be used as subscripts to other lists:

```
assert ('a'..'g')[ 3..5 ] == ['d','e','f']
assert ('a'..'g').getAt( 3..5 ) == ['d','e','f'] //equivalent method name

assert ('a'..'g')[ 1, 3, 5, 6 ] == ['b','d','f','g']
assert ('a'..'g')[ 1, *3..5 ] == ['b','d','e','f']
assert ('a'..'g')[ 1, 3..5 ] == ['b','d','e','f'] //range in subscript flattened automatically
assert ('a'..'g')[-5..-2] == ['c','d','e','f']
assert ('a'..'g').getAt( [ 1, *3..5 ] ) == ['b','d','e','f'] //equivalent method name
assert ('a'..'g').getAt( [ 1, 3..5 ] ) == ['b','d','e','f']
```

We can view a sublist of a list:

```
def list=[1,2,3,4,5], sl= list.subList(2,4)
sl[0]= 9 //if we change the sublist...
assert list == [1,2,9,4,5] //...backing list changes...
list[3]= 11
assert sl == [9,11] //...and vice versa
```

We can perform the same methods on the subscripted lists as we can on the lists they're produced from:

```
assert ['a','b','c','d','e'][1..3].indexOf('c') == 1 //note: index of sublist, not of list
```

We can update items using subscripting too:

```
def list = ['a','b','c','d','e','f','g']
list[2..3] = 'z'
assert list == ['a', 'b', 'z', 'e', 'f', 'g'] //swap two entries for one
list[4..4]= ['u','v']
assert list == ['a', 'b', 'z', 'e', 'u', 'v', 'g'] //swap one entry for two

def list= ['a', 'b', 'z', 'e', 'u', 'v', 'g']
list[0..1]= []
assert list == ['z', 'e', 'u', 'v', 'g'] //remove entries from index range
list[1..1]= []
assert list == ['z', 'u', 'v', 'g'] //remove entry at index
```

We can also use a method instead of [] with ranges:

```
def list = ['a','b','c','d','e','f','g']
list.putAt(2..3, 'z')
assert list == ['a', 'b', 'z', 'e', 'f', 'g']
list.putAt(4..4, ['u','v'])
assert list == ['a', 'b', 'z', 'e', 'u', 'v', 'g']
list.putAt(1..<3, [])
assert list == ['a', 'e', 'u', 'v', 'g']
list.putAt( 0..<0, 'm' ) //
assert list == ['m', 'a', 'e', 'u', 'v', 'g']
list.removeRange(1,3) //another method to do similar, means: list[1..<3]= []
list[1..2].clear()
assert list == ['m', 'g']
```

More List Utilities

To reverse a list:

```
assert [1,2,3].reverse() == [3,2,1]

def list= ['a','b','c','d','e']
Collections.reverse( list )
assert list == ['e','d','c','b','a']
use(Collections){ list.reverse() } //alternative syntax for null-returning
Collections.reverse(List)
assert list == ['a','b','c','d','e']

def list2= []
[1,2,3,4,5].reverseEach{ list2 << it*2 } //same as, but more efficient than:
[...].reverse().each{...}
assert list2 == [10,8,6,4,2]

assert [1,2,3,4,5,6][3..1] == [4,3,2] //use backwards range to reverse returned sublist

def list3 = [1, 2, -3, 5, 6, -7, 9]
```

```
def rmc= Collections.reverseOrder()
Collections.sort(list3, rmc)
assert list3 == [9, 6, 5, 2, 1, -3, -7]

def list4 = [1, 2, -3, 5, 6, -7, 9]
def mc= [ compare: {a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ] as Comparator
def rmc2= Collections.reverseOrder( mc )
Collections.sort(list4, rmc2)
assert list4 == [9, -7, 6, 5, -3, 2, 1]
```

We can perform a binary search on a sorted list:

```
assert Collections.binarySearch([2,5,6,7,9,11,13,26,31,33], 26) == 7 //list must already be
sorted
assert Collections.binarySearch([2,5,6,7,9,11,13,31,33], 26) == -8
//if key not there, give negative of one plus the index before which key would be if it was
there
def mc= [ compare: {a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ] as Comparator
assert Collections.binarySearch([2,-5,-6,7,9,-11,13,26,31,-33], 26, mc) == 7 //give comparator
list sorted by
```

We can remove or retain elements in bulk. retainAll() gives the intersection of two lists; removeAll() gives the asymmetric difference.

```
def list= ['a','b','c','b','b','e','e']
assert list.removeAll( ['b','z'] ) //remove 'b' and 'z', return true because list changed
assert list == ['a','c','e','e']
assert ! list.removeAll( ['b','z'] ) //return false because list didn't change
assert list == ['a','c','e','e']
assert list.retainAll( ['a','e'] ) //retain only 'a' and 'e', return true because list changed
assert list == ['a','e','e']
assert ! list.retainAll( ['a','e'] ) //retain only 'a' and 'e', return true because list didn't
change
assert list == ['a','e','e']
```

Some miscellaneous methods:

```
def list= ['a', 7, 'b', 9, 7, 7, 2.4, 7]
Collections.replaceAll( list, 7, 55)
assert list == ['a', 55, 'b', 9, 55, 55, 2.4, 55]

list= ['a', 7, 'b', 9, 7, 7, 2.4, 7]
use(Collections){ list.replaceAll(7, 55) } //alternative syntax
assert list == ['a', 55, 'b', 9, 55, 55, 2.4, 55]

list= ['a',2,null,4,'zyx',2.5]
use(Collections){ list.fill( 'g' ) } //or: Collections.fill( list, 'g' )
assert list == ['g', 'g', 'g', 'g', 'g', 'g']

list= ['a', 'e', 'i', 'o', 'u', 'z']
use(Collections){ list.swap(2, 4) } //or: Collections.swap(list, 2, 4)
assert list == ['a', 'e', 'u', 'o', 'i', 'z']

assert Collections.frequency(['a','b','a','c','a','a','d','e'], 'a') == 4
use(Collections){ assert ['a','b','a','c','a','a','d','e'].frequency('a') == 4 }

list= ['a','b','c','d','e']
Collections.rotate(list, 3)
assert list == ['c','d','e','a','b']
use(Collections){ list.rotate(-2) }
assert list == ['e','a','b','c','d']

list= [1,2,3,4,5]
Collections.shuffle(list, new Random()) //we can supply our own random number generator...
assert list != [1,2,3,4,5]
```

```

list= [1,2,3,4,5]
Collections.shuffle(list) //...or use the default one
assert list != [1,2,3,4,5]

assert [3,5,5,5,2].unique() == [3,5,2]
def mc= [ compare: {a,b-> a.equals(b) || a.equals(-b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ] as
Comparator
assert [3,5,5,-5,2,-7].unique(mc) == [3,5,2,-7] //remove subsequent items comparator considers
equal
assert [3,5,5,-5,2,-7].unique{a, b-> a == b || a == -b? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ==
[3,5,2,-7]

list= [1,2,3]
Collections.copy( list, [9,8,7] )
assert list == [9,8,7] //overwrites original data
Collections.copy( list, [11,12] ) //source list shorter...
assert list == [11,12,7] //...which leaves remaining entries unchanged
try{ Collections.copy( list, [21,22,23,24] ); assert 0 } //source list too long
catch(e){ assert e instanceof IndexOutOfBoundsException }

list= [1,8,8,2,3,7,6,4,6,6,2,3,7,5]
assert Collections.indexOfSubList( list, [2,3,7] ) == 3
assert Collections.lastIndexOfSubList( list, [2,3,7] ) == 10
assert Collections.indexOfSubList( list, [9,9,13] ) == -1 //if sublist doesn't exist

```

Sets

A set is an unordered collection of objects, with no duplicates. It can be considered as a list with restrictions, and is often constructed from a list:

```

def s1= [1,2,3,3,3,4] as Set, s2= [4,3,2,1] as Set, s3= new HashSet( [1,4,2,4,3,4] )
assert s1.class == HashSet && s2.class == HashSet //the specific kind of set being used
assert s1 == s2
assert s1 == s3
assert s2 == s3
assert s1.asList() && s1.toList() //a choice of two methods to convert a set to a list
assert ( ([] as Set) << null << null << null ) == [null] as Set

```

A set should not contain itself as an element.

Most methods available to lists, besides those that don't make sense for unordered items, are available to sets.

```

[ { it[1] }, { it.getAt(1) }, { it.putAt(1,4) }, { it.reverse() } ].
each{ try{ it([1,2,3] as Set); assert 0 }catch(e){ assert e instanceof MissingMethodException
} }

```

The add() and addAll() methods return false if the set wasn't changed as a result of the operation:

```

def s= [1,2] as Set
assert s.add(3)
assert ! s.add(2)
assert s.addAll( [5,4] )
assert ! s.addAll( [5,4] )
assert s == [1,2,3,5,4] as Set

```

Examples with Lists and Sets

For small numbers of items, it's common in Groovy to use a list for set processing, and only convert it to a set when necessary, eg, for output.

Though the uniqueness of set items is useful for some processing, for example, if we want to separate the unique and duplicating items in a list:

```
list=[1,2,7,2,2,4,7,11,5,2,5]
def uniques= [] as Set, dups= [] as Set
list.each{ uniques.add(it) || dups.add(it) }
uniques.removeAll(dups)
assert uniques == [1,4,11] as Set && dups == [2,5,7] as Set
```

To calculate the symmetric set difference of two sets non-destructively:

```
def s1=[1,2,3,4,5,6], s2=[4,5,6,7,8,9]
def diff = (s1 as Set) + s2
tmp = s1 as Set
tmp.retainAll(s2)
diff.removeAll(tmp)
assert diff == [1,2,3,7,8,9]
```

SortedSet

A sorted set is one with extra methods that utilize the sorting of the elements. It's often more efficient than doing the same with lists.

```
def list= [3,2,3,3,1,7,5]
assert new TreeSet(list) == new TreeSet([1,1,1,2,5,7,3,1])
assert new TreeSet(list).toList() == list.unique().sort()

assert new TreeSet(list).first() == list.unique().min()
assert new TreeSet(list).last() == list.unique().max()
```

We can construct a TreeSet by giving a comparator to order the elements in the set:

```
def c= [ compare: {a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ] as Comparator
def ts= new TreeSet( c )
ts<< 3 << -7 << 9 << -2 << -4
assert ts == new TreeSet( [-2, 3, -4, -7, 9] )
assert ts.comparator() == c //retrieve the comparator
```

The range-views, `headSet()` `tailSet()` and `subSet()`, are useful views of the items in a sorted set. These range-views remain valid even if the backing sorted set is modified directly. The sorted set returned by these methods will throw an `IllegalArgumentException` if the user attempts to insert an element out of the range.

```
def ss= new TreeSet(['a','b','c','d','e'])

def hs= ss.headSet('c')
assert hs == new TreeSet(['a','b']) //return all elements < specified element
hs.remove('a')
assert ss == new TreeSet(['b','c','d','e']) //headset is simply a view of the data in ss

def ts= ss.tailSet('c')
```

```

assert ts == new TreeSet(['c','d','e']) //return all elements >= specified element
ts.remove('d')
assert ss == new TreeSet(['b','c','e']) //tailset is also a view of data in ss

def bs= ss.subSet('b','e')
assert bs == new TreeSet(['b','c']) //return all elements >= but < specified element
bs.remove('c')
assert ss == new TreeSet(['b','e']) //subset is simply a view of the data in ss

ss << 'a' << 'd'
assert hs == new TreeSet(['a','b']) //if backing sorted set changes, so do range-views
assert ts == new TreeSet(['d','e'])
assert bs == new TreeSet(['b','d'])

```

For a SortedSet of strings, we can append '\0' to a string to calculate the next possible string:

```

def dic= new TreeSet( ['aardvark', 'banana', 'egghead', 'encephalograph', 'flotsam',
'jamboree'] )
assert dic.subSet('banana', 'flotsam').size() == 3 //incl 'banana' but excl 'flotsam'
assert dic.subSet('banana', 'flotsam\0').size() == 4 //incl both
assert dic.subSet('banana\0', 'flotsam').size() == 2 //excl both
dic.subSet('e', 'f').clear()
assert dic == new TreeSet( ['aardvark', 'banana', 'flotsam', 'jamboree'] ) //clear all words
beginning with 'e'

```

To go one element backwards from an element elt in a SortedSet:

```

Object predecessor = ss.headSet( elt ).last()

```

Immutable Collections

We can convert a list or set into one that can't be modified:

```

def imList= ['a', 'b', 'c'].asImmutable()
try{ imList<< 'd'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
imList= Collections.unmodifiableList( ['a', 'b', 'c'] ) //alternative way
try{ imList<< 'd'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }

def imSet= (['a', 'b', 'c'] as Set).asImmutable()
try{ imSet<< 'd'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
imSet= Collections.unmodifiableSet( ['a', 'b', 'c'] as Set ) //alternative way
try{ imSet<< 'd'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }

def imSortedSet= ( new TreeSet(['a', 'b', 'c']) ).asImmutable()
try{ imSortedSet<< 'd'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
imSortedSet= Collections.unmodifiableSortedSet( new TreeSet(['a', 'b', 'c']) ) //alternative
way
try{ imSortedSet<< 'd'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }

```

We can create an empty list or set that can't be modified:

```

def list= Collections.emptyList()
assert list == []
try{ list<< 'a'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
list= Collections.EMPTY_LIST
assert list == []
try{ list<< 'a'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }

def set= Collections.emptySet()
assert set == [] as Set

```

```
try{ set<< 'a'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
set= Collections.EMPTY_SET
assert set == [] as Set
try{ set<< 'a'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
```

We can create a single-element list that can't be modified:

```
def singList= Collections.singletonList('a')
assert singList == ['a']
try{ singList<< 'b'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }

def singSet = Collections.singleton('a')
assert singSet == ['a'] as Set
try{ singSet<< 'b'; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
```

Groovy Floating Point Math

This page last changed on Mar 08, 2007 by [gavingrover](#).

As well as BigDecimal, decimals can have type Float or Double. Unlike BigDecimal which has no size limit, Float and Double are fixed-size, and thus more efficient in calculations. BigDecimal stores its value as base-10 digits, while Float and Double store their values as binary digits. So although using them is more efficient in calculations, the result of calculations will not be as exact as in base-10, eg, $3.1f + 0.4f$ computes to 3.499999910593033, instead of 3.5.

We can force a decimal to have a specific type other than BigDecimal by giving a suffix (F for Float, D for Double):

```
assert 1.200065d.class == Double
assert 1.234f.class == Float
assert (-1.23E23D).class == Double
assert (1.167g).class == BigDecimal //Although g suffix for BigDecimals is optional, it makes
examples more readable
```

We can enquire the minimum and maximum values for Floats and Doubles:

```
assert Float.MIN_VALUE == 1.4E-45f
assert Float.MAX_VALUE == 3.4028235E38f
assert Double.MIN_VALUE == 4.9E-324d
assert Double.MAX_VALUE == 1.7976931348623157E308d
```

We can represent infinities by using some predefined constants (prefixed by either Float or Double):

```
assert (1f / 0f) == Double.POSITIVE_INFINITY
assert (-1f / 0f) == Double.NEGATIVE_INFINITY
assert Double.POSITIVE_INFINITY == Float.POSITIVE_INFINITY
assert 0.0f != -(0.0f) //positive and negative zeroes are not equal, when negative is written
-(0.0f) ...
assert 0.0f == -0.0f //... but when negative is written -0.0f, it's evaluated as positive
```

If a nonzero Double literal is too large or too small, it's represented by Double.POSITIVE_INFINITY or Double.NEGATIVE_INFINITY or 0.0:

```
assert Double.MAX_VALUE * Double.MAX_VALUE == Double.POSITIVE_INFINITY
assert Double.MIN_VALUE * Double.MIN_VALUE == 0.0d
assert -Double.MAX_VALUE * Double.MAX_VALUE == Double.NEGATIVE_INFINITY
assert -Double.MAX_VALUE * -Double.MAX_VALUE == Double.POSITIVE_INFINITY
```

Classes Float and Double can both be written uncapsitalized, ie, float and double.

```
assert Float.TYPE == float
assert Double.TYPE == double
```

There's a special variable called Double.NaN (and Float.NaN), meaning "Not a Number", which is sometimes returned from math calculations. Once introduced into a math calculation, the result will (usually) be NaN.

Conversions

The Float and Double classes, along with BigDecimal, BigInteger, Integer, Long, Short, and Byte, can all be converted to one another.

Converting numbers to integers may involve rounding or truncation:

```
assert 45.76f as int == 45i //truncated
assert 45.76d as int == 45i
assert 45.76f.toInteger() == 45i //method name
assert 45.76f.toLong() == 45L
assert 200.8f as byte == -56 as byte //sign reversed after truncation
assert 45.76f.toBigInteger() == 45
```

Converting from integers to float or double (may involve rounding):

```
assert 789g as Float == 789f
assert 45i.toFloat() == 45f //method name
assert 789g.toFloat() == 789f
assert 789g.floatValue() == 789f //alternative method name
assert 45i as double == 45d
assert 6789g.toDouble() == 6789d //method name
assert 6789g.doubleValue() == 6789d //alternative method name
assert new BigInteger( '1' + '0'*40 ).floatValue() == Float.POSITIVE_INFINITY //one with 40 zeroes after it
assert new BigInteger( '1234567890' * 3 ).floatValue() == 1.2345679e29f //precision lost on conversion
```

Converting from BigDecimal to float or double (may involve rounding):

```
assert 89.980 as float == 89.98f
assert 1.432157168 as float == 1.4321572f //rounded
assert 78.9g.toFloat() == 78.9f
assert 456.789g.floatValue() == 456.789f
assert 6.789g.toDouble() == 6.789d
assert 2345.6789g.doubleValue() == 2345.6789d
assert new BigDecimal( '-' + '1' *45 ).floatValue() == Float.NEGATIVE_INFINITY
assert new BigDecimal( '0.' + '0'*45 + '1' ).floatValue() == 0.0f
assert new BigDecimal( '0.' + '1234567890' *3 ).floatValue() == 0.12345679f //precision lost on conversion
```

We can convert a double to a float. but there's no Double() constructor accepting a float as an argument.

```
assert 23.45e37d as float == 23.45e37f
assert new Float( 23.45e37d ) == 23.45e37f
assert new Float( 23.45e67d ) == Float.POSITIVE_INFINITY
assert 123.45e12f as double //conversion inexact
```

We can create a Float or Double from a string representation of the number, either base-10 or hex:

```
[ '77', '1.23e-23', '4.56', '-1.7E1', '98.7e2', '-0.27e-30' ].each{
    assert it.toFloat()
    assert new Float(it)
    assert it.toDouble()
    assert new Double(it)
}
assert new Float( ' 1.23e-23 ' ) //leading and trailing whitespace removed
```

```

try{ new Float( null ); assert 0 }catch(e){ assert e instanceof NullPointerException }
[ 'NaN', '-NaN', 'Infinity', '-Infinity', '+Infinity' ].each{ assert new Float(it) }

assert new Float( ' -0Xabc.defP7' ) //we can have hexadecimal mantissa, with P indicating
exponent
assert new Float( ' 0xABC.DEFp17 ' ) //part after P must be base-10, not more hex
assert new Float( '0X.defP-3f \n' ) //any whitespace OK (spaces, tabs, newlines, carriage
returns, etc)
try{ new Float( ' @0X6azQ/3d' ); assert 0 }catch(e){ assert e instanceof NumberFormatException
}
//because the string doesn't contain a parsable number in the form of a Float
assert Float.valueOf( '0xABp17' ) //alternate means of constructing float from string
representation
assert Float.parseFloat( '0xABp17' ) //another alternate means of constructing float from
string
assert new Double( '0x12bc.89aP7d ' )

```

The string is first converted to a double, then if need be converted to a float.

Converting from double to BigDecimal is only exact when the double has an exact binary representation, eg, 0.5, 0.25. If a float is supplied, it's converted to a double first, then given to the BigDecimal constructor. The scale of the returned BigDecimal is the smallest value such that $(10^{**scale} * val)$ is an integer.

```

assert new BigDecimal(0.25d) == 0.25 //exact conversion because 0.25 has an exact binary
representation
assert new BigDecimal(0.1d) == 0.1000000000000000055511151231257827021181583404541015625
(0.1d).toBigDecimal() == new BigDecimal(0.1d) //alternative method name
assert new BigDecimal(0.1f) == 0.100000001490116119384765625 //inexact conversion as 0.1 has a
recurring decimal part in binary
assert (0.1f as BigDecimal) == 0.100000001490116119384765625
assert new BigDecimal(0.1d, new java.math.MathContext(25) ) == 0.1000000000000000055511151
//rounds to 25 places as specified

```

A more exact way to convert a double to a BigDecimal:

```

assert BigDecimal.valueOf( 0.25d ) == 0.25
assert BigDecimal.valueOf( 0.1d ) == 0.1 //always exact, because converts double to a string
first
assert new BigDecimal( Double.toString( 0.1d ) ) == 0.1 //explicitly convert double to string,
then to BigDecimal
assert BigDecimal.valueOf( -23.456e-17d ) == -2.3456E-16
assert BigDecimal.valueOf( -23.456e-17f ) == -2.3455999317674643E-16 //result inexact because
float converted to double first
try{ BigDecimal.valueOf( Double.POSITIVE_INFINITY ); assert 0 }catch(e){ assert e instanceof
NumberFormatException }
try{ BigDecimal.valueOf( Double.NaN ); assert 0 }catch(e){ assert e instanceof
NumberFormatException }
//however, infinities and NaN won't convert that way

```

We can convert a float or double to a unique string representation in base-10. There must be at least one digit to represent the fractional part, and beyond that as many, but only as many, more digits as are needed to uniquely distinguish the argument value from adjacent values of type float. (The returned string must be for the float value nearest to the exact mathematical value supplied; if two float representations are equally close to that value, then the string must be for one of them and the least significant bit of the mantissa must be 0.)

```

assert Float.toString( 3.0e6f ) == '3000000.0' //no leading zeros
assert Float.toString( 3.0e0f ) == '3.0' //at least one digit after the point
assert Float.toString( 3.0e-3f ) == '0.0030'
assert Float.toString( 3.0e7f ) == '3.0E7' //exponent used if it would be > 6 or < -3

```

```
assert Float.toString( 3.0e-4f ) == '3.0E-4' //mantissa >= 1 and < 10
```

We can also convert a float or double to a hexadecimal string representation:

```
[
    0.0f: '0x0.0p0',
    (-0.0f): '0x0.0p0', //no negative sign in hex string rep'n of -0.0f
    1.0f: '0x1.0p0', //most returned strings begin with '0x1.' or '-0x1.'
    2.0f: '0x1.0p1',
    3.0f: '0x1.8p1',
    5.0f: '0x1.4p2',
    (-1.0f): '-0x1.0p0',
    0.5f: '0x1.0p-1',
    0.25f: '0x1.0p-2',
    (Float.MAX_VALUE): '0x1.fffffepl27',
    (Float.MIN_VALUE): '0x0.000002p-126', //low values beginning with '0x0.' are called
    'subnormal'
    (Float.NEGATIVE_INFINITY): '-Infinity',
    (Float.NaN): 'NaN',
].each{ k, v->
    assert Float.toHexString(k) == v
}
```

Floating-Point Arithmetic

We can perform the same basic operations that integers and BigDecimal can:

```
assert 3.4f.plus( 3.3f ) == 3.4f + 3.3f
assert 3.4f.minus( 2.1f ) == 3.4f - 2.1f
assert 3.0f.multiply( 3.1f ) == 3.0f * 3.1f
assert 3.0f.multiply( 3f ) == 3.0f * 3f
assert 3.0.multiply( 3f ) == 3.0 * 3f
assert 7.7f.negate() == -7.7f //unary operation/method
assert (-7.7f).negate() == -(-7.7f)
assert +(7.7f) == 7.7f
try{ 3.4f.multiply(null); assert false }catch(e){ assert e instanceof NullPointerException }
//methods throw NullPointerException if passed a null
```

For + - and *, anything with a Double or Float converts both arguments to a Double:

```
assert (23.4f + 7.998d).class == Double
assert (23.4f - 123.45g).class == Double
assert (7.998d * 123.45g).class == Double
assert (23.4f - i=789).class == Double
```

We can divide using floats and doubles:

```
assert 2.4f.div( 1.6f ) == ( 2.4f / 1.6f )
assert ( 2.5f / 1i ).class == Double //produces double result if either operand is float or
double
assert ( 2.5f / 1.25 ).class == Double
```

We can perform mod on floats and doubles:

```
def a= 34.56f % 5
assert a == 34.56f.mod(5) && a < 5.0f && a >= 0.0f

def b= 34.56f % 5.1f
```

```
assert b == 34.56f.mod(5.1f) && b < 5.0f && b >= 0.0f

def c= -34.56f % 5.1f
assert c == (-34.56f).mod(5.1f) && c <= 0.0f && c > -5.0f
```

IEEERemainder resembles mod in some ways:

```
def Infinity=Double.POSITIVE_INFINITY, NaN=Double.NaN, Zero=0.0d
assert Math.IEEERemainder( 33d, 10d ) == 3d //give remainder after rounding to nearest value
assert Math.IEEERemainder( 37d, 10d ) == -3d
assert Math.IEEERemainder( -33d, 10d ) == -3d
assert Math.IEEERemainder( -37d, 10d ) == 3d
assert Math.IEEERemainder( 35d, 10d ) == -5d //when two values equally near, use even number
assert Math.IEEERemainder( 45d, 10d ) == 5d
assert Math.IEEERemainder( Zero, 10d ) == Zero
assert Math.IEEERemainder( -Zero, 10d ) == -Zero
assert Math.IEEERemainder( Infinity, 10d ) == NaN
assert Math.IEEERemainder( 35d, Zero ) == NaN
assert Math.IEEERemainder( 35d, Infinity ) == 35d
```

We can perform other methods:

```
assert (-23.4f).abs() == 23.4f
assert (-23.414d).abs() == 23.414d

assert 14.49f.round() == 14i
assert 14.5f.round() == 15i
assert (-14.5f).round() == -14i
assert 14.555d.round() == 15L
```

We can raise a float or double to a power:

```
assert 4.5f**3 == 91.125d //double returned
assert 4.5f.power(3) == 4.5f**3 //using equivalent method instead
assert 1.1.power(1000000000) == Double.POSITIVE_INFINITY
```

We can test whether a float or double is a number and whether it's an infinite number:

```
def Infinity=Double.POSITIVE_INFINITY, NaN=Double.NaN, Zero=0.0d
assert NaN.isNaN()
assert Double.isNaN( NaN )
assert Infinity.isInfinite()
assert (-Infinity).isInfinite()
assert Double.isInfinite( Infinity )
assert Double.isInfinite( -Infinity )
assert Float.isInfinite( Float.NEGATIVE_INFINITY )
```

We can test whether two floats or doubles have equal values using operators or methods:

```
assert 345f.equals( 3.45e2f ) && 345f == 3.45e2f //equals() and == behave the same in all cases
assert ! 34.5f.equals( 13.4f ) && 34.5f != 13.4f //equivalent
assert Float.NaN.equals( Float.NaN ) && Float.NaN == Float.NaN
assert 0.0f == -0.0f && 0.0f.equals( -0.0f ) //-0.0f is evaluated as positive zero
assert 0.0f != -(0.0f) && ! 0.0f.equals( -(0.0f) ) //negative zero must be written -(0.0f)
assert 345d.equals( 3.45e2d ) && 345d == 3.45e2d
assert Float.POSITIVE_INFINITY.equals( Float.POSITIVE_INFINITY ) &&
    Float.POSITIVE_INFINITY == Float.POSITIVE_INFINITY
assert ! Float.POSITIVE_INFINITY.equals( Float.NEGATIVE_INFINITY ) &&
    ! ( Float.POSITIVE_INFINITY == Float.NEGATIVE_INFINITY )
```


We can compare floats and doubles using the `<=>` operator, the `compareTo()` method, and the `compare()` static method:

```
assert (2.50f <=> 2.5f) == 0 && 2.50f.compareTo(2.5f) == 0
assert (-3.45f <=> 1.23f) == -1 && (-3.45f).compareTo(1.23f) == -1
assert (1.23d <=> -0.12d) == 1 && 1.23d.compareTo(-0.12d) == 1
assert (-1.23d < -0.12d) && (-1.23d).compareTo(-0.12d) < 0

assert (Float.NaN > Float.POSITIVE_INFINITY) && Float.NaN.compareTo(Float.POSITIVE_INFINITY) > 0
assert (0.0f <=> -0.0f) == 0
assert (Float.NaN <=> Float.NaN) == 0 && Float.NaN.compareTo(Float.NaN) == 0
assert Float.compare( 3.4f, 7.9f ) == -1
assert Double.compare( 3.4d, -7.9d ) == 1
```

Auto-incrementing and -decrementing work on floats and doubles:

```
def a= 12.315d
a++
assert a == 13.315d
--a
assert a == 12.315d
```

Non-zero floats and doubles evaluate as true in boolean contexts:

```
assert (1.23d? true: false)
assert ! (0.0f? true: false)
```

Bitwise Operations

We can convert a float to the equivalent int bits, or a double to equivalent float bits. For a float, bit 31(mask 0x80000000) is the sign, bits 30-23 (mask 0x7f800000) are the exponent, and bits 22-0 (mask 0x007fffff) are the mantissa. For a double, bit 63 is the sign, bits 62-52 are the exponent, and bits 51-0 are the mantissa.

```
assert Float.floatToIntBits( 0.0f ) == 0
assert Float.floatToIntBits( 15.15f ) == 0x41726666
assert Float.floatToIntBits( Float.NaN ) == 0x7fc00000
assert Float.floatToIntBits( Float.POSITIVE_INFINITY ) == 0x7f800000
assert Float.floatToIntBits( Float.NEGATIVE_INFINITY ) == (0xff800000 as int)
assert Double.doubleToLongBits( 15.15d ) == 0x402e4ccccccccc
```

The methods `floatToRawIntBits()` and `doubleToRawLongBits()` act similarly, except that they preserve Not-a-Number (NaN) values. So If the argument is NaN, the result is the integer or long representing the actual NaN value produced from the last calculation, not the canonical `Float.NaN` value to which all the bit patterns encoding a NaN can be collapsed (ie, 0x7f800001 through 0x7ffffff and 0xff800001 through 0xffffffff).

The `intBitsToFloat()` and `longBitsToDouble()` methods act oppositely. In all cases, giving the integer resulting from calling `Float.floatToIntBits()` or `Float.floatToRawIntBits()` to the `intBitsToFloat(int)` method will produce the original floating-point value, except for a few NaN values. Similarly with doubles. These methods are the only operations that can distinguish between two NaN values of the same type with different bit patterns.

```

assert Float.intBitsToFloat( 0x7fc00000 ) == Float.NaN
assert Float.intBitsToFloat( 0x7f800000 ) == Float.POSITIVE_INFINITY
assert Float.intBitsToFloat( 0xff800000 as Int ) == Float.NEGATIVE_INFINITY
assert Float.intBitsToFloat( 0 ) == 0.0f
assert Float.intBitsToFloat( 0x41726666 ) == 15.15f
assert Double.longBitsToDouble( 0x402e4cccccccccd ) == 15.15d
assert Float.intBitsToFloat( Float.floatToIntBits( 15.15f ) ) == 15.15f

```

As well as infinities and NaN, both Float and Double have other constants:

```

assert Float.MAX_VALUE == Float.intBitsToFloat(0x7f7fffff)
assert Float.MIN_NORMAL == Float.intBitsToFloat(0x00800000) //the smallest positive nonzero
normal value
assert Float.MIN_VALUE == Float.intBitsToFloat(0x1) //the smallest positive nonzero value,
including subnormal values
assert Float.MAX_EXPONENT == Math.getExponent(Float.MAX_VALUE)
assert Float.MIN_EXPONENT == Math.getExponent(Float.MIN_NORMAL)
assert Float.MIN_EXPONENT == Math.getExponent(Float.MIN_VALUE) + 1 //for subnormal values

```

Floating-Point Calculations

There are two constants of type Double, Math.PI and Math.E, that can't be represented exactly, not even as a recurring decimal.

The trigonometric functions behave as expected with the argument in radians, but 0.0 isn't represented exactly. For example, sine:

```

assert Math.sin( 0.0 ) == 0.0
assert Math.sin( 0.5 * Math.PI ) == 1.0
assert Math.sin( Math.PI ) < 1e-15 //almost 0.0, but not quite
assert Math.sin( 1.5 * Math.PI ) == -1.0
assert Math.sin( 2 * Math.PI ) > -1e-15 //almost 0.0
assert Math.sin( -0.5 * Math.PI ) == -1.0
assert Math.sin( -Math.PI ) > -1e-15 //almost 0.0
assert Math.sin( -1.5 * Math.PI ) == 1.0
assert Math.sin( -2 * Math.PI ) < 1e-15 //almost 0.0
assert Math.sin( Double.POSITIVE_INFINITY ) == Double.NaN
assert Math.sin( Double.NEGATIVE_INFINITY ) == Double.NaN

```

Other trig functions are:

```

assert Math.cos( Double.POSITIVE_INFINITY ) == Double.NaN
assert Math.tan( Double.NEGATIVE_INFINITY ) == Double.NaN
assert Math.asin( 0.0 ) == 0.0
assert Math.asin( 1.0 ) == 0.5 * Math.PI
assert Math.asin( 1.001 ) == Double.NaN
assert Math.acos( -1.0 ) == Math.PI
assert Math.acos( -1.001 ) == Double.NaN
assert Math.atan( 0.0 ) == 0.0

```

Some logarithmic functions:

```

def Infinity= Double.POSITIVE_INFINITY, NaN= Double.NaN, Zero= 0.0d

[ (Infinity): Infinity,
  10000: 4,
  10: 1,

```

```

        1: 0,
        0.1: -1,
        0.00001: -5,
        0.0: -Infinity,
        (-0.001): NaN,
    ].each{ k, v -> assert Math.log10(k) == v } //returns base-10 logarithm

    [ (Infinity): Infinity,
      (Math.E): 1,
      1: 0,
      0.0: -Infinity,
      (-0.001): NaN,
    ].each{ k, v -> assert Math.log(k) == v } //returns natural logarithm

    assert Math.exp( Infinity ) == Infinity //returns Math.E raised to a power
    assert Math.exp( -Infinity ) == 0.0

```

`Math.ulp(d)` returns the size of the units of the last place for doubles (the difference between the value and the next larger in magnitude).

```

assert Math.ulp( 123.456d ) == Math.ulp( -123.456d )
assert Math.ulp( 0.123456789d ) != Math.ulp( 0.123456789f ) //if Float, a different scale is
used
assert Math.ulp( Double.POSITIVE_INFINITY ) == Double.POSITIVE_INFINITY
assert Math.ulp( Double.NEGATIVE_INFINITY ) == Double.POSITIVE_INFINITY
assert Math.ulp( 0.0d ) == Double.MIN_VALUE
assert Math.ulp( Double.MIN_VALUE ) == Double.MIN_VALUE
assert Double.MAX_VALUE > Math.ulp( Double.MAX_VALUE )

```

Accuracy of the Math methods is measured in terms of such ulps for the worst-case scenario. If a method always has an error less than 0.5 ulps, the method always returns the floating-point number nearest the exact result, and so is always correctly rounded. However, doing this and maintaining floating-point calculation speed together is impractical. Instead, for the Math class, a larger error bound of 1 or 2 ulps is allowed for certain methods. But most methods with more than 0.5 ulp errors are still required to be semi-monotonic, ie, whenever the mathematical function is non-decreasing, so is the floating-point approximation, and vice versa. Not all approximations that have 1 ulp accuracy meet the monotonicity requirements. `sin`, `cos`, `tan`, `asin`, `acos`, `atan`, `exp`, `log`, and `log10` give results within 1 ulp of the exact result that are semi-monotonic.

Further Calculations

We can find the polar coordinate of two (x,y) coordinates. The result is within 2 ulps of the exact result, and is semi-monotonic.

```

def Infinity= Double.POSITIVE_INFINITY, NaN= Double.NaN, Zero= 0.0d

[
    [ 1d, 1d ]: 0.25d * Math.PI,
    [ 1d, -1d ]: 0.75d * Math.PI,
    [ -1d, 1d ]: -0.25d * Math.PI,
    [ -1d, -1d ]: -0.75d * Math.PI,

    [ 0d, 1d ]: 0d,
    [ -(0d), 1d ]: -(0d),
    [ 0d, -1d ]: Math.PI,
    [ -(0d), -1d ]: -Math.PI, // -(0d) instead of 0d gives huge difference in result
    [ 1d, 0d ]: 0.5d * Math.PI,
    [ 1d, -(0d) ]: 0.5d * Math.PI,
    [ -1d, 0d ]: -0.5d * Math.PI,
    [ -1d, -(0d) ]: -0.5d * Math.PI,

    [ Double.NaN, 1d ]: Double.NaN, //NaN returned if either argument is NaN

```

```

    [ 1d, Infinity ]: 0d,
    [ 1d, -Infinity ]: Math.PI,
    [ -1d, Infinity ]: -(0d),
    [ -1d, -Infinity ]: -Math.PI,
    [ Infinity, 1d ]: 0.5d * Math.PI,
    [ Infinity, -1d ]: 0.5d * Math.PI,
    [ -Infinity, 1d ]: -0.5d * Math.PI,
    [ -Infinity, -1d ]: -0.5d * Math.PI,
    [ Infinity, Infinity ]: 0.25d * Math.PI,
    [ Infinity, -Infinity ]: 0.75d * Math.PI,
    [ -Infinity, Infinity ]: -0.25d * Math.PI,
    [ -Infinity, -Infinity ]: -0.75d * Math.PI,
  ].each{k,v->
    if( Math.atan2( k[0], k[1] ) != v ) println "( ${k[0]}, ${k[1]} ): ${Math.atan2(k[0],k[1])};
    $v"
  }
}

```

We can perform the hyperbolic trigonometric functions:

```

assertClose= {it1,it2,ulp->
  assert it1 > it2 - ulp*Math.ulp(it2) && it1 < it2 + ulp*Math.ulp(it2)
}
def Infinity=Double.POSITIVE_INFINITY, Zero=0d, NaN=Double.NaN, E=Math.E
assertClose Math.sinh( 2d ), 0.5d*(E**2d - E**-2d), 2.5d //sinh() result will be with 2.5 ulp
of exact value
assert Math.sinh( Infinity ) == Infinity
assert Math.sinh( -Infinity ) == -Infinity
assert Math.sinh( Zero ) == Zero
assert Math.sinh( -Zero ) == -Zero
assertClose Math.cosh( 2d ), 0.5d*(E**2d + E**-2d), 2.5d
assert Math.cosh( Infinity ) == Infinity
assert Math.cosh( -Infinity ) == Infinity
assert Math.cosh( Zero ) == 1d
assert Math.cosh( -Zero ) == 1d
assertClose Math.tanh( 2d ), Math.sinh( 2d )/Math.cosh( 2d ), 2.5d
assert Math.tanh( Infinity ) == 1d
assert Math.tanh( -Infinity ) == -1d
assert Math.tanh( Zero ) == Zero
assert Math.tanh( -Zero ) == -Zero
//once the exact result of tanh is within 1/2 of an ulp of the limit value of +/- 1, a
correctly signed +/- 1.0 will be returned



```

We can convert between degrees and radians. The conversion is generally inexact.

```

assert Math.toDegrees( Math.PI ) == 180.0
assert Math.toRadians( 90.0 ) == 0.5 * Math.PI

```


We can calculate $(E^x)-1$ $(1+x)$ in one call. For values of x near 0, **Math.expml**  + 1d is much closer than **Math.exp**  to the true result of e^x . The result will be semi-monotonic, and within 1 ulp of the exact result. Once the exact result of $e^x - 1$ is within 1/2 ulp of the limit value -1, -1d will be returned.

```

assertClose= {it1,it2,ulp->
  assert it1 > it2 - ulp*Math.ulp(it2) && it1 < it2 + ulp*Math.ulp(it2)
}
def Infinity=Double.POSITIVE_INFINITY, NaN=Double.NaN, Zero= 0d, E= Math.E

assertClose Math.expml( 123.4d ), E**123.4d - 1, 31
assertClose Math.expml( 23.4d ), E**23.4d - 1, 10
assertClose Math.expml( 3.4d ), E**3.4d - 1, 3
assert Math.expml( Infinity ) == Infinity
assert Math.expml( -Infinity ) == -1d
assert Math.expml( Zero ) == Zero
assert Math.expml( -Zero ) == -Zero

```

We can also calculate $\ln(1 + x)$ in one call. For small values of x , `Math.log1p`  is much closer than `Math.log(1d + x)` to the true result of $\ln(1 + x)$. The result will be semi-monotonic, and within 1 ulp of the exact result.

```
def Infinity=Double.POSITIVE_INFINITY, NaN=Double.NaN, Zero= 0d
assert Math.log1p( 123.4d ) == Math.log(1d + 123.4d)
assert Math.log1p( 23.4d ) == Math.log(1d + 23.4d)
assert Math.log1p( 3.4d ) == Math.log(1d + 3.4d)
assert Math.log1p( -1.1d ) == NaN
assert Math.log1p( Infinity ) == Infinity
assert Math.log1p( -1d ) == -Infinity
assert Math.log1p( Zero ) == Zero
assert Math.log1p( -Zero ) == -Zero
```

Scale binary `scalb(x,y)` calculates $(x * y^{**2})$ using a single operation, giving a more accurate result. If the exponent of the result would be larger than `Float/Double.MAX_EXPONENT`, an infinity is returned. If the result is subnormal, precision may be lost. When the result is non-NaN, the result has the same sign as x .

```
def Infinity= Double.POSITIVE_INFINITY, NaN= Double.NaN, Zero= 0.0d
assert Math.scalb(5, 3) == 5 * 2**3
assert Math.scalb(NaN, 3) == NaN
assert Math.scalb(Infinity, 3) == Infinity //same sign
assert Math.scalb(Zero, 3) == Zero //same sign
```

We have square root and cube root methods. For `cbt`, the computed result must be within 1 ulp of the exact result.

```
def ten= Math.sqrt( 10 ) * Math.sqrt( 10 )
def error= 1e-14
assert ten > 10 - error && ten < 10 + error

assert Math.sqrt( -0.001 ) == Double.NaN
assert Math.sqrt( 0 ) == 0
assert Math.sqrt( Double.POSITIVE_INFINITY ) == Double.POSITIVE_INFINITY

def ten= Math.cbrt( 10 ) * Math.cbrt( 10 ) * Math.cbrt( 10 )
def error= 1e-14
assert ten > 10 - error && ten < 10 + error

assert Math.cbrt( -123.456 ) == -Math.cbrt( 123.456 )
assert Math.cbrt( 0 ) == 0
assert Math.cbrt( Double.POSITIVE_INFINITY ) == Double.POSITIVE_INFINITY
assert Math.cbrt( Double.NEGATIVE_INFINITY ) == Double.NEGATIVE_INFINITY
```

We can find the ceiling and floor of doubles:

```
assert Math.ceil( 6.77 ) == 7; assert Math.floor( 6.77 ) == 6
assert Math.ceil( -34.43 ) == -34; assert Math.floor( -34.43 ) == -35
assert Math.ceil( 0.73 ) == 1.0; assert Math.floor( 0.73 ) == 0.0
assert Math.ceil( -0.73 ) == -0.0d; assert Math.floor( -0.73 ) == -1.0 //sign required for
-0.0d
assert Math.ceil( 13.0 ) == 13.0; assert Math.floor( 13.0 ) == 13.0
assert Math.ceil( 0.0 ) == 0.0; Math.floor( 0.0 ) == 0.0
assert Math.ceil( 23.45 ) == -Math.floor( -23.45 ) //Math.ceil(x) always equals -Math.floor(-x)
```

We can round doubles to the nearest long (or floats to the nearest integer). The calculation is `Math.floor(a + 0.5d)` as Long, or `Math.floor(a + 0.5f)` as Integer

```
[
    7.45: 7,
    7.5: 8,
    (-3.95): -4,
    (-3.5): -3,
    (Double.NaN): 0,
    (Double.NEGATIVE_INFINITY): Long.MIN_VALUE,
    (Long.MIN_VALUE as Double): Long.MIN_VALUE,
    (Double.POSITIVE_INFINITY): Long.MAX_VALUE,
    (Long.MAX_VALUE as Double): Long.MAX_VALUE,
].each{ k, v -> assert Math.round( k ) == v }
```

Unlike the numerical comparison operators, `max()` and `min()` considers negative zero to be strictly smaller than positive zero. If one argument is positive zero and the other negative zero, the result is positive zero.

```
assert Math.max( 7i, 9i ) == 9i //returns the same class as its arguments
assert Math.min( 23L, 19L ) == 19L
assert Math.min( 1.7f, 0.3f ) == 0.3f
assert Math.min( -6.7d, 1.3d ) == -6.7d
assert Math.min( 7i, 9L ) == 7L //converts result to most precise type of argument
assert Math.min( 1L, 3.3f ) == 1f
assert Math.min( -6.7f, 1.3d ) == -6.699999809265137d
```

Some other methods:

```
[ 7.49d: 7.0d,
  7.5d: 8.0d,
  8.5d: 8d,
  (-7.5d): -8d,
  7d: 7d,
  0d: 0d,
  (Double.POSITIVE_INFINITY): Double.POSITIVE_INFINITY,
].each{ k, v-> assert Math rint( k ) == v } //round to nearest integer (or even integer)

assert Math.abs( -23i ) == 23i
assert Math.abs( 234L ) == 234L
assert Math.abs( 0i ) == 0i
assert Math.abs( Integer.MIN_VALUE ) == Integer.MIN_VALUE //WARNING: this result not intuitive
assert Math.abs( Long.MIN_VALUE ) == Long.MIN_VALUE

assert Math.abs( -23.45f ) == 23.45f
assert Math.abs( -123.4d ) == 123.4d
assert Math.abs( 0.0f ) == 0.0f
assert Math.abs( -0.0f ) == 0.0f
assert Math.abs( Float.NEGATIVE_INFINITY ) == Float.POSITIVE_INFINITY

[ -23.45f, 781.23f, Float.NEGATIVE_INFINITY ].each{
  assert Math.abs(it) == Float.intBitsToFloat(0x7fffffff & Float.floatToIntBits(it))
  assert Math.abs(it) == Float.intBitsToFloat((Float.floatToIntBits(it)<<1)>>>1)
} //there's related assertions for doubles
```

The `pow()` method returns the value of the first argument raised to the power of the second argument. If both arguments are integers, then the result is exactly equal to the mathematical result of raising the first argument to the power of the second argument if that result can in fact be represented exactly as a double value. Otherwise, special rules exist for processing zeros and infinities:

```
def Infinity= Double.POSITIVE_INFINITY, NaN= Double.NaN
[
  [ 3d, 0d ]: 1d,
  [ 3d, -(0d) ]: 1d,
  [ 3d, 1d ]: 3d,
  [ 3d, Infinity ]: Infinity,
  [ -3d, Infinity ]: Infinity,
```

```

[ 0.3d, -Infinity ]: Infinity,
[ -0.3d, -Infinity ]: Infinity,
[ 3d, -Infinity ]: 0d,
[ -3d, -Infinity ]: 0d,
[ 0.3d, Infinity ]: 0d,
[ -0.3d, Infinity ]: 0d,
[ 1d, Infinity ]: Double.NaN,
[ 0d, 1d ]: 0d,
[ Infinity, -1d ]: 0d,
[ 0d, -1d ]: Infinity,
[ Infinity, 1d ]: Infinity,
[ -(0d), 2d ]: 0d, //exponent >0 but not finite odd integer
[ -Infinity, -2d ]: 0d, //exponent <0 but not finite odd integer
[ -(0d), 3d ]: -(0d), //exponent is positive finite odd integer
[ -Infinity, -3d ]: -(0d), //exponent is negative finite odd integer
[ -(0d), -2d ]: Infinity, //exponent <0 but not finite odd integer
[ -Infinity, 2d ]: Infinity, //exponent >0 but not finite odd integer
[ -(0d), -3d ]: -Infinity, //exponent is negative finite odd integer
[ -Infinity, 3d ]: -Infinity, //exponent is positive finite odd integer
[ -3d, 4i ]: {-> def a= Math.abs(-3d); a*a*a*a }(), //exponent is finite even integer
[ -3d, 5i ]: {-> def a= Math.abs(-3d); -a*a*a*a*a }(), //exponent is finite odd integer
[ -3d, 2.5 ]: NaN, //exponent is finite and not an integer
[ NaN, 0d ]: 1d //exception to the NaN ripple rule
].each{k, v->
  assert Math.pow( k[0], k[1] ) == v
}

```

More methods:

```

assert Math.random() >= 0d //this method uses new Random() when first called
assert Math.random() < 1d

assert Math.signum( 17.75d ) == 1d
assert Math.signum( 17.75f ) == 1f
assert Math.signum( -19.5d ) == -1d
assert Math.signum( 0d ) == 0d
assert Math.signum( -(0d) ) == -(0d)

```

We can use copySign() to return a first argument with the sign of the second argument.

```

assert Math.copySign( 34.4f, -2.1f ) == -34.4f
assert Math.copySign( -1234.4d, 2.23d ) == 1234.4d

```

We can compute the hypotenuse with risk of intermediate overflow (or underflow). The computed result is within 1 ulp of the exact result. If one parameter is held constant, the results will be semi-monotonic in the other parameter.

```

def Infinity=Double.POSITIVE_INFINITY, NaN=Double.NaN
assert Math.hypot( 9d, 16d ) == Math.sqrt( 9d**2 + 16d**2 )
assert Math.hypot( Infinity, 234d ) == Infinity
assert Math.hypot( NaN, 234d ) == NaN
assert Math.hypot( Infinity, NaN ) == Infinity

```

We can get the exponent from the binary representation of a double or float:

```

def Infinity=Double.POSITIVE_INFINITY, Zero=0d, NaN=Double.NaN, E=Math.E
assert Math.getExponent(2.345e31d) <= Double.MAX_EXPONENT
assert Math.getExponent(2.345e31d) >= Double.MIN_EXPONENT
assert Math.getExponent( NaN ) == Double.MAX_EXPONENT + 1
assert Math.getExponent( Infinity ) == Double.MAX_EXPONENT + 1
assert Math.getExponent( Zero ) == Double.MIN_EXPONENT - 1 //this is also the value of
subnormal exponents

```

```
assert Math.getExponent(12.3e4f) <= Float.MAX_EXPONENT && Math.getExponent(12.3e4f) >=
Float.MIN_EXPONENT
```

We can return the floating point number adjacent to the first arg in the direction of the second arg:

```
def Infinity=Double.POSITIVE_INFINITY, NaN=Double.NaN, Zero= 0d
assert Math.nextAfter( 12.34d, 999d ) == 12.34d + Math.ulp( 12.34d )
assert Math.nextAfter( 12.34d, -999d ) == 12.34d - Math.ulp( 12.34d )
assert Math.nextAfter( 12.34f, 999f ) == 12.34f + Math.ulp( 12.34f )
assert Math.nextAfter( 12.34d, 12.34d ) == 12.34d //if numbers equal, return second one
assert Math.nextAfter( Zero, -Zero ) == -Zero //numbers are 'equal', and second one returned
assert Math.nextAfter( Double.MIN_VALUE, -12d ) == Zero
assert Math.nextAfter( -Double.MIN_VALUE, 12d ) == -Zero
assert Math.nextAfter( Double.MAX_VALUE, Infinity ) == Infinity
assert Math.nextAfter( -Double.MAX_VALUE, -Infinity ) == -Infinity
assert Math.nextAfter( Infinity, 12d ) == Double.MAX_VALUE
assert Math.nextAfter( -Infinity, 12d ) == -Double.MAX_VALUE
assert Math.nextAfter( Zero, Infinity ) == Double.MIN_VALUE
assert Math.nextAfter( Infinity, Infinity ) == Infinity
assert Math.nextUp( 12.34d ) == Math.nextAfter( 12.34d, Infinity ) //shortcut method for both
doubles and floats
```

The result is NaN if the argument is NaN for ulp, sin, cos, tan, asin, acos, atan, exp, log, log10, sqrt, cbrt, IEEEremainder, ceil, floor, rint, atan2, abs, max, min, signum, sinh, cosh, tanh, expm1, log1p, nextAfter, and nextUp.

But not so with pow, round, hypot, copySign, getExponent, and scalb.

There's another math library called StrictMath that's a mirror of Math, with exactly the same methods. However, some methods (eg, sin, cos, tan, asin, acos, atan, exp, log, log10, cbrt, atan2, pow, sinh, cosh, tanh, hypot, expm1, and log1p) follow stricter IEEE rules about what values must be returned. For example, whereas the Math.copySign method usually treats some NaN arguments as positive and others as negative to allow greater performance, the StrictMath.copySign method requires all NaN sign arguments to be treated as positive values.

Groovy Integer Math

This page last changed on Mar 08, 2007 by [gavingrover](#).

Groovy numbers are either decimals or integers. The 3 main types of integers are Integer, Long, and BigInteger. BigInteger has no size limit, while Integer and Long do. We can enquire their minimum and maximum values:

```
assert Integer.MAX_VALUE == 2147483647 //at 2 billion, this is big enough for most uses
assert Integer.MIN_VALUE == -2147483648
assert Long.MAX_VALUE == -9223372036854775807
assert Long.MIN_VALUE == -9223372036854775808
```

Integers will normally be the smallest type into which the value will fit (using 2's-complement representation):

```
assert 110.class == Integer
assert 3000000000.class == Long //value too large for an Integer
assert 10000000000000000000.class == BigInteger //value too large for a Long
```

We can represent integers in base-10, hexadecimal, or octal notation:

```
[ 2, -17, +987, 0 ].each{ println it } //base-10 integers, positive or negative
[ 0xAce, 0X01ff ].each{ assert it } //hex using leading 0x (lowercase or uppercase for
a,b,c,d,e,f,x)
[ 077, 01 ].each{ assert it } //octal using leading 0
```

We can negate hexadecimal and octals to represent negative numbers.

```
assert 0x7FFFFFFF.class == Integer
assert (-0x7FFFFFFF).class == Integer //we must negate using the minus sign
assert 0x80000000.class == Long
assert (-0x80000000).class == Integer
assert (-0x80000001).class == Long
```

We can force an integer (including hexadecimal and octals) to have a specific type by giving a suffix (I for Integer, L for Long, G for BigInteger):

```
assert 42i.class == Integer //either uppercase or lowercase, but lowercase i more readable
assert 123L.class == Long //uppercase L more readable
assert 456g.class == BigInteger
assert 0xFFi.class == Integer
```

Fixed-Size Integers

The fixed-size integers, Integer and Long, each have size limits but are more efficient in calculations.

There are also the less common Byte and Short types of integer, which act like the Integer type in math operations.

```

assert Short.MAX_VALUE == 32767
assert Short.MIN_VALUE == -32768
assert Byte.MAX_VALUE == 127
assert Byte.MIN_VALUE == -128
a= new Byte('34')
assert (a+2).class == Integer

```

We can enquire the bit-size of each type of fixed-size integer:

```

assert Integer.SIZE == 32
assert Long.SIZE == 64
assert Short.SIZE == 16
assert Byte.SIZE == 8

```

The class Integer can often be written int. The classes Long, Short, and Byte can each also often be written uncapitalized, ie, long, short, and byte. We can enquire these alternative (aka "primitive type") names:

```

assert Integer.TYPE == int
assert Long.TYPE == long
assert Short.TYPE == short
assert Byte.TYPE == byte

```

The fixed-size integer classes can be converted to one another:

```

assert 45L as Integer == 45i
assert 45L as int == 45i //example of using 'int' for Integer
assert 45L.toInteger() == 45i //alternative syntax
assert 23L.intValue() == 23i //another alternative syntax
assert 45i as Long == 45L
assert 45i as long == 45L
assert 23i.toLong() == 23L
assert 45i.longValue() == 45L
assert 256i as Byte == 0 //if converted number too large to fit in target, only the lowest
order bits returned...
assert 200i as byte == -56 //...and this may result in a negative number

```

We can create new fixed-sized integers from strings:

```

assert '42'.toInteger() == 42i
assert '56'.toLong() == 56L
try{ 'moo'.toLong(); assert false }catch(e){ assert e instanceof NumberFormatException }
assert new Integer( '45' ) == 45i
assert new Byte( '45' ) == 45 as byte
try{ new Integer( 'oink' ); assert false }catch(e){ assert e instanceof NumberFormatException }

```

To convert from a fixed-size integer to a string in various bases:

```

assert Integer.toString( 29, 16 ) == '1d' //second character is the base/radix
assert Long.toString( 29L, 16 ) == '1d' //Long version behaves just like Integer version
assert Integer.toString( -29, 16 ) == '-1d' //if number is negative, so is first character of
returned string
assert Integer.toString(0) == '0' //only time result begins with zero is if it is zero
assert Integer.toString( 29, 16 ).toUpperCase() == '1D'
assert Integer.toString( 29 ) == '29' //second argument defaults to 10
assert Short.toString( 29 as short ) == '29' //Short version only accepts one parameter, only
allowing base 10

```

If the base/radix isn't between `Character.MIN_RADIX` and `Character.MAX_RADIX`, base 10 is used instead:

```
assert Integer.toString( 999, Character.MIN_RADIX - 1 ) == Integer.toString( 999, 10 )
assert Integer.toString( 999, Character.MAX_RADIX + 1 ) == Integer.toString( 999, 10 )
assert Character.MAX_RADIX == 36 //the symbols letters 0123456789abcdefghijklmnopqrstuvwxyz are used
```

The common bases have similar methods which always return an unsigned integer:

```
assert Integer.toHexString(29) == '1d' //return unsigned base-16 integer
assert Integer.toHexString(0) == '0'
assert Integer.toHexString(-17) == 'fffffffef'
assert Long.toHexString(-17L) == 'fffffffffffffffef'

assert Integer.toHexString(29) == Integer.toString(29,16) //same as toString(,16) when number positive...
assert Integer.toHexString(-17) != Integer.toString(-17,16) //...but different when number negative

assert Integer.toOctalString(29) == '35'
assert Integer.toOctalString(0) == '0'
assert Integer.toOctalString(-17) == '37777777757'
assert Integer.toBinaryString(29) == '11101'
```

We can convert a string representation to an integer, using a specified base/radix:

```
assert Integer.parseInt("0", 10) == 0
assert Integer.parseInt("473", 10) == 473
assert Long.parseLong("473", 10) == 473L //Long type/class has similarly-acting method
assert Integer.parseInt("473") == 473 //base 10 is the default base/radix
assert Integer.parseInt("-0", 10) == 0
assert Integer.parseInt("-FF", 16) == -255
assert Integer.parseInt("1100110", 2) == 102
assert Integer.parseInt("2147483647", 10) == 2147483647
assert Integer.parseInt("-2147483648", 10) == -2147483648
assert Integer.parseInt("Kona", 27) == 411787
assert Long.parseLong("Hazelnut", 36) == 1356099454469L
assert Short.parseShort("-FF", 16) == -255
```

A `NumberFormatException` may be thrown:

```
[ { Integer.parseInt("2147483648", 10) }, //number too large
  { Integer.parseInt("99", 8) }, //digit 9 not octal
  { Integer.parseInt("Kona", 10) }, //digits not decimal
  { Integer.parseInt("1111", Character.MIN_RADIX - 1 ) }, //radix too small
  { Integer.parseInt("1111", Character.MAX_RADIX + 1 ) }, //radix too large
  { Integer.parseInt( '@#$$' ) }, //invalid number
  { Integer.parseInt( ' ' ) }, //invalid number
].each{ c-> try{ c(); assert false }catch(e){assert e instanceof NumberFormatException} }
```

An alternative method name is:

```
assert Integer.valueOf( '12af', 16 ) == 0x12af //same as: Integer.parseInt( '12af', 16 )
assert Long.valueOf( '123' ) == 123 //same as: Long.parseLong( '123' )
assert Short.valueOf( 027 as short ) == 027
```

We can convert a string to a fixed-size integer, similar to `parseInt()` etc, but with the radix instead

indicated inside the string:

```
assert Integer.decode('0xff') == 0xFF
assert Integer.decode('#FF') == 0xFF
assert Long.decode('#FF') == 0xFFL //long, short, and byte also can be decoded
assert Short.decode('#FF') == 0xFF as short
assert Byte.decode('#F') == 0xF as byte
assert Integer.decode('-077') == -077
assert Integer.decode('2345') == 2345
try{ Integer.decode('7 @8'); assert false }catch(e){ assert e instanceof NumberFormatException
}
```

We can return an integer representing the sign:

```
assert Integer.signum(45i) == 1
assert Integer.signum(0i) == 0
assert Integer.signum(-43i) == -1
assert Long.signum(-43L) == -1
```

We can compare fixed-size integers with each other:

```
assert 45i.compareTo( 47L ) < 0
assert (45 as byte).compareTo( 43 as short ) > 0
assert 45.compareTo( 45 ) == 0
```

Calculations with Fixed-Size Integers

We can perform addition, subtraction, multiplication, exponents, modulus, and negations on Integers and Longs, using both an operator syntax and a method syntax:

```
assert 34 + 33 == 67      && 34.plus( 33 ) == 67
assert 34L - 21L == 13L  && 34L.minus( 21L ) == 13L
assert 3 * 31 == 93      && 3.multiply( 31 ) == 93
assert 23 % 3 == 2       && 23.mod( 3 ) == 2
assert 3**2 == 9         && 3.power( 2 ) == 9
assert -(3) == -3       && 3.negate() == -3
```

Not all calculations have a special operator symbol:

```
assert 22.intdiv(5) == 4
assert (-22).intdiv(5) == -4
assert (-34).abs() == 34
assert (-34L).abs() == 34L
```

We can divide an integer into another, resulting in a decimal number. We'll look at this topic in the next tutorial, Groovy BigDecimal Math.

We can increment and decrement variables, using operators, either before and after evaluation:

```
def a= 7
assert ++a == 7 && a == 8 && a-- == 8 && a == 7 &&
      ++a == 8 && a == 8 && --a == 7 && a == 7
```

```
def b = 7, c = 7 //These operators use methods next() and previous()
assert ( ++b ) == ( c = c.next() )
assert b == c
assert ( --b ) == ( c = c.previous() )
assert b == c
assert ( b++ ) == { def z = c; c = c.next(); z }()
assert b == c

def b= Integer.MAX_VALUE
assert ++b == Integer.MIN_VALUE && --b == Integer.MAX_VALUE
```

Rules of parentheses and precedence apply to these operators. The operators have the same precedence irrespective of what type of values they operate on.

```
assert 3*(4+5) != 3*4+5 //parenthesized expressions always have highest precedence

assert -3**2 == -(3**2) //power has next highest precedence
assert ( 2*3**2 == 2*(3**2) ) && ( 2*3**2 != (2*3)**2 )

assert -3+2 != -(3+2) //unary operators have next highest precedence
assert ~234 == ~(234) //unary operators group right-to-left

//multiplication and modulo have next highest precedence
assert 3*4%5 == (3*4)%5 //multiplication and modulo have equal precedence
assert 3%4*5 == (3%4)*5

assert 4+5-6 == 3 //addition and subtraction have equal precedence, lower than mult/etc
assert 5+3*4 == 5+(3*4)
```

Integers often convert their types during math operations. For + - *, a Long with an Integer converts the Integer to a Long:

```
assert (23i+45L).class == Long
```

Because the fixed-sized integers have fixed width, they might overflow their boundaries during math operations, so we need to be aware of the range of values we'll use a fixed-size integer for:

```
assert 256*256*256*256 == 0 //each 256 is an Integer, so final product also an Integer, and
calc overflowed
assert 256L*256*256*256 == 4294967296L
//we can fix this problem by using a long at the beginning of the calculation
```

We can compare fixed-size integers using <=> < <= > >= operators, of lower precedence than addition/etc:

```
assert (4 <=> 7) == -1 && 4.compareTo(7) == -1
assert (4 <= 4) == 0 && 4.compareTo(4) == 0
assert (4 <=> 2) == 1 && 4.compareTo(2) == 1
assert 14 > 7 && 14.compareTo(7) > 0
assert 14 >= 8 && 14.compareTo(8) >= 0
assert -4 < 3 && (-4).compareTo(3) < 0
assert -14 <= -9 && (-14).compareTo(-9) <= 0
```

The operators == != are of lower precedence than the other comparison operators:

```
def a = 4, b = 4, c = 5
```

```
assert a == b && a.equals(b)
assert a != c && ! a.equals(c)
```

Bit-Manipulation on Fixed-Sized Integers

We can examine and manipulate the individual bits on the fixed-sized integers.

To return an int or long with a single 1-bit in the position of the highest-order 1-bit in the argument:

```
assert Integer.highestOneBit( 45 ) == 32
assert Integer.highestOneBit( 27 ) == 16
assert Integer.highestOneBit( 0 ) == 0
assert Integer.highestOneBit( -1 ) == -128*256*256*256
assert Long.highestOneBit( -1L ) == -128*256*256*256 * 256*256*256*256

assert Integer.lowestOneBit( 45i ) == 1 //match lowest order 1-bit in argument
assert Integer.lowestOneBit( 46i ) == 2
assert Integer.lowestOneBit( 48i ) == 16
```

To return the number of zero bits preceding the highest-order 1-bit:

```
[ 0:32, 1:31, 2:30, 4:29 ].each{ k, v->
  assert Integer.numberOfLeadingZeros( k ) == v
  //returns the number of zero-bits preceding the highest-order 1-bit
  assert Long.numberOfLeadingZeros( k as long ) == v + 32
}
[ 0:32, 45:0, 46:1, 48:4 ].each{ k, v->
  assert Integer.numberOfTrailingZeros( k ) == v
} //returns the number of 0-bits following the lowest-order 1-bit

assert Integer.bitCount( 7 ) == 3 //returns the number of 1-bits in the binary representation
assert Integer.bitCount( -1 ) == 32
```

We can perform a bitwise complement of the bits in a fixed-size integer using the ~ operator:

```
def x= 0x33333333i
assert ~x == -x - 1 //under 2's-complement, bitwise complement and negation are related in this way
```

We can shift the bits of a fixed-size integer to the left or right. This is of lower precedence than addition/etc, but higher than the comparison operators.

```
assert 0xB4F<<4 == 0xB4F0      && 0xB4F.leftShift( 4 ) == 0xB4F0 //shift 4 bits to the left
assert 0xD23C>>4 == 0xD23      && 0xD23C.rightShift( 4 ) == 0xD23 //shift 4 bits to the right,
dropping off digits
assert -0xFFF>>4 == -0x100      && (-0xFFF).rightShift( 4 ) == -0x100 //sign-extension performed
when right-shifting...
assert -0xFFF>>>4 == 0xFFFFF00 && (-0xFFF).rightShiftUnsigned(4) == 0xFFFFF00 //...unless
triple >>> used
[ 0xABC, -0x98765 ].each{
  it << 8 == it >> -8
}
```

We can rotate the bits in an integer or long:

```

assert Integer.rotateLeft( 0x456789AB, 4 ) == 0x56789AB4
//we use multiples of 4 only to show what's happening easier
assert Integer.rotateLeft( 0x456789AB, 12 ) ==
    Integer.rotateRight( 0x456789AB, Integer.SIZE - 12 ) //rotating left and right are inverse
operations
assert Integer.rotateLeft( 0x456789AB, 32 ) == 0x456789AB //no change here
assert Long.rotateRight( 0x0123456789ABCDEF, 40 ) == 0x6789ABCDEF012345

```

We can perform bitwise 'and', 'or', and 'xor' operations on fixed-size integers. This is of lower precedence than the comparison operators.

```

assert (0x33 & 0x11) == 0x11 && 0x33.and(0x11) == 0x11
assert (0x33 | 0x11) == 0x33 && 0x33.or(0x11) == 0x33
assert (0x33 ^ 0x11) == 0x22 && 0x33.xor(0x11) == 0x22

```

We can reverse the bits or bytes of the binary representation of an int or long:

```

assert Integer.toString( 123456, 2 ) == '11110001001000000'
assert Integer.toString( Integer.reverse( 123456 ), 2 ) == '100100011110000000000000000'
//reverse bits
assert Integer.reverseBytes( 0x157ACE42 ) == 0x42CE7A15 //also works for bytes

```

Boolean, Conditional, and Assignment Operators with Fixed-Sized Integers

The boolean, conditional, and assignment operators are of even lower precedence than the bitwise operators.

When using an integer with boolean operators `!`, `&&`, and `||`, 0 evaluates to false, while every other integer evaluates to true:

```

assert ! 0; assert 1; assert 2; assert -1; assert -2
assert ( ! 1 && 0 ) != ( ! (1 && 0) )
// the unary ! has the same, high, precedence as the other unary operators
assert ( 1 || 0 && 0 ) != ( (1 || 0) && 0 ) // && has higher precedence than ||

```

The boolean operators `&&` and `||` only have their operands evaluated until the final result is known. This affects operands with side effects, such as increment or decrement operators:

```

def x = 0
0 && x++
assert x == 0 //x++ wasn't performed because falsity of (0 && x++) was known when 0 evaluated
1 || x++
assert x == 0 //x++ wasn't performed because truth of (1 || x++) was known when 1 evaluated

```

We can use the conditional operator `?:`, of lower precedence than the boolean operators, to choose between two values:

```

def x = 1? 7: -5
assert x == 7

```

We can put the assignment operator `=` within expressions, but must surround it with parentheses

because its precedence is lower than the conditional:

```
def x, y = (x = 3) && 1
assert (x == 3) && y

def i = 2, j = (i=3) * i //in the multiplication, lefthand (i=3) evaluated before righthand i
assert j == 9
```

Of equal precedence as the plain assignment operator `=` are the quick assignment `*=` `+=` `-=` `%=` `<=<` `>=>` `>>=` `&=` `^=` `|=` operators:

```
def a = 7
a += 2 //short for a = a + 2
assert a == 9
a += (a = 3) //expands to a = a + (a = 3) before any part is evaluated
assert a == 12
```

BigIntegers

The `BigInteger` has arbitrary precision, growing as large as necessary to accommodate the results of an operation.

We can explicitly convert fixed-sized integers to a `BigInteger`, and vice versa:

```
assert 45i as BigInteger == 45g
assert 45L.toBigInteger() == 45g
assert 45g as Integer == 45i
assert 45g.intValue() == 45i //alternate syntax
assert 45g as Long == 45L
assert 45g.longValue() == 45L
assert 256g as Byte == 0 //if converted number too large to fit in target, only the lowest
order bits returned...
assert 200g as byte == -56 //...and this may result in a negative number
```

A method and some fields that give a little more efficiency:

```
assert BigInteger.valueOf( 45L ) == 45g //works for longs only (not for ints, shorts, or bytes)
assert BigInteger.ZERO == 0g
assert BigInteger.ONE == 1g
assert BigInteger.TEN == 10g
```

We can construct a `BigInteger` using an array of bytes:

```
assert new BigInteger( [1,2,3] as byte[] ) == 1g*256*256 + 2*256 + 3 //big-endian 2's
complement representation
try{new BigInteger( [] as byte[] ); assert 0}catch(e){assert e instanceof
NumberFormatException} //empty array not allowed
assert new BigInteger( -1, [1,2] as byte[] ) == -258g //we pass in sign as a separate argument
assert new BigInteger( 1, [1,2] as byte[] ) == 258g
assert new BigInteger( 0, [0,0] as byte[] ) == 0g
assert new BigInteger( 1, [] as byte[] ) == 0 //empty array allowable
try{ new BigInteger( 2, [1,2,3] as byte[] ); assert 0 }catch(e){ assert e instanceof
NumberFormatException}
//sign value must be -1, 0, or 1
```


We can convert a `BigInteger` back to an array of bytes:

```
def ba= (1g*256*256 + 2*256 + 3).toByteArray() //big-endian 2's complement representation
assert ba.size() == 3 && ba[ 0 ] == 1 && ba[ 1 ] == 2 && ba[ 2 ] == 3
def bb= 255g.toByteArray()
assert bb.size() == 2 && bb[ 0 ] == 0 && bb[ 1 ] == -1 //always includes at least one sign bit
def bc= (-(2g*256 + 3)).toByteArray()
assert bc.size() == 2 && bc[ 0 ] == -3 && bc[ 1 ] == -3
```

We can pass in a string in a certain base/radix:

```
assert '27'.toBigInteger() == 27g
assert new BigInteger("27", 10) == 27g
assert new BigInteger("27") == 27g //default radix is 10
assert new BigInteger("110", 2) == 6g
assert new BigInteger("-1F", 16) == -31g
[ { new BigInteger(" 27", 10) }, //no whitespace allowed in string
  { new BigInteger("Z", Character.MAX_RADIX + 1 ) }, //radix out of range
  { new BigInteger("0", Character.MIN_RADIX - 1 ) }, //radix out of range
].each{ try{ it(); assert 0 }catch(e){ assert e instanceof NumberFormatException } }
```

We can convert the `BigInteger` back to a string:

```
assert 6g.toString(2) == '110'
assert (-31g).toString(16) == '-1f'
assert 27g.toString() == '27' //default radix is 10
assert 27g.toString( Character.MAX_RADIX + 1 ) == '27' //radix is 10 if radix argument invalid
```

We can construct a randomly-generated `BigInteger`:

```
assert new BigInteger( 20, new Random() ).toString( 2 ).size() == 20 //20 is max bit length,
must be >= 0
assert new BigInteger( 20, new Random() ) >= 0
```

Arithmetic with `BigInteger`s

We can perform the usual arithmetic operations `+` `-` `*` using either methods or operations:

```
assert 34g.plus( 33g ) == 34g + 33g
assert 34g.add( 33g ) == 34g + 33g //alternative name for plus
assert 34g.minus( 21g ) == 34g - 21g
assert 34g.subtract( 21g ) == 34g - 21g //alternative name for minus
assert 3g.multiply( 31g ) == 3g * 31g
assert 7g.negate() == -7g //unary operation/method
assert (-7g).negate() == 7g
```

For `+` `-` `*`, a `BigInteger` causes any fixed-width integers in the calculation to be converted to a `BigInteger`:

```
assert (45L + 123g).class == BigInteger
assert (23 - 123g).class == BigInteger
assert ( 3g * 31 ).class == BigInteger
assert ( 3 * 31g ).class == BigInteger
assert 3g.multiply( 31 ).class == BigInteger
assert 3.multiply( 31g ).class == BigInteger
```

We can introduce a BigInteger into an expression with Integers or Longs if overflow may occur. But make sure the BigInteger is introduced before an intermediate value that may overflow, for example, the first-used value in a calculation:

```
assert 256L*256*256*256 * 256*256*256*256 == 0
//the first 256 is a Long, so each intermediate and final product also Long, and calc
overflowed
assert 256g*256*256*256 * 256*256*256*256 == 18446744073709551616
//no overflow here because BigInteger introduced using 'g' suffix in first value
```

We can also increment and decrement BigIntegers:

```
def a= 7g
assert a++ == 7g && a == 8g && a-- == 8g && a == 7g &&
      ++a == 8g && a == 8g && --a == 7g && a == 7g
```

We can find out the quotient and remainder:

```
assert 7g.divide( 4g ) == 1g
assert 7g.remainder( 4g ) == 3g
def a= 7g.divideAndRemainder( 4g )
assert a[0] == 1g //quotient, same result as divide()
assert a[1] == 3g //remainder, same result as remainder()

assert 7g.divide( -4g ) == -1g
assert 7g.remainder( -4g ) == 3g
assert (-7g).divide( 4g ) == -1g
assert (-7g).remainder( 4g ) == -3g //division of a negative yields a negative (or zero)
remainder
assert (-7g).divide( -4g ) == 1g
assert (-7g).remainder( -4g ) == -3g
```

Other methods for arithmetic:

```
assert 22g.intdiv(5g) == 4g
assert (-22g).intdiv(5g) == -4g

assert 7g.abs() == 7g //absolute value
assert (-7g).abs() == 7g

assert 28g.gcd(35g) == 7g //greatest common divisor of absolute value of each number
assert (-28g).gcd(35g) == 7g
assert 28g.gcd(-35g) == 7g
assert (-28g).gcd(-35g) == 7g
assert 0g.gcd(9g) == 9g
assert 0g.gcd(0g) == 0g

assert 4g**3 == 64g //raising to the power
assert (4g**3).class == Integer //raising to the power converts a BigInteger to an integer
assert 4g.power(3) == 64g //using method
assert 4g.pow(3) == 64g //pow() is different to, and sometimes slower than, power()
assert (-4g).power(3) == -64g
assert 4g.power(0) == 1g //exponent must be integer >=0

assert 7g % 4g == 3g && 7g.mod( 4g ) == 3g //modulo arithmetic, using operator or method
assert 8g % 4g == 0g
assert -7g % 4g == 1g //result of mod is always zero or positive, between 0 and (modulus-1)
inclusive
try{ 7g % -4g; assert 0 }catch(e){ assert e instanceof ArithmeticException } //mod value must
be positive

assert 4g.modPow( 3g, 9g ) == 1 //calculates as ((4**3) mod 9), result always zero or positive
assert 4g.modPow( -2g, 9g ) == 4 //negative exponents allowed, but mod value must be positive
```

```

assert 4g.modInverse( 3g ) == 1 //calculates as ((4**-1) mod 3)
    //mod must be positive, and value must have a multiplicative inverse mod m (ie, be
    relatively prime to m)

assert 7g.max(5g) == 7g //maximum and minimum
assert 4g.min(5g) == 4g
def a=5g, b=5g, c=a.min(b)
assert [a,b].any{ c.is(it) } //either a or b may be returned if they're both equal

assert (-45g <=> -43g) && ( (-45g).compareTo( -43g ) == -1 ) //comparing two BigIntegers
assert 14g >= 8g          && 14g.compareTo(8g) >= 0

assert 45g.signum() == 1 //return sign as -1,0, or 1
assert 0g.signum() == 0
assert (-43g).signum() == -1

```

We can construct a randomly generated positive BigInteger with a specified bit length (at least 2 bits), that is probably prime to a specific certainty. The probability the BigInteger is prime is $>(1 - (1/2)^{\text{certainty}})$. If the certainty ≤ 0 , true always returned. The execution time is proportional to the value of this parameter. We must pass in a new Random object:

```

100.times{
    def primes= [17g, 19g, 23g, 29g, 31g] //bitlength is 5, so primes from 16 to 31 incl
    assert new BigInteger( 5, 50, new Random() ) in primes //5 is bit-length, 50 is certainty
    (must be integer)
}

def pp= BigInteger.probablePrime( 20, new Random() ) //if we don't want to specify certainty
    //20 is bit-length; there's <1.0e-30 chance the number isn't prime

def pn= pp.nextProbablePrime() //this is probably next prime, but definitely no primes skipped
over
( (pp+1)..<pn ).each{
    assert ! it.isProbablePrime(50)
    //we can test for primality to specific certainty (here, 50). True if probably prime,
    false if definitely composite
}
assert 10g.nextProbablePrime() == 11
assert 0g.nextProbablePrime() == 2

```

Bit-Manipulation on BigIntegers

All operations behave as if BigIntegers were represented in two's-complement notation. Bit operations operate on a single bit of the two's-complement representation of their operand/s. The infinite word size ensures that there are infinitely many virtual sign bits preceding each BigInteger. None of the single-bit operations can produce a BigInteger with a different sign from the BigInteger being operated on, as they affect only a single bit.

```

assert 0x33g.testBit(1) //true if bit is 1, indexing beginning at 0 from righthand side
assert ! 0x33g.testBit(2)
(2..100).each{
    assert (-0x3g).testBit(it) //negative BigIntegers have virtual infinite sign-extension
}

```

Unlike with fixed-width integers, BigIntegers don't have a method to show the hex, octal, or binary representation of a negative number. We can use this code instead to look at the first 16 lowest-order virtual bits:

```

def binRepr={n->

```

```

    (15..0).inject(''){flo,it->
      flo<< (n.testBit(it)? 1: 0)
    }
  }
  assert 0x33g.toString(2) == '110011'
  assert binRepr(0x33g) as String == '0000000000110011'
  assert (-0x33g).toString(2) == '-110011' //not what we want to see
  assert binRepr(-0x33g) as String == '111111111001101' //notice the negative sign bit extended virtually

```

More bit-manip methods:

```

assert 0x33g.setBit(6) == 0x73g //0x33g is binary 110011
assert 0x33g.clearBit(4) == 0x23g
assert 0x33g.flipBit(1) == 0x31g
assert 0x33g.flipBit(2) == 0x37g
assert 0x1g.getLowestSetBit() == 0 //index of the rightmost one bit in this BigInteger
assert 0x2g.getLowestSetBit() == 1
assert 0x8g.getLowestSetBit() == 3
assert 0x33g.bitLength() == 6 //number of bits in minimal representation of number
assert (-0x33g).bitLength() == 6 //exclude sign bit
assert 0x33g.bitCount() == 4 //number of bits that differ from sign bit
assert (-0x33g).bitCount() == 3

```

Setting, clearing, or flipping bit in virtual sign makes that bit part of the number:

```

assert (-0x33g).clearBit(9) == -0x233g

```

We can perform bit-shifting on BigIntegers. The shortcut operators >> and << can't be used, only the method names can be (they're also spelt differently to the fixed-size integer versions of the names, eg, "shiftLeft" instead of "leftShift"). There's no shift-right-unsigned method because this doesn't make sense for BigIntegers with virtual infinite-length sign bits.

```

assert 0xB4Fg.shiftLeft( 4 ) == 0xB4F0g //shift 4 bits to the left
assert 0xD23Cg.shiftRight( 4 ) == 0xD23g //shift 4 bits to the right, dropping off digits
assert (-0xFFFg).shiftRight( 4 ) == -0x100g //sign-extension performed when right-shifting
[ 0xABCg, -0x98765g ].each{
  it.shiftLeft( 8 ) == it.shiftRight( -8 )
}

```

We can perform 'not', 'and', 'or', and 'xor' bitwise operations on BigIntegers:

```

assert 123g.not() == -124g //in 2's-complement, negate and add 1
assert -0xFFg.not() == 0x100g

assert ( 0x33g & 0x11g ) == 0x11g && 0x33g.and(0x11g) == 0x11g
assert ( 0x33g | 0x11g ) == 0x33g && 0x33g.or(0x11g) == 0x33g
assert ( 0x33g ^ 0x11g ) == 0x22g && 0x33g.xor(0x11g) == 0x22g
assert 0x33g.andNot(0x11g) == 0x22g && (0x33g & (~ 0x11g)) == 0x22g //convenience operation

```

For negative numbers:

```

assert (-1g & -1g) == -1g //and returns a negative if both operands are negative
assert (1g | -1g) == -1g //or returns a negative number if either operand is negative
assert (1g ^ -1g) == -2g //xor returns a negative number if exactly one operand is negative
assert (-1g ^ -2g) == 1g

```

When the two operands are of different lengths, the sign on the shorter of the two operands is virtually extended prior to the operation:

```
assert 11g.and(-2g) == 10g //01011 and 11110 is 01010, ie, 10g
```

Java Reflection in Groovy

This page last changed on Feb 17, 2007 by [gavingrover](#).

As in Java, we can examine classes in Groovy to find out information in the form of strings, using the Reflection API.

Examining Classes

To find out a class's name and superclasses:

```
class A{}
assert A.name == 'A'
assert new A().class.name == 'A'
assert A.class.name == 'A' //'class' is optionally used here

class B extends A{}
assert B.name == 'B'

class C extends B{}
def hierarchy= []
def s = C
while(s != null){ hierarchy << s.name; s= s.superclass }
assert hierarchy == [ 'C', 'B', 'A', 'java.lang.Object' ]
```

To examine the interfaces:

```
interface A1{}
interface A2{}
class A implements A1, A2{}
def interfacesA = [] as Set //use a set because interfaces are unordered
A.interfaces.each{ interfacesA << it.name }
assert interfacesA == [ 'A1', 'A2', 'groovy.lang.GroovyObject' ] as Set

interface B1{}
class B extends A implements B1{}
def interfacesB = [] as Set
B.interfaces.each{ interfacesB << it.name }
assert interfacesB == [ 'B1' ] as Set //only immediately implemented interfaces are reported
```

We can check if a class is a class or an interface:

```
assert Observer.isInterface()
assert ! Observable.isInterface()
```

Examining Within the Class

We can examine public fields and their types:

```
class A{
    def adyn //if no modifier, field is private
    String astr
```

```

    public apdyn
    public String apstr
    protected aqdyn
}
interface B1{}
interface B2{}
class B extends A implements B1, B2{
    def bdyn
    int bint
    public bpdyn
    public int bpint
    protected bqdyn
}
def dets = [] as Set
B.fields.each{ //public fields only
    dets << [ it.name, it.type.name ] //name of field and name of type
}
assert dets == [
    [ 'apstr', 'java.lang.String' ],
    [ 'apdyn', 'java.lang.Object' ],
    [ 'bpint', 'int' ],
    [ 'bpdyn', 'java.lang.Object' ],
    [ '__timestamp', 'java.lang.Long' ], //added by Groovy
] as Set

```

We can look at a certain field of a class:

```

assert Math.fields.name as Set == [ 'E', 'PI' ] as Set
assert Math.class.getField('PI').toString() == 'public static final double java.lang.Math.PI'
assert Math.class.getField('PI').getDouble() == 3.141592653589793 //we must know the type of
the value

```

We can also look at the constructors and methods of a class:

```

assert HashMap.constructors.collect{ it.parameterTypes.name } as Set ==
    [ ['int'], [], ['java.util.Map'], ['int', 'float'] ] as Set
GroovyObject.methods.each{ println it } //to print full details of each method of a class
assert GroovyObject.methods.name as Set ==
    [ 'invokeMethod', 'getMetaClass', 'setMetaClass', 'setProperty', 'getProperty' ] as Set
assert GroovyObject.getMethod('getMetaClass').toString() ==
    'public abstract groovy.lang.MetaClass groovy.lang.GroovyObject.getMetaClass()'

```

Some code to find out all the getters for a class:

```

getters= {
    it.methods.name.findAll{ it =~ /^get[A-Z]/ }.collect{ it[3].toLowerCase()+it[4..-1] }.join(',')
}
assert getters( GroovyObject ) == 'metaClass, property'

```

To see all nested classes for a particular class (eg, of Character):

```

assert Character.classes.name as Set ==
    [ 'java.lang.Character$Subset', 'java.lang.Character$UnicodeBlock' ] as Set

```

To query a particular nested class (eg, Character.UnicodeBlock):

```

Character.UnicodeBlock.fields.name.each{ println it } //to list all public constants

```

Reflecting the Reflection classes themselves

We can use reflection on the reflection classes themselves. For example:

```
assert Class.methods[0].class == java.lang.reflect.Method //find the class of any method of any
class...
java.lang.reflect.Method.methods.each{ println it.name } //...then find its method names...

//...to help us build a custom-formatted listing of method details
HashMap.class.methods.each{
    println "$it.name( ${it.parameterTypes.name.join(', ')} ) returns $it.returnType.name " +
        "${it.exceptionTypes.size()}>0?'throws ':''}${it.exceptionTypes.name.join(', ')}"
}
```

We can look at the modifiers of methods and classes:

```
import java.lang.reflect.Modifier
Modifier.methods.name.sort{}.each{ println it } //use reflection on the reflection classes...

//...to help us build a custom-formatted listing of modifier details
[
    (ArrayList.getMethod( 'remove', [Object] as Class[] )): [ 'public' ] as Set,
    (Collections.getMethod( 'synchronizedList', [List] as Class[] )): [ 'public', 'static' ] as
Set,
    (Math): [ 'public', 'final' ] as
Set,
    (ClassLoader): [ 'public', 'abstract' ] as
Set,
].each{ key, val->
    def m= key.modifiers
    def mods= [
        ({Modifier.isPublic(it)}): 'public',
        ({Modifier.isProtected(it)}): 'protected',
        ({Modifier.isPrivate(it)}): 'private',
        ({Modifier.isInterface(it)}): 'interface',
        ({Modifier.isAbstract(it)}): 'abstract',
        ({Modifier.isFinal(it)}): 'final',
        ({Modifier.isStatic(it)}): 'static',
        ({Modifier.isVolatile(it)}): 'volatile',
        ({Modifier.isNative(it)}): 'native',
        ({Modifier.isStrict(it)}): 'strict',
        ({Modifier.isSynchronized(it)}): 'synchronized',
        ({Modifier.isTransient(it)}): 'transient',
    ].collect{ k, v-> k(m)? v: null } as Set
    mods.removeAll( [null] )
    assert mods == val
}
```

Packages

To see all packages loaded by system:

```
Package.packages.name.each{ println it }
```

Manipulating Objects

When a class is unknown at compile time (eg, we only have a string representation of a class name), we can use reflection to create objects:


```

assert Class.forName("java.util.HashMap").newInstance() == [:]

def constructor = Class.forName("java.util.HashMap").getConstructor( [ int, float ] as Class[]
)
assert constructor.toString() == 'public java.util.HashMap(int,float)'
assert constructor.newInstance( 12, 34.5f ) == [:]

```

We can examine and change public fields for a class referring using a String for the name:

```

class A{
  public value1
  protected value2
  A( int v ){ value1= v; value2 = v }
}
def a= new A( 100 )
assert A.getField( 'value1' ).get( a ) == 100 //public fields only

try{ A.getField( 'value2' ).get( a ); assert false }
catch(Exception e){ assert e instanceof NoSuchFieldException }

A.getField( 'value1' ).set( a, 350 )
assert a.value1 == 350

```

And we can call methods using a string for the name:

```

assert String.getMethod( 'concat', [ String ] as Class[] ).
  invoke( 'Hello, ', [ 'world!' ] as Object[] ) == 'Hello, world!'

```

Working with Arrays

We can examine and manipulate arrays. To enquire the public array fields of a class:

```

class A{
  public boolean alive
  public int[] codes
  public Date[] dates
  protected boolean[] states
}
//find all public array fields
def pubFields= new A().class.fields.findAll{ it.type.isArray() }.collect{ [it.name,
it.type.name] }
assert pubFields == [
  [ 'codes', '[I' ], //'[I' means array of int
  [ 'dates', '[Ljava.util.Date;' ], //means array of object java.util.Date
]

```

To enquire the component type/s of an array:

```

[
  (int[]): [ '[I', 'int' ],
  (Date[]): [ '[Ljava.util.Date;', 'java.util.Date' ],
  (new Date[6].class): [ '[Ljava.util.Date;', 'java.util.Date' ], //instantiated class
  (String[][]): [ '[Ljava.lang.String;', '[Ljava.lang.String;' ],
].each{
  k, v -> assert [ k.name, k.componentType.name ] == v
}

```

Manipulating Arrays

We can create and copy arrays when their component type and size is unknown at compile time:

```
import java.lang.reflect.Array
def a1 = [55, 66] as int[]

//component type and size unknown at compile time...
def a2 = Array.newInstance( a1.class.componentType, a1.size() * 2 )
assert a2.class.componentType == int
assert a2.size() == 4
System.arraycopy( a1, 0, a2, 0, a1.size() )
assert a2 as List == [55, 66, 0, 0] as List
```

We can create multi-dimensional arrays in a similar way, where component type and array sizes can be unknown at compile time:

```
import java.lang.reflect.Array

//assertion checking code...
assert1D= {x,y->
    assert x.size() == y.size()
    for( int i: x.size() - 1 ) assert x[ i ] == y[ i ]
}
assert2D= {x,y->
    assert x.size() == y.size()
    for( int i: x.size() - 1 ){
        assert x[ i ].size() == y[ i ].size()
        for( int j: x[ i ].size() - 1 ) assert x[ i ][ j ] == y[ i ][ j ]
    }
}

//each is a 1-D int array with 3 elts
def a0= new char[ 3 ]
def a1= Array.newInstance( char, 3 )
def a2= Array.newInstance( char, [ 3 ] as int[] )
assert1D( a0, a1 )
assert1D( a0, a2 )

//both are a 2-D 3x4 array of String elts
def b0= new String[3][4]
def b1= Array.newInstance( String, [ 3, 4 ] as int[] )
assert2D( b0, b1 )

//both are a 2-D array of 6 char arrays, with undefined tail dimension
def c0 = new char[6][]
def c1 = Array.newInstance( char[], [ 6 ] as int[] )
assert1D( c0, c1 )
```

We can use set() and get() to copy the contents of one array index to another:

```
import java.lang.reflect.Array
def a= [ 12, 78 ] as int[], b= new int[ 4 ]
Array.set( b, 0, Array.get( a, 0 ) )
assert b[ 0 ] == 12
```

This tutorial is loosely based on Sun's tutorial on Java Reflection, but using Groovy code instead.

Maps and SortedMaps

This page last changed on Mar 29, 2007 by [gavingrover](#).

A map is a mapping from unique unordered keys to values:

```
def map= ['id':'FX-11', 'name':'Radish', 'no':1234, 99:'Y'] //keys can be of any type, and
mixed together; so can values
assert map == ['name':'Radish', 'id':'FX-11', 99:'Y', 'no':1234] //order of keys irrelevant
assert map.size() == 4
assert [1:'a', 2:'b', 1:'c' ] == [1:'c', 2:'b'] //keys unique

def map2= [
  'id': 'FX-17',
  name: 'Turnip', //string-keys that are valid identifiers need not be quoted
  99: 123, //any data can be a key
  (-97): 987, //keys with complex syntax must be parenthesized
  "tail's": true, //trailing comma OK
]

assert map2.id == 'FX-17' //we can use field syntax for keys that are valid identifiers
assert map2['id'] == 'FX-17' //we can always use subscript syntax
assert map2.getAt('id') == 'FX-17' //some alternative method names
assert map2.get('id') == 'FX-17'
assert map2['address'] == null //if key doesn't exist in map
assert map2.get('address', 'No fixed abode') == 'No fixed abode' //default value for
non-existent keys

assert map2.class == null //field syntax always refers to value of key, even if it doesn't
exist
//use getClass() instead of class for maps...
assert map2.getClass() == HashMap //the kind of Map being used

assert map2."tail's" == true //string-keys that aren't valid identifiers can be used as a field
by quoting them
assert ! map2.'99' && ! map2.'-97' //doesn't work for numbers, though

map2.name = 'Potato'
map2[-107] = 'washed, but not peeled'
map2.putAt('alias', 'Spud') //different alternative method names when assigning value
map2.put('address', 'underground')
assert map2.name == 'Potato' && map2[-107] == 'washed, but not peeled' &&
  map2.alias == 'Spud' && map2.address == 'underground'
assert map2 == [ id: 'FX-17', name: 'Potato', alias: 'Spud', address: 'underground',
  99: 123, (-97): 987, (-107): 'washed, but not peeled', "tail's": true ]

def id= 'address'
def map3= [id: 11, (id): 22] //if we want a variable's value to become the key, we wrap it
between parentheses
assert map3 == [id: 11, address: 22]
```

It's a common idiom to construct an empty map and assign values:

```
def map4= [:]
map4[ 1 ]= 'a'
map4[ 2 ]= 'b'
map4[ true ]= 'p' //we can use boolean values as a key
map4[ false ]= 'q'
map4[ null ]= 'x' //we can also use null as a key
map4[ 'null' ]= 'z'
assert map4 == [1:'a', 2:'b', (true):'p', (false):'q', (null):'x', 'null':'z' ]
```

We can use `each()` and `eachWithIndex()` to access keys and values:

```
def p= new StringBuffer()
[1:'a', 2:'b', 3:'c'].each{ p << it.key +': ' + it.value +'; ' } //we supply a closure with
```

```

either 1 param...
assert p.toString() == '1: a; 2: b; 3: c; '

def q= new StringBuffer()
[1:'a', 2:'b', 3:'c'].each{ k, v-> q << k +': ' + v +'; ' } //...or 2 params
assert q.toString() == '1: a; 2: b; 3: c; '

def r= new StringBuffer()
[1:'a', 2:'b', 3:'c'].eachWithIndex{ it, i-> r << it.key +'(' + i +')': ' + it.value +'; ' }
//eachIndex() always takes 2 params
assert r.toString() == '1(0): a; 2(1): b; 3(2): c; '

```

We can check the contents of a map with various methods:

```

assert [:].isEmpty()
assert ! [1:'a', 2:'b'].isEmpty()
assert [1:'a', 2:'b'].containsKey(2)
assert ! [1:'a', 2:'b'].containsKey(4)
assert [1:'a', 2:'b'].containsValue('b')
assert ! [1:'a', 2:'b'].containsValue('z')

```

We can clear a map:

```

def m= [1:'a', 2:'b']
m.clear()
assert m == [:]

```

Further map methods:

```

def defaults= [1:'a', 2:'b', 3:'c', 4:'d'], overrides= [2:'z', 5:'x', 13:'x']
def result= new HashMap(defaults)
result.putAll(overrides)
assert result == [1:'a', 2:'z', 3:'c', 4:'d', 5:'x', 13:'x']
result.remove(2)
assert result == [1:'a', 3:'c', 4:'d', 5:'x', 13:'x']
result.remove(2)
assert result == [1:'a', 3:'c', 4:'d', 5:'x', 13:'x']

```

Great care must be exercised if mutable objects are used as map keys. The behavior of a map is not specified if the value of an object is changed in a manner that affects equals comparisons while the object is a key in the map. A special case of this prohibition is that a map should not contain itself as a key.

Collection views of a map

We can inspect the keys, values, and entries in a view:

```

def m2= [1:'a', 2:'b', 3:'c']

def es=m2.entrySet()
es.each{
  assert it.key in [1,2,3]
  assert it.value in ['a','b','c']
  it.value *= 3 //change value in entry set...
}
assert m2 == [1:'aaa', 2:'bbb', 3:'ccc'] //...and backing map IS updated

def ks= m2.keySet()
assert ks == [1,2,3] as Set

```

```

ks.each{ it *= 2 } //change key...
assert m2 == [1:'aaa', 2:'bbb', 3:'ccc'] //...but backing map NOT updated
ks.remove( 2 ) //remove key...
assert m2 == [1:'aaa', 3:'ccc'] //...and backing map IS updated

def vals= m2.values()
assert vals.toList() == ['aaa', 'ccc']
vals.each{ it = it+'z' } //change value...
assert m2 == [1:'aaa', 3:'ccc'] //...but backing map NOT updated
vals.remove( 'aaa' ) //remove value...
assert m2 == [3:'ccc'] //...and backing map IS updated

vals.clear() //clear values...
assert m2 == [:] //...and backing map IS updated

assert es.is( m2.entrySet() ) //same instance always returned
assert ks.is( m2.keySet() )
assert vals.is( m2.values() )

```

We can use these views for various checks:

```

def m1= [1:'a', 3:'c', 5:'e'], m2= [1:'a', 5:'e']
assert m1.entrySet().containsAll(m2.entrySet()) //true if m1 contains all of m2's mappings
def m3= [1:'g', 5:'z', 3:'x']
m1.keySet().equals(m3.keySet()) //true if maps contain mappings for same keys

```

These views also support the removeAll() and retainAll() operations:

```

def m= [1:'a', 2:'b', 3:'c', 4:'d', 5:'e']
m.keySet().retainAll( [2,3,4] as Set )
assert m == [2:'b', 3:'c', 4:'d']
m.values().removeAll( ['c','d','e'] as Set )
assert m == [2:'b']

```

Some more map operations:

```

def m= [1:'a', 2:'b', 3:'c', 4:'d', 5:'e']
assert [86: m, 99: 'end'].clone()[86].is( m ) //clone() makes a shallow copy

def c= []
def d= ['a', 'bb', 'ccc', 'dddd', 'eeeee']
assert m.collect{ it.value * it.key } == d
assert m.collect(c){ it.value * it.key } == d
assert c == d

assert m.findAll{ it.key == 2 || it.value == 'e' } == [2:'b', 5:'e']
def me= m.find{ it.key % 2 == 0 }
assert [me.key, me.value] in [ [2,'b'], [4,'d'] ]

assert m.toMapString() == '[1:"a", 2:"b", 3:"c", 4:"d", 5:"e"]'

def sm= m.subMap( [2,3,4] )
sm[3]= 'z'
assert sm == [2:'b', 3:'z', 4:'d']
assert m == [1:'a', 2:'b', 3:'c', 4:'d', 5:'e'] //backing map is not modified

assert m.every{ it.value.size() == 1 }
assert m.any{ it.key % 4 == 0 }

```

Special Notations

We can use special notations to access all of a certain key in a list of similarly-keyed maps:

```

def x = [ ['a':11, 'b':12], ['a':21, 'b':22] ]
assert x.a == [11, 21] //GPath notation
assert x*.a == [11, 21] //spread dot notation

x = [ ['a':11, 'b':12], ['a':21, 'b':22], null ]
assert x*.a == [11, 21, null] //caters for null values
assert x*.a == x.collect{ it?.a } //equivalent notation
try{ x.a; assert 0 }catch(e){ assert e instanceof NullPointerException } //GPath doesn't cater
for null values

class MyClass{ def getA(){ 'abc' } }
x = [ ['a':21, 'b':22], null, new MyClass() ]
assert x*.a == [21, null, 'abc'] //properties treated like map subscripting

def c1= new MyClass(), c2= new MyClass()
assert [c1, c2]*.getA() == [c1.getA(), c2.getA()] //spread dot also works for method calls
assert [c1, c2]*.getA() == ['abc', 'abc']

assert ['z':900, *:['a':100, 'b':200], 'a':300] == ['a':300, 'b':200, 'z':900] //spread map
notation in map definition
assert [ *:[3:3, *: [5:5] ], 7:7] == [3:3, 5:5, 7:7]

def f(){ [ 1:'u', 2:'v', 3:'w' ] }
assert [*:f(), 10:'zz'] == [1:'u', 10:'zz', 2:'v', 3:'w'] //spread map notation in function
arguments
def f(m){ m.c }
assert f(*:['a':10, 'b':20, 'c':30], 'e':50) == 30

def f(m, i, j, k){ [m, i, j, k] } //using spread map notation with mixed unnamed and named
arguments
assert f('e':100, *[4, 5], *:['a':10, 'b':20, 'c':30], 6) == [ ["e":100, "b":20, "c":30,
"a":10], 4, 5, 6 ]

```

Grouping

We can group a list into a map using some criteria:

```

assert [ 'a', 7, 'b', [2,3] ].groupBy{ it.class } ==
  [ (String.class): ['a', 'b'], (Integer.class): [ 7 ], (ArrayList.class): [[2,3]] ]

assert [
  [name:'Clark', city:'London'], [name:'Sharma', city:'London'],
  [name:'Maradona', city:'LA'], [name:'Zhang', city:'HK'],
  [name:'Ali', city: 'HK'], [name:'Liu', city:'HK'],
].groupBy{ it.city } == [
  London: [ [name:'Clark', city:'London'], [name:'Sharma', city:'London'] ],
  LA: [ [name:'Maradona', city:'LA'] ],
  HK: [ [name:'Zhang', city:'HK'], [name:'Ali', city: 'HK'], [name:'Liu', city:'HK'] ],
]

```

By using `groupBy()` and `findAll()` on a list of similarly-keyed maps, we can emulate SQL:

```

assert ('The quick brown fox jumps over the lazy dog'.toList()*).toLowerCase() - ' '.
  findAll{ it in 'aeiou'.toList() }. //emulate SQL's WHERE clause with findAll() method
  groupBy{ it }. //emulate GROUP BY clause with groupBy() method
  findAll{ it.value.size() > 1 }. //emulate HAVING clause with findAll() method after the
groupBy() one
  entrySet().sort{ it.key }.reverse(). //emulate ORDER BY clause with sort() and reverse()
methods
  collect{ "${it.key}:${it.value.size()}" }.join(' ') == 'u:2, o:4, e:3'

```

An example with more than one "table" of data:

```
//find all letters in the "lazy dog" sentence appearing more often than those in the "liquor
jugs" one
def dogLetters= ('The quick brown fox jumps over the lazy dog'.toList().toLowerCase() - ' '),
jugLetters= ('Pack my box with five dozen liquor jugs'.toList().toLowerCase() - ' ')
assert dogLetters.groupBy{ it }.
  findAll{ it.value.size() > jugLetters.groupBy{ it }[ it.key ].size() }.
  entrySet().sort{ it.key }.collect{ "$it.key:${it.value.size()}" }.join(' ') == 'e:3, h:2, o:4,
r:2, t:2'
```

HashMap Internals

A HashMap is constructed in various ways:

```
def set1= new HashSet() //uses initial capacity of 16 and load factor of 0.75
def set2= new HashSet(25) //uses load factor of 0.75
def set3= new HashSet(25, 0.8f)
def set4= [:] //the shortcut syntax
```

The capacity is the number of buckets in the HashMap, and the initial capacity is the capacity when it's created. The load factor measures how full the HashMap will get before its capacity is automatically increased. When the number of entries exceeds the product of the load factor and the current capacity, the HashMap is rehashed so it has about twice the number of buckets. A HashMap gives constant-time performance for lookup (getting and putting). Iterating over collection views gives time performance proportional to the capacity of the HashMap instance plus its the number of keys. So don't set the initial capacity too high or the load factor too low. As a general rule, the default load factor (0.75) offers a good tradeoff between time and space costs. Higher values decrease the space overhead but increase the lookup cost. Creating a HashMap with a sufficiently large capacity will allow mappings to be stored more efficiently than letting it perform automatic rehashing as needed to grow the table.

A HashSet is implemented with a HashMap, and is constructed with the same choices of parameters:

```
def set1= new HashSet() //uses initial capacity of 16 and load factor of 0.75
def set2= new HashSet(25) //uses load factor of 0.75
def set3= new HashSet(25, 0.8f)
def set4= Collections.newSetFromMap( [:] ) //we can supply our own empty map for the
implementation
```

SortedMap

A sorted map is one with extra methods that utilize the sorting of the keys. Some constructors and methods:

```
def map= [3:'c', 2:'d', 1:'e', 5:'a', 4:'b'], tm= new TreeMap(map)
assert tm.firstKey() == map.keySet().min() && tm.firstKey() == 1
assert tm.lastKey() == map.keySet().max() && tm.lastKey() == 5
assert tm.findIndexOf{ it.key==4 } == 3
```

We can construct a TreeMap by giving a comparator to order the elements in the map:

```
def c= [ compare: {a,b-> a.equals(b)? 0: Math.abs(a)<Math.abs(b)? -1: 1 } ] as Comparator
```

```
def tm= new TreeMap( c )
tm[3]= 'a'; tm[-7]= 'b'; tm[9]= 'c'; tm[-2]= 'd'; tm[-4]= 'e'
assert tm == new TreeMap( [(-2):'d', 3:'a', (-4):'e', (-7):'b', 9:'c'] )
assert tm.comparator() == c //retrieve the comparator

def tm2= new TreeMap( tm ) //use same map entries and comparator
assert tm2.comparator() == c

def tm3= new TreeMap( tm as HashMap ) //special syntax to use same map entries but default
comparator only
assert tm3.comparator() == null
```

The range-views, headMap() tailMap() and subMap(), are useful views of the items in a sorted map. They act similarly to the corresponding range-views in a sorted set.

```
def sm= new TreeMap(['a':1, 'b':2, 'c':3, 'd':4, 'e':5])
def hm= sm.headMap('c')
assert hm == new TreeMap(['a':1, 'b':2]) //headMap() returns all elements with key < specified
key
hm.remove('a')
assert sm == new TreeMap(['b':2, 'c':3, 'd':4, 'e':5]) //headmap is simply a view of the data
in sm
sm['a']= 1; sm['f']= 6
assert sm == new TreeMap(['a':1, 'b':2, 'c':3, 'd':4, 'e':5, 'f':6]) //if backing sorted map
changes, so do range-views
def tm= sm.tailMap('c')
assert tm == new TreeMap(['c':3, 'd':4, 'e':5, 'f':6]) //tailMap() returns all elements with
key >= specified element
def bm= sm.subMap('b','e')
assert bm == new TreeMap(['b':2, 'c':3, 'd':4]) //subMap() returns all elements with key >= but
< specified element
try{ bm['z']= 26; assert 0 }catch(e){ assert e instanceof IllegalArgumentException } //attempt
to insert an element out of range
```

Immutable Maps

We can convert a map into one that can't be modified:

```
def imMap= ([ 'a':1, 'b':2, 'c':3 ] as Map).asImmutable()
try{ imMap['d']= 4; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
imMap= Collections.unmodifiableMap( [ 'a':1, 'b':2, 'c':3 ] as Map ) //alternative way
try{ imMap['d']= 4; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }

def imSortedMap= ( new TreeMap(['a':1, 'b':2, 'c':3]) ).asImmutable()
try{ imSortedMap['d']= 4; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
imSortedMap= Collections.unmodifiableSortedMap( new TreeMap(['a':1, 'b':2, 'c':3]) )
//alternative way
try{ imSortedMap['d']= 4; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
}
```

We can create an empty map that can't be modified:

```
def map= Collections.emptyMap()
assert map == [:]
try{ map['a']= 1; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
map= Collections.EMPTY_MAP
assert map == [:]
try{ map['a']= 1; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
```

We can create a single-element list that can't be modified:


```
def singMap = Collections.singletonMap('a', 1)
assert singMap == ['a': 1]
try{ singMap['b']= 2; assert 0 }catch(e){ assert e instanceof UnsupportedOperationException }
```

Object Arrays

This page last changed on Mar 27, 2007 by [gavingrover](#).

An object array is a fixed-size sequence of objects:

```
def a= new Object[4] //we must specify the size of the fixed-array
assert a.size() == 4
assert a.length == 4 //field alternative to size()
a.each{ assert it == null } //default value is null
assert a instanceof Object[]
assert a.class == Object[]

a[0]= 'a'
a[1]= 2 //elements can be any value
a.putAt(2, 'c') //alternative method name syntax
a[3]= false
assert a[0] == 'a' && a[1] == 2 && a.getAt(2) == 'c' && a.getAt(3) == false //either subscript
or method name
assert a[-4] == 'a' && a[-3] == 2 && a[-2] == 'c' && a[-1] == false //subscripts can be
negative

try{ a[4]; assert 0 }catch(e){ assert e instanceof ArrayIndexOutOfBoundsException }
try{ a[-5]; assert 0 }catch(e){ assert e instanceof ArrayIndexOutOfBoundsException }

assert a[1..2] == [2, 'c'] //we can use the same subscripting as for lists
assert a[2..2] == ['c']
assert a[0, 2..3] == ['a', 'c', false]

assert a.toList() == ['a', 2, 'c', false]
assert a as List == ['a', 2, 'c', false]
assert a.toArrayString() == '{"a", 2, "c", false}'
```

The subscript used in constructing object arrays is evaluated as an integer:

```
assert new Object[ 0x100000003 ].size() == 3 //index coerced to integer, positive or negative
try{ new Object[ 0x80000000 ]; assert 0 }catch(e){ assert e instanceof
NegativeArraySizeException }
```

We can specify the initial collection of contained objects when we construct the array. Those objects can be any other entity in Groovy, eg, numbers, boolean values, characters, strings, regexes, lists, maps, closures, expandos, classes, class instances, or even other object arrays:

```
assert [
    14.25,
    17g,
    [1,2,3],
    'Hello, world',
    ['a', false, null, 5] as Object[],
    new Object[200],
    { it*it },
    ArrayList,
] as Object[]
```

We can make a shallow copy using `clone()`:

```
def aq= [1,2]
assert ([ aq, 3 ] as Object[]).clone()[0].is( aq ) //clone() makes a shallow copy only
```

We have a special syntax for constructing multi-dimensional object arrays with null initial values:

```

assert [ new Object[3], new Object[2], new Object[1] ] //usual syntax
assert [ new Object[3], new Object[3], new Object[3] ] //usual syntax when each constituent
array of equal size

def m= new Object[3][3] //special syntax when each constituent array of equal size
(0..<m.size()).each{i->
  (0..<m[i].size()).each{j->
    assert m[i][j] == null //we can also subscript with special syntax using consecutive
indexes
  }
}

```

There are strict rules concerning evaluation when subscripting object arrays:

```

class MyException extends Exception{}
def exception(){ throw new MyException() }
def i, a, b

i= 4
a= new Object[i][i=3] //first subscript evaluated before next one
assert a.size() == 4 && a[0].size() == 3

a= [ 11, 12, 13, 14 ] as Object[]
b= [ 3, 2, 1, 0 ] as Object[]
assert a[(a=b)[2]] == 12 //outside of subscript evaluated before inside, ie, a[b[2]] or a[1] or
12

i= 1 //if what's outside subscript throws exception, subscript isn't evaluated
try{ exception()[i=2] }catch(e){ assert i == 1 }

i= 1
a= new Object[2][2] //if evaluation of a subscript throws exception, subscripts to the right
aren't evaluated...
try{ a[ exception() ][i=2] }catch(e){ assert i == 1 }

//index evaluated before indexing occurs (including checking whether what's outside subscript
is null)
a= null
try{ a[exception()]; assert 0 }catch(e){ assert e instanceof MyException }
//NullPointerException never occurs here
i= 1
try{ a[i=2]; assert 0 }catch(e){ assert i == 2 && e instanceof NullPointerException }

```

Implementing an ArrayList with an Object Array

ArrayLists are implemented with object arrays internally. Each ArrayList instance has a capacity, the size of a fixed-size array used to store the elements. This array is always at least as large as the list size, and its capacity grows automatically as elements are added to the list. To see the internal capacity of lists constructed with various values:

```

class Extras{
  static enq(List l){ l.elementData.size() }
}
def measure= { list, times->
  def sizes= []
  times.times{
    def size
    use(Extras){ size= list.enq() }
    (size - list.size() + 1).times{ list << 'a' }
    sizes << size
  }
  sizes
}

def list1= new ArrayList()
def measure1= measure(list1, 10)

```

```

assert measure1 == [10, 16, 25, 38, 58, 88, 133, 200, 301, 452]

def list2= new ArrayList(10)
def measure2= measure(list2, 10)
assert measure2 == measure1

def list3= new ArrayList(5)
def measure3= measure(list3, 10)
assert measure3 == [5, 8, 13, 20, 31, 47, 71, 107, 161, 242]

def list4= []
def measure4= measure(list4, 10)
assert measure4 == [0, 1, 2, 4, 7, 11, 17, 26, 40, 61]

def list5= new ArrayList(0)
def measure5= measure(list5, 10)
assert measure5 == measure4

```

For efficiency, we can increase the capacity of a list before adding a large number of elements:

```

class Extras{ static enq(List l){l.elementData.size()} }
use(Extras){
  list= []
  list.ensureCapacity(200)
  assert list.enq() == 200
  list<< 'a'<< 'b'<< 'c'
  assert list.enq() == 200
  list.trimToSize() //we can also trim the internal fixed-size array to the list size
  assert list.enq() == 3
}

```

We can see how many times a list has been modified:

```

list= []<< 'a' << 'b'; assert list.modCount == 2
list.remove('a'); assert list.modCount == 3

```

Using the Proxy Meta Class in depth

This page last changed on Mar 22, 2007 by [gavingrover](#).

We can use the ProxyMetaClass to replace the metaclass being used by a class within a selected block for the current thread only.

Interceptors with ProxyMetaClass

By using ProxyMetaClass, we can attach an interceptor to a class for a block of code. The Groovy-supplied Interceptor interface has three methods. The beforeInvoke() method specifies code to be executed before the intercepted method, the doInvoke() indicates whether to execute the intercepted method, and afterInvoke() executes after the intercepted method finishes, or after a false-returning doInvoke(). The result parameter passed to afterInvoke() is the result of executing the method, or what was returned from beforeInvoke() if the intercepted method wasn't executed. What afterInvoke() returns is returned from the method call in the main flow of the program.

```
class MyClass{
    public MyClass(String s){ println "constructing $s" }
    public String sayHello(String name){
        println "saying hello to $name"
        "Hello " + name //return this value
    }
}

class MyInterceptor implements Interceptor{
    Object beforeInvoke(Object object, String methodName, Object[] arguments){
        println " BEFORE $object .$methodName $arguments"
        if( methodName == 'sayHello' ) arguments[0] += ' and family' //we can change the arguments
        null //value returned here isn't actually used anywhere else
    }
    boolean doInvoke(){ true } //whether or not to invoke the intercepted method with
    beforeInvoke's copy of arguments

    Object afterInvoke(Object object, String methodName, Object[] arguments, Object result){
        println " AFTER $object .$methodName $arguments: $result"
        if( methodName == 'sayHello' ) result= (result as String) + ' and in-laws' //we can change
the returned value
        result
    }
}

def proxy= ProxyMetaClass.getInstance( MyClass ) //create proxy metaclass for MyClass
proxy.interceptor= new MyInterceptor() //attach new interceptor to MyClass's proxy metaclass
proxy.use{
    def invoice= new MyClass('trade')
    println invoice.sayHello('Ms Pearl')
}

/*example output:
    BEFORE class MyClass .ctor {"trade"}
constructing trade
    AFTER class MyClass .ctor {"trade"}: MyClass@1d63e39
    BEFORE MyClass@1d63e39 .sayHello {"Ms Pearl"}
saying hello to Ms Pearl and family
    AFTER MyClass@1d63e39 .sayHello {"Ms Pearl and family"}: Hello Ms Pearl and family
Hello Ms Pearl and family and in-laws
*/
```

We can invoke a different method instead of the one called:

```
class MyClass{
```

```

    public String sayHello(String name){
        println "saying hello to $name"
        return "Hello " + name
    }
    public String sayGoodbye(String name){
        println "saying goodbye to $name"
        return "Goodbye " + name
    }
}

class MyInterceptor implements Interceptor{
    def proxy //good idea for interceptor to reference proxy
    def toInvoke= true //so we can change whether or not to invoke the original method
    def resultFromSayGoodBye

    Object beforeInvoke(Object object, String methodName, Object[] arguments){
        if( object instanceof MyClass && methodName == 'sayHello' ){
            resultFromSayGoodBye= object.sayGoodbye(arguments[0]) //so we can invoke a different
method
            //resultFromSayGoodBye= InvokerHelper.invokeMethod( object, 'sayGoodbye', arguments[0] )
            //alternative syntax to invoke method when uncommented

            toInvoke= false //don't invoke sayHello
        }
    }
    boolean doInvoke(){ toInvoke }

    Object afterInvoke(Object object, String methodName, Object[] arguments, Object result){
        if( object instanceof MyClass && methodName == 'sayHello' ){
            toInvoke= true
            result= resultFromSayGoodBye
        }
        result
    }
}

//a utility to match up class, interceptor, and code...
def useInterceptor= { Class theClass, Class theInterceptor, Closure theCode->
    def proxy= ProxyMetaClass.getInstance( theClass )
    def interceptor= theInterceptor.newInstance() //must use dynamic constructor here
    proxy.interceptor= interceptor
    interceptor.proxy= proxy
    proxy.use( theCode )
}

useInterceptor( MyClass, MyInterceptor ){
    println new MyClass().sayHello('Ms Pearl')
}

/*output:
saying goodbye to Ms Pearl
Goodbye Ms Pearl
*/

```

We can even use interceptors on predefined Java classes:

```

class MyInterceptor implements Interceptor{
    def proxy
    Object beforeInvoke(Object object, String methodName, Object[] arguments){
        null
    }
    boolean doInvoke(){ true }
    Object afterInvoke(Object object, String methodName, Object[] arguments, Object result){
        if( object instanceof ArrayList && methodName == 'size' ){
            result = (result as Integer) + 10 //add 10 to size of ArrayLists
        }
        result
    }
}

useInterceptor( ArrayList, MyInterceptor ){ //re-use this utility from the previous example
    assert ['a', 'b', 'c'].size() == 13
}

```

```
}
```

The interception is only valid in the current thread. We can also combine categories with interceptors in various ways, also only valid in the current thread:

```
class MyCategory{
    static String exaggerate( String s ){ "exaggerated: $s" }
}

class StringInterceptor implements Interceptor{
    static proxy
    Object beforeInvoke(Object object, String methodName, Object[] arguments){
        proxy.interceptor= null //prevents interception inside interceptor
        if( object instanceof String )
            use(MyCategory){ assert object.exaggerate() == "exaggerated: $object" }
        proxy.interceptor= this
        null
    }
    boolean doInvoke(){ true }
    Object afterInvoke(Object object, String methodName, Object[] arguments, Object result){
        if( object instanceof String )
            result= "intercepted: $result"
        result
    }
}

useInterceptor( String, StringInterceptor ){
    assert new String('silver').toString() == 'intercepted: silver'

    use(MyCategory){
        assert new String('golden').exaggerate() == 'intercepted: exaggerated: golden'
    }

    Thread.start{ //no interception in spawned thread...
        use(MyCategory){
            assert new String('bronze').exaggerate() == 'exaggerated: bronze'
        }
    }
}
```

Unintercepted Interceptors

Usually we don't want to intercept methods inside the interceptor. We need to define our own `UninterceptedInterceptor` for this:

```
abstract class UninterceptedInterceptor implements Interceptor{
    def proxy= null

    abstract Object doBefore( Object object, String methodName, Object[] arguments )

    public Object beforeInvoke( Object object, String methodName, Object[] arguments ){
        proxy.interceptor= null //turn off interception
        def result
        try{
            result= doBefore(object, methodName, arguments)
        }catch(Exception e){
            throw e
        }finally{
            proxy.interceptor= this //turn interception back on
        }
        result
    }
    abstract boolean doInvoke()

    abstract Object doAfter( Object object, String methodName, Object[] arguments, Object result
    )
}
```

```

    public Object afterInvoke( Object object, String methodName, Object[] arguments, Object
result ){
        proxy.interceptor= null //turn off interception
        try{
            result= doAfter(object, methodName, arguments, result)
        }catch(Exception e){
            throw e
        }finally{
            proxy.interceptor= this //turn interception back on
        }
        result
    }
}

```

With the `UninterceptedInterceptor` class and `useInterceptor` utility, we can demonstrate a certain method being intercepted outside of the interceptor only:

```

class MyInterceptor extends UninterceptedInterceptor{
    Object doBefore( Object object, String methodName, Object[] arguments ){
        null
    }
    boolean doInvoke(){ true }

    Object doAfter( Object object, String methodName, Object[] arguments, Object result ){
        if( object instanceof ArrayList && methodName == 'size' ){
            result = (result as Integer) + [1,2,3,4,5,6,7,8,9,10].size() //call ArrayList size()
            method here without stack overflow
        }
        result
    }
}

useInterceptor( ArrayList, MyInterceptor ){
    assert ['a', 'b', 'c'].size() == 13
}

```

Intercepting many classes in one block

Often, we want to intercept more than one class in one block. This example is of an aliasing interceptor, which disables some English-language names for selected classes, and replaces them with Spanish-language names. We re-use the `UninterceptedInterceptor` class and `useInterceptor` utility from previous examples.

```

import org.codehaus.groovy.runtime.InvokerHelper

abstract class AliasInterceptor extends UninterceptedInterceptor{
    protected aliases= [:]

    private toReturn= null, toThrow= false, toInvoke= false

    Object doBefore( Object object, String methodName, Object[] arguments ){
        if( methodName in aliases.keySet() )
            toReturn= InvokerHelper.invokeMethod( object, aliases[methodName], arguments ) //use
Spanish names instead
        else if( methodName in aliases.values() ) toThrow= true //disable the English names
        else toInvoke= true //run other methods unchanged
        null
    }
    Object doAfter( Object object, String methodName, Object[] arguments, Object result ){
        if( toReturn != null ){
            result= toReturn
            toReturn= null
        }else if( toThrow ){
            toThrow= false
            throw new MissingMethodException( methodName, object.getClass(), arguments )
        }else toInvoke= false
    }
}

```



```

    result
  }
  boolean doInvoke(){ toInvoke }
}

class ArrayListAliasInterceptor extends AliasInterceptor{
  {aliases.putAll( [tamano:'size', todos:'each' ] )} //Spanish aliases
}

class HashMapAliasInterceptor extends AliasInterceptor{
  {aliases.putAll( [tamano:'size', todos:'each' ] )}
}

class LinkedHashMapAliasInterceptor extends AliasInterceptor{
  {aliases.putAll( [tamano:'size', todos:'each' ] )}
}

```

We call the code like so:

```

def useAliasing= { Closure c->
  useInterceptor(ArrayList, ArrayListAliasInterceptor){
    useInterceptor(HashMap, HashMapAliasInterceptor){
      useInterceptor(LinkedHashMap, LinkedHashMapAliasInterceptor){ //although LinkedHashMap is
descended from HashMap, set up interception separately
        c()
      }
    }
  }
}

useAliasing{
  def a= [1, 3, 5, 7, 9]
  println 'size: '+ a.tamano() //Spanish 'tamano' is an alias for the 'size' method
  try{ println a.size(); assert 0 }catch(e){ assert e instanceof MissingMethodException }
//English 'size' method disabled
  a.todos{ println 'item: '+ it }
  println ''

  def b= [a:1, c:3, e:5, g:7]
  println 'size: '+ b.tamano()
  try{ println b.size(); assert 0 }catch(e){ assert e instanceof MissingMethodException }
  b.todos{ println 'item: '+ it }
  println ''

  def c= new LinkedHashMap( [e:5, g:7, i:9] )
  println 'size: '+ c.tamano()
  try{ println c.size(); assert 0 }catch(e){ assert e instanceof MissingMethodException }
  c.todos{ println 'item: '+ it }
}

```

We can put the cascadingly indented code into a list to make it neater by defining a utility category method on the List class. Unfortunately, doing so as follows only runs in versions of Groovy up to Groovy-1.0-RC-01. It doesn't work from Groovy-1.0-RC-02 onwards for an unknown reason, perhaps a bug.

```

class Extras{
  static closureInject(List self, Closure base){
    def z= []
    self.eachWithIndex{ it, i-> z<< {-> it( z[i+1] )} }
    z<< base
    z[0]()
  }
}

use(Extras){
  [ {c-> useInterceptor(ArrayList, ArrayListAliasInterceptor){ c() }},
    {c-> useInterceptor(HashMap, HashMapAliasInterceptor){ c() }},
    {c-> useInterceptor(LinkedHashMap, LinkedHashMapAliasInterceptor){ c() }}]

```

```

}.closureInject{
    def a= [1, 3, 5, 7, 9], b= [a:1, c:3, e:5, g:7], c= new LinkedHashMap( [e:5, g:7, i:9] )

    println 'size: ' + a.tamano()
    try{ println a.size(); assert 0 }catch(e){ assert e instanceof MissingMethodException }
    a.todos{ println 'item: ' + it }
    println ''

    println 'size: ' + b.tamano()
    try{ println b.size(); assert 0 }catch(e){ assert e instanceof MissingMethodException }
    b.todos{ println 'item: ' + it }
    println ''

    println 'size: ' + c.tamano()
    try{ println c.size(); assert 0 }catch(e){ assert e instanceof MissingMethodException }
    c.todos{ println 'item: ' + it }
}
}

```

Our own ProxyMetaClass

We can define our own proxy meta-classes. However, the following examples only run in versions of Groovy up to Groovy-1.0-RC-01. Due to an unrelated bug, we can't implement them this way in Groovy-1.0-RC-02 or later. The Groovy developers also intend changing the MetaClassImpl class in future releases so we would have to implement our own ProxyMetaClasses differently.

One case for which we'd define our own proxy meta-class is to implement our own style of interceptors, here, an around-interceptor:

```

import org.codehaus.groovy.runtime.InvokerHelper

public class MyProxyMetaClass extends MetaClassImpl{
    protected adaptee= null
    def interceptor= null
    MyProxyMetaClass(MetaClassRegistry registry, Class theClass, MetaClass adaptee){
        super(registry, theClass); this.adaptee = adaptee
    }
    static getInstance(Class theClass){
        def metaRegistry = InvokerHelper.getInstance().getMetaRegistry()
        new MyProxyMetaClass(metaRegistry, theClass, metaRegistry.getMetaClass(theClass) )
    }
    void use(Closure closure){
        registry.setMetaClass(theClass, this)
        try{ closure.call() }
        finally{ registry.setMetaClass(theClass, adaptee) }
    }
    void use(GroovyObject object, Closure closure){
        object.setMetaClass(this)
        try{ closure.call() }
        finally{ object.setMetaClass(adaptee) }
    }
    Object invokeMethod(final Object object, final String methodName, final Object[]
arguments){
        doCall(object, methodName, arguments, { adaptee.invokeMethod(object, methodName,
arguments) } )
    }
    Object invokeStaticMethod(final Object object, final String methodName, final Object[]
arguments){
        doCall(object, methodName, arguments, { adaptee.invokeStaticMethod(object, methodName,
arguments) } )
    }
    Object invokeConstructor(final Object[] arguments){
        doCall(theClass, "ctor", arguments, { adaptee.invokeConstructor(arguments) } )
    }
    Object invokeConstructorAt(final Class at, final Object[] arguments){
        doCall(theClass, "ctor", arguments, { adaptee.invokeConstructorAt(at, arguments) } )
    }
    private Object doCall(Object object, String methodName, Object[] arguments, Closure

```

```

howToInvoke){
    if (null == interceptor){ return howToInvoke.call() }
    interceptor.aroundInvoke(object, methodName, arguments, howToInvoke)
}
}

interface AroundInterceptor{
    Object aroundInvoke(Object object, String methodName, Object[] arguments, Closure proceed)
}

```

We can then run our code:

```

class MyInterceptor implements AroundInterceptor{
    Object aroundInvoke(Object object, String methodName, Object[] arguments, Closure proceed){
        println " BEFORE $object .${methodName} $arguments"
        def result= proceed()
        println " AFTER $object .${methodName} $arguments: $result"
        result
    }
}

class MyClass{
    void sayHi(){ System.out.println 'hi' }
}

def interceptor= new MyInterceptor()
def proxy= MyProxyMetaClass.getInstance( MyClass )
proxy.use{
    proxy.interceptor= interceptor
    new MyClass().sayHi()
}

/*outputs:
  BEFORE class MyClass .ctor {}
  AFTER class MyClass .ctor {}: MyClass@1f5d386
  BEFORE MyClass@1f5d386 .sayHi {}
hi
  AFTER MyClass@1f5d386 .sayHi {}: null
*/

```

Using many Interceptors with our own ProxyMetaClass

We can only use one interceptor with the ProxyMetaClass supplied by Groovy, so we need to provide our own when attaching more than one interceptor to a class:

```

import org.codehaus.groovy.runtime.InvokerHelper

public class MultiInterceptorProxyMetaClass extends MetaClassImpl{
    protected adaptee= null
    def interceptors= [] //reference a list of interceptors, instead of just one

    MultiInterceptorProxyMetaClass( MetaClassRegistry registry, Class theClass, MetaClass adaptee
    ){
        super(registry, theClass)
        this.adaptee = adaptee
        if( null == adaptee )
            throw new IllegalArgumentException( "adaptee must not be null" )
    }
    static getInstance(Class theClass){
        def metaRegistry= InvokerHelper.getInstance().getMetaRegistry()
        new MultiInterceptorProxyMetaClass( metaRegistry, theClass,
        metaRegistry.getMetaClass(theClass) )
    }
    void use(Closure closure){
        registry.setMetaClass(theClass, this)
        registry.getMetaClass(theClass).initialise() //for version Groovy-1.0-RC-01 only
        try{ closure.call() }
    }
}

```

```

        finally{ registry.setMetaClass(theClass, adaptee) }
    }
    void use(GroovyObject object, Closure closure){
        object.setMetaClass(this)
        try{ closure.call() }
        finally{ object.setMetaClass(adaptee) }
    }
    Object invokeMethod( final Object object, final String methodName, final Object[] arguments
    ){
        doCall(object, methodName, arguments, { adaptee.invokeMethod(object, methodName, arguments)
        } )
    }
    Object invokeStaticMethod( final Object object, final String methodName, final Object[]
    arguments ){
        doCall(object, methodName, arguments, { adaptee.invokeStaticMethod(object, methodName,
        arguments) } )
    }
    Object invokeConstructor( final Object[] arguments){
        doCall(theClass, "ctor", arguments, { adaptee.invokeConstructor(arguments) } )
    }
    public Object invokeConstructorAt( final Class at, final Object[] arguments){
        doCall(theClass, "ctor", arguments, { adaptee.invokeConstructorAt(at, arguments) } )
    }
    private Object doCall( Object object, String methodName, Object[] arguments, Closure
    howToInvoke ){
        if( interceptors == [] ){ return howToInvoke.call() }
        def result
        interceptors.each{ //different logic to cater for all the interceptors

            result= it.beforeInvoke(object, methodName, arguments)
            if( it.doInvoke() ){ result= howToInvoke.call() }
            it.afterInvoke(object, methodName, arguments, result)
        }
        result
    }
}

```

Using a MultiInterceptorProxyMetaClass for the Observer pattern

A common design pattern is the Observer pattern. Using interceptors, we can abstract the observation code into its own class, the ObserverProtocol, which can be used by subclasses. It enables us to add and remove observing objects for an observed object. We use method interception to decouple the observing and observed objects from the observation relationship itself.

```

abstract class ObserverProtocol implements Interceptor{
    private perSubjectObservers

    protected getObservers( subject ){
        if( perSubjectObservers == null ) perSubjectObservers= [:]
        def observers= perSubjectObservers[ subject ]
        if( observers == null ){
            observers= []
            perSubjectObservers[ subject ]= observers
        }
        observers
    }

    public void addObserver( subject, observer ){
        getObservers(subject) << observer
    }
    public void removeObserver( subject, observer ){
        getObservers(subject).remove(observer)
    }

    abstract Object beforeInvoke( Object object, String methodName, Object[] arguments )

    abstract boolean doInvoke()

    abstract Object afterInvoke( Object object, String methodName, Object[] arguments, Object
    result )
}

```

```
}
```

We can extend this ObserverProtocol with domain-specific observers. Because this example uses our own ProxyMetaClass, it can only run in Groovy-1.0-RC-01 or earlier. The example is a Groovy rewrite of one first implemented in AspectJ by Jan Hannemann and Gregor Kiczales at <http://www.cs.ubc.ca/~jan/AODPs/>.

```
public class Screen{ //functional class to be observed
    def name
    public Screen( String s ){
        this.name= s
    }
    public void display( String s ){
        println(this.name + ": " + s)
    }
}

public class Point{ //class to be observed
    def x, y, color
    public Point( int x, int y, Color color ){
        this.x=x
        this.y=y
        this.color=color
    }
}

class ColorObserver extends ObserverProtocol{
    Object beforeInvoke( Object object, String methodName, Object[] arguments ){ null }
    boolean doInvoke(){ true }
    Object afterInvoke( Object object, String methodName, Object[] arguments, Object result ){
        if( object instanceof Point && methodName == 'setColor' ){
            getObservers(object).each{
                it.display("Screen updated (point subject changed color).")
            }
        }
        result
    }
}

class CoordinateObserver extends ObserverProtocol{
    Object beforeInvoke( Object object, String methodName, Object[] arguments ){ null }
    boolean doInvoke(){ true }
    Object afterInvoke( Object object, String methodName, Object[] arguments, Object result ){
        if( object instanceof Point && ['setX', 'setY'].contains(methodName) ){
            getObservers(object).each{
                it.display("Screen updated (point subject changed coordinates).")
            }
        }
        result
    }
}

class ScreenObserver extends ObserverProtocol{
    Object beforeInvoke( Object object, String methodName, Object[] arguments ){ null }
    boolean doInvoke(){ true }
    Object afterInvoke( Object object, String methodName, Object[] arguments, Object result ){
        if( object instanceof Screen && methodName == 'display' ){
            getObservers(object).each{
                it.display("Screen updated (screen subject changed message).")
            }
        }
        result
    }
}
```

Now we run the program. It first creates five Screen objects (s1, s2, s3, s4, and s5) and one point object, then sets up some observing relationships (namely, s1 and s2 will observe color changes to the point, s3 and s4 will observe coordinate changes to the point, and s5 will observe s2's and s4's display method), and finally, make changes to the point, first, the color, then its x-coordinate. The color change triggers s1 and s2 to each print an appropriate message. s2's message triggers its observer s5 to print a message.

The coordinate change triggers s3 and s4 to print a message. s4's message also triggers the observer s5.

```
import java.awt.Color

def colorObserver= new ColorObserver()
def coordinateObserver= new CoordinateObserver()
def screenObserver= new ScreenObserver()

def pointProxy= MultiInterceptorProxyMetaClass.getInstance( Point )
pointProxy.interceptors << colorObserver << coordinateObserver //multi-interception used here
pointProxy.use{

  def screenProxy= MultiInterceptorProxyMetaClass.getInstance( Screen )
  screenProxy.interceptors << screenObserver
  screenProxy.use{

    println("Creating Screen s1,s2,s3,s4,s5 and Point p")
    def s1= new Screen('s1'),
      s2= new Screen('s2'),
      s3= new Screen('s3'),
      s4= new Screen('s4'),
      s5= new Screen('s5')
    def p= new Point(5, 5, Color.blue)

    println("Creating observing relationships:")
    println(" - s1 and s2 observe color changes to p")
    println(" - s3 and s4 observe coordinate changes to p")
    println(" - s5 observes s2's and s4's display() method")

    colorObserver.addObserver(p, s1)
    colorObserver.addObserver(p, s2)
    coordinateObserver.addObserver(p, s3)
    coordinateObserver.addObserver(p, s4)
    screenObserver.addObserver(s2, s5)
    screenObserver.addObserver(s4, s5)

    println("Changing p's color:")
    p.setColor(Color.red)

    println("Changing p's x-coordinate:")
    p.setX(4)

    println("done.")
  }
}

/*output:
Creating Screen s1,s2,s3,s4,s5 and Point p
Creating observing relationships:
- s1 and s2 observe color changes to p
- s3 and s4 observe coordinate changes to p
- s5 observes s2's and s4's display() method
Changing p's color:
s1: Screen updated (point subject changed color).
s2: Screen updated (point subject changed color).
s5: Screen updated (screen subject changed message).
Changing p's x-coordinate:
s3: Screen updated (point subject changed coordinates).
s4: Screen updated (point subject changed coordinates).
s5: Screen updated (screen subject changed message).
done.
*/
```

Using a MultiInterceptorProxyMetaClass and UninterceptableFriendlyInterceptor for the Decorator pattern

We can use more than one uninterceptable interceptor with a proxy meta-class. A good example where this is necessary is the Decorator pattern. We re-use the MultiInterceptorProxyMetaClass from previous examples, but must write a special unintercepted interceptor, which we call an UninterceptableFriendlyInterceptor, that can be used as one of many with the

MultiInterceptorProxyMetaClass.

```
abstract class UninterceptedFriendlyInterceptor implements Interceptor{
    def proxy= null

    abstract Object doBefore( Object object, String methodName, Object[] arguments )

    public Object beforeInvoke(Object object, String methodName, Object[] arguments){
        def theInterceptors= proxy.interceptors
        proxy.interceptors= null
        def result
        try{
            result= doBefore(object, methodName, arguments)
        }catch(Exception e){
            throw e
        }finally{
            proxy.interceptors= theInterceptors
        }
        result
    }
    abstract boolean doInvoke()

    abstract Object doAfter( Object object, String methodName, Object[] arguments, Object result
    )

    public Object afterInvoke(Object object, String methodName, Object[] arguments, Object
    result){
        def theInterceptors= proxy.interceptors
        proxy.interceptors= null
        try{
            result= doAfter(object, methodName, arguments, result)
        }catch(Exception e){
            throw e
        }finally{
            proxy.interceptors= theInterceptors
        }
        result
    }
}
```

For our example Decorator pattern, we'll code an OutputStreamWriter that prints extra if necessary. We use decorators extended from the UninterceptableFriendlyInterceptor. Firstly, a NewlineDecorator that uses a line-width policy to perhaps place the output on a new line. And second, a very simple WhitespaceDecorator that ensures there's some whitespace between any two consecutive items output. Each has only very simple logic for this example.

```
abstract class PrintDecorator extends UninterceptedFriendlyInterceptor{
    abstract Object doBefore( Object object, String methodName, Object[] arguments )

    abstract Object doAfter( Object object, String methodName, Object[] arguments, Object result
    )

    //only execute the intercepted method if it's the last class in the chain of decorators
    around the method...
    boolean doInvoke(){ proxy.interceptors[-1] == this }
}

class NewlineDecorator extends PrintDecorator{
    int lineSizeSoFar= 0

    Object doBefore( Object object, String methodName, Object[] arguments ){
        if( methodName == 'leftShift' && arguments[0] instanceof String ){
            if( lineSizeSoFar + arguments[0].size() > 30){
                arguments[0]= '\r\n' + arguments[0]
                lineSizeSoFar= 0
            }else{
                lineSizeSoFar += arguments[0].size()
            }
        }
    }
}
```

```

    Object doAfter( Object object, String methodName, Object[] arguments, Object result ){
        result
    }
}

class WhitespaceDecorator extends PrintDecorator{
    def prevOutput= ' '

    Object doBefore( Object object, String methodName, Object[] arguments ){
        if( methodName == 'leftShift' && arguments[0] instanceof String ){
            if( prevOutput[-1] != ' ' && prevOutput[-1] != '\n' ){
                arguments[0] = ' ' + arguments[0]
            }
        }
    }

    Object doAfter( Object object, String methodName, Object[] arguments, Object result ){
        if( methodName == 'leftShift' && arguments[0] instanceof String ){
            prevOutput= arguments[0]
        }
        result
    }
}

```

After the classes, interceptors, and code block are matched up, the printing logic and the `OutputStreamWriter` are both unaware that the output is being decorated. Each decorator will perhaps modify the output, then pass it along to the next decorator to do the same. The distinct items of output sent to the `OutputStreamWriter` are separated by spaces, whether or not a space was in the output string in the program, and the output fits within a certain width.

```

oswProxy= MultiInterceptorProxyMetaClass.getInstance( OutputStreamWriter )
[ new NewlineDecorator(),
  new WhitespaceDecorator(), //the order of these decorators is important
].each{
    it.proxy= oswProxy
    oswProxy.interceptors << it
}
oswProxy.use{
    def wtr= new OutputStreamWriter( new FileOutputStream( new File('TheOutput.txt') ) )
    wtr<< "Singing in the Rain" <<
        "hello " <<
        "climate  " <<
        "hotrod" <<
        "far out and spacy" <<
        'Clementine, darling'
    wtr.close()
}

/*output file:
Singing in the Rain hello
climate  hotrod far out and spacy
Clementine, darling
*/

```


Installing Groovy

This page last changed on Jan 07, 2007 by [bl7385](#).

This document describes how to install a binary distribution of Groovy.

The latest release of Groovy is [groovy-1.0](#).

- [download](#) a binary distribution of Groovy and unpack the distribution into some file on your local file system.
- set your `GROOVY_HOME` environment variable to the directory you unpacked the distribution
- add `GROOVY_HOME/bin` to your `PATH` environment variable.
- set your `JAVA_HOME` environment variable to point to your JDK. On OS X this is `/Library/Java/Home`, on other unixes its often `/usr/java` etc. If you've already installed tools like Ant or Maven you've probably already done this step.
- you should now have Groovy installed properly. You can test this by typing the following in a command shell...

```
groovysh
```

Which should create an interactive groovy shell where you can type Groovy statements. Or to run the [Swing interactive console](#) type

```
groovyConsole
```

To run a specific groovy script type

```
groovy SomeScript.groovy
```

[Next](#)

Quick Start

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Before beginning...

Before playing with the examples you'll find below, you should first look at:

- [Installing Groovy](#)
- [Embedding Groovy](#)
- [Running](#)

Some optional more advanced topics you may also wish to peruse:

- [Command Line](#) : Groovy can be launched in shell script mode
- [Compiling Groovy](#) : Groovy can be launched as any java program
- [Bean Scripting Framework](#) : embedding groovy in java code

Your First Groovy

```
//hello.groovy
println "hello, world"
for (arg in this.args ) {
    println "Argument:" + arg;
}
// this is a comment
/* a block comment, commenting out an alternative to above:
this.args.each{ arg -> println "hello, ${arg}" }
*/
```

To run it from command line

```
groovy hello.groovy MyName yourName HisName
```

Overview

Groovy classes compile down to Java bytecode and so there's a 1-1 mapping between a Groovy class and a Java class.

Indeed each Groovy class can be used inside normal Java code - since it is a Java class too.

Probably the easiest way to get groovy is to try working with collections. In Groovy List (`java.util.List`) and Map (`java.util.Map`) are both first class objects in the syntax. So to create a List of objects you can do the following...

```
def list = [1, 2, 'hello', new java.util.Date()]
assert list.size() == 4
```

```
assert list.get(2) == 'hello'
assert list[2] == 'hello'
```

Notice that everything is an object (or that auto-boxing takes place when working with numbers). To create maps...

```
def map = ['name':'James', 'location':'London']
assert map.size() == 2
assert map.get('name') == 'James'
assert map['name'] == 'James'
```

Iterating over collections is easy...

```
def list = [1, 2, 3]
for (i in list) { println i }
```

Once you have some collections you can then use some of the new collection helper methods or try working with closures...

Working with closures

Closures are similar to Java's inner classes, except they are a single method which is invocable, with arbitrary parameters. A closure can have as many parameters as you wish...

```
def closure = { param -> println("hello ${param}") }
closure.call("world!")

closure = { greeting, name -> println(greeting + name) }
closure.call("hello ", "world!")
```

If no parameter(s) is(are) specified before -> symbol then a default named parameter, called 'it' can be used. e.g.

```
def closure = { println "hello " + it }
closure.call("world!")
```

Using closures allows us to process collections (arrays, maps, strings, files, SQL connections and so forth) in a clean way. e.g

```
[1, 2, 3].each ({ item -> print "${item}-" })
["k1":"v1", "k2":"v2"].each {key, value -> println key + "=" + value}
```

Note: If a given closure is the last parameter of a method, its definition can reside outside of the parentheses. Thus the following code is valid:

```
def fun(int i, Closure c) {
    c.call(i)
}
```

```
// put Closure out of ()
[1, 2, 3].each() ({ item -> print "${item}-" })
fun(123) { i -> println i }

// omit ()
[1, 2, 3].each ({ item -> print "${item}-" })

// normal
[1, 2, 3].each(({ item -> print "${item}-" }))

def closure = { i -> println i }

//[1, 2, 3].each() closure // error. closure has been defined
```

Here are a number of helper methods available on collections & strings...

each

iterate via a closure

```
[1, 2, 3].each { item -> print "${item}-" }
```

collect

collect the return value of calling a closure on each item in a collection

```
def value = [1, 2, 3].collect { it * 2 }
assert value == [2, 4, 6]
```

find

finds first item matching closure predicate

```
def value = [1, 2, 3].find { it > 1 }
assert value == 2
```

findAll

finds all items matching closure predicate

```
def value = [1, 2, 3].findAll { it > 1 }
assert value == [2, 3]
```

inject

allows you to pass a value into the first iteration and then pass the result of that iteration into the next

iteration and so on. This is ideal for counting and other forms of processing

```
def value = [1, 2, 3].inject('counting: ') { str, item -> str + item }
assert value == "counting: 123"

value = [1, 2, 3].inject(0) { count, item -> count + item }
assert value == 6
```

In addition there's 2 new methods for doing boolean logic on some collection...

every

returns true if all items match the closure predicate

```
def value = [1, 2, 3].every { it < 5 }
assert value

value = [1, 2, 3].every { item -> item < 3 }
assert ! value
```

any

returns true if any item match the closure predicate

```
def value = [1, 2, 3].any { it > 2 }
assert value

value = [1, 2, 3].any { item -> item > 3 }
assert value == false
```

Other helper methods include:

max / min

returns the max/min values of the collection - for Comparable objects

```
value = [9, 4, 2, 10, 5].max()
assert value == 10
value = [9, 4, 2, 10, 5].min()
assert value == 2
value = ['x', 'y', 'a', 'z'].min()
assert value == 'a'
```

join

concatenates the values of the collection together with a string value

```
def value = [1, 2, 3].join('-')  
assert value == '1-2-3'
```

Running

This page last changed on Mar 03, 2007 by [furashgf](#).

Groovy scripts are a number of statements and class declarations in a text file. Groovy scripts can be used similarly to other scripting languages. There are various ways of running Groovy scripts

Using the interactive console

Groovy has a Swing interactive console that allows you to type in commands and execute them rather like using an SQL query tool. History is available and such like so you can move forwards and backwards through commands etc.

If you [install](#) a binary distribution of Groovy then you can run the Groovy Swing console by typing this on the command line.

```
groovyConsole
```

For a command line interactive shell type

```
groovysh
```

To run the Swing Groovy console from a source distribution type...

```
maven console
```

To see how to add things to the classpath see below.

Running Groovy scripts from your IDE

There is a helper class called [GroovyShell](#)

which has a `main(String[])` method for running any Groovy script. You can run any groovy script as follows

```
java groovy.lang.GroovyShell foo/MyScript.groovy [arguments]
```

You can then run the above Groovy `main()` in your IDE to run or debug any Groovy script.

Running Groovy scripts from the command line

There are shell scripts called 'groovy' or 'groovy.bat' depending on your platform which is part of the Groovy runtime.

Once the runtime is [installed](#) you can just run groovy like any other script...

```
groovy foo/MyScript.groovy [arguments]
```

If you are using Groovy built from CVS Head (after Beta-5, see below if you want to upgrade), apart from Groovy scripts, you may also now run different kind of classes from the command-line.

- Classes with a main method of course,
- Classes extending GroovyTestCase are run with JUnit's test runner,
- Classes implementing the Runnable interface are instantiated either with a constructor with String[] as argument, or with a no-args constructor, then their run() method is called.

To work from the latest and greatest Groovy, do a cvs checkout and then type

```
maven groovy:make-install
```

You'll then have a full binary distribution made for you in groovy/target/install. You can then add groovy/target/install/bin to your path and you can then run groovy scripts easily from the command line.

To see how to add things to the classpath see below.

Creating Unix scripts with Groovy

You can write unix scripts with Groovy and execute them directly on the command line as if they were normal unix shell scripts. Providing you have installed the Groovy binary distribution (see above) and 'groovy' is on your PATH then the following should work.

The following is a sample script which is [in CVS](#)

. Save it as helloWorld.groovy.

```
#!/usr/bin/env groovy
println("Hello world")
for (a in this.args) {
    println("Argument: " + a)
}
```

Then to run the script from the command line, just make sure the script is executable then you can call it.


```
chmod +x helloWorld
./helloWorld
```

Adding things to the classpath

When running command line scripts or interactive shells you might want to add things to your classpath such as JDBC drivers or JMS implementations etc. To do this you have a few choices

- add things to your CLASSPATH environment variable
- pass -classpath (or -cp) into the command you used to create the shell or run the script
- It's also possible to create a `~/.groovy/lib` directory and add whatever jars you need in there.

Increasing Groovy's JVM Heap Size

To increase the amount of memory allocated to your groovy scripts, set your JAVA_OPTS environment variable. `JAVA_OPTS="-Xmx..."`

Readline support in groovysh

1. Add the attached groovysh-readline.jar into `~/.groovy/lib`
2. Build javareadline <http://java-readline.sourceforge.net/> and move jar and dll/so/jnilib into `~/.groovy/lib`

User Guide

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Welcome to the Groovy User Guide. We hope you find it useful.

The User Guide assumes you have already downloaded and installed Groovy. See the [Getting Started Guide](#) if this is not that case.

- [Advanced OO](#)
 - [Groovy way to implement interfaces](#)
- [Bean Scripting Framework](#)
- [Bitwise Operations](#)
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- [Input Output](#)
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 - [Creating XML with Groovy and DOM](#)
 - [Creating XML with Groovy and DOM4J](#)
 - [Creating XML with Groovy and JDOM](#)
 - [Creating XML with Groovy and XOM](#)
 - [Reading XML using Groovy's DOMCategory](#)
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 - [Reading XML with Groovy and DOM](#)
 - [Reading XML with Groovy and DOM4J](#)
 - [Reading XML with Groovy and Jaxen](#)
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Advanced OO

This page last changed on Dec 28, 2006 by [paulk_asert](#).

Groovy way to implement interfaces

This page last changed on Feb 15, 2007 by [gbarr](#).

Groovy provides some very convenient ways to implement interfaces.

Implement interfaces with a closure

An interface with a single method can be implemented with a closure like so:

```
new Thread(  
    {println "running"} as Runnable  
).start()
```

You can also use a closure to implement an interface with more than one method. The closure will be invoked for each method on the interface. Since you need a closure whose parameter list matches that of all of the methods you typically will want to use an array as the sole parameter. This can be used just as it is for any Groovy closure and will collect all of the arguments in an array. For example:

```
interface X  
{ void f(); void g(int n); void h(String s, int n); }  
  
x = {Object[] args -> println "method called with $args"} as X  
x.f()  
x.g(1)  
x.h("hello",2)
```

Implement interfaces with a map

More commonly an interface with multiple methods would be implemented with a map like so:

```
impl = [  
    i: 10,  
    hasNext: { impl.i > 0 },  
    next: { impl.i-- },  
]  
iter = impl as Iterator  
while ( iter.hasNext() )  
    println iter.next()
```

Note this is a rather contrived example, but illustrates the concept.

You only need to implement those methods that are actually called, but if a method is called that doesn't exist in the map a *NullPointerException* is thrown. For example:

```
interface X  
{ void f(); void g(int n); void h(String s, int n); }  
  
x = [ f: {println "f called"} ] as X  
x.f()  
//x.g()      // NPE here
```

Be careful that you don't accidentally define the map with { }. Can you guess what happens with the following?

```
x = { f: {println "f called"} } as X
x.f()
x.g(1)
```

What we've defined here is a closure with a label and a block. Since we've just defined a single closure every method call will invoke the closure. Some languages use { } to define maps so this is an easy mistake until you get used to using [:] to define maps in Groovy.

Note that using the "as" operator as above requires that you have a static reference to the interface you want to implement with a map. If you have a reference to the java.lang.Class object representing the interface (i.e. do not know or can not hard code the type at script write time) you want to implement, you can use the asType method like this:

```
def loggerInterface = Class.forName( 'my.LoggerInterface' )
def logger = [
    log : { Object[] params -> println "LOG: ${params[0]}"; if( params.length > 1 )
    params[1].printStackTrace() }
    close : { println "logger.close called" }
].asType( loggerInterface )
```

See also:

- [Developer Testing using Closures instead of Mocks](#)

Bean Scripting Framework

This page last changed on Oct 25, 2006 by [paulk_asert](#).

Groovy integrates cleanly with [BSF](#) (the Bean Scripting Framework) which allows you to embed any scripting engine into your Java code while keeping your Java code decoupled from any particular scripting engine specifics.

The BSF engine for Groovy is implemented by the [GroovyEngine](#) class; however, that fact is normally hidden away by the BSF APIs. You just treat Groovy like any of the other scripting languages via the BSF API.

Note: Groovy has its own native support for integration with Java. See [Embedding Groovy](#) for further details. So you only need to worry about BSF if you want to also be able to call other languages from Java, e.g. [JRuby](#) or if you want to remain very loosely coupled from your scripting language.

Getting started

Provided you have Groovy and BSF jars in your classpath, you can use the following Java code to run a sample Groovy script:

```
String myScript = "println('Hello World')\n  return [1, 2, 3]";
BSFManager manager = new BSFManager();
List answer = (List) manager.eval("groovy", "myScript.groovy", 0, 0, myScript);
assertEquals(3, answer.size());
```

Passing in variables

BSF lets you pass beans between Java and your scripting language. You can *register/unregister* beans which makes them known to BSF. You can then use BSF methods to *lookup* beans as required. Alternatively, you can *declare/undeclare* beans. This will register them but also make them available for use directly in your scripting language. This second approach is the normal approach used with Groovy. Here is an example:

```
manager.declareBean("xyz", new Integer(4), Integer.class);
Object answer = manager.eval("groovy", "test.groovy", 0, 0, "xyz + 1");
assertEquals(new Integer(5), answer);
```

Other calling options

The previous examples used the *eval* method. BSF makes multiple methods available for your use (see the [BSF documentation](#) for more details). One of the other available methods is *apply*. It allows you to define an anonymous function in your scripting language and apply that function to arguments. Groovy supports this function using closures. Here is an example:

```
Vector ignoreParamNames = null;
Vector args = new Vector();
args.add(new Integer(2));
args.add(new Integer(5));
args.add(new Integer(1));
Integer actual = (Integer) manager.apply("groovy", "applyTest", 0, 0,
    "def summer = { a, b, c -> a * 100 + b * 10 + c }", ignoreParamNames, args);
assertEquals(251, actual.intValue());
```

Access to the scripting engine

Although you don't normally need it, BSF does provide a hook that lets you get directly to the scripting engine. One of the functions which the engine can perform is to invoke a single method call on an object. Here is an example:

```
BSFEngine bsfEngine = manager.loadScriptingEngine("groovy");
manager.declareBean("myvar", "hello", String.class);
Object myvar = manager.lookupBean("myvar");
String result = (String) bsfEngine.call(myvar, "reverse", new Object[]{});
assertEquals("olleh", result);
```

Legacy points of interest

If you must integrate with early version of BSF (i.e. prior to **bsf 2.3.0-rc2**) then you'll need to manually register the Groovy language with BSF using the following snippet of code:

```
BSFManager.registerScriptingEngine(
    "groovy",
    "org.codehaus.groovy.bsf.GroovyEngine",
    new String[] { "groovy", "gy" }
);
```


Bitwise Operations

This page last changed on Nov 28, 2006 by [paulk_asert](#).

From Groovy 1.0 beta 10, Groovy supports bitwise operations:

<<, >>, >>>, |, &, ^, and ~.

	<u>Meaning</u>
<<	Bitwise Left Shift Operator
>>	Bitwise Right Shift Operator
>>>	Bitwise Unsigned Right Shift Operator
	Bitwise Or Operator
&	Bitwise And Operator
^	Bitwise Xor Operator
~	Bitwise Negation Operator
<<=	Bitwise Left Shift Assign Operator
>>=	Bitwise Right Shift Assign Operator
>>>=	Bitwise Unsigned Right Shift Assign Operator
=	Bitwise Or Assign Operator
&=	Bitwise And Assign Operator
^=	Bitwise Xor Operator

For example,

```
assert (1 << 2) == 4      // bitwise left shift
assert (4 >> 1) == 2      // bitwise right shift
assert (15 >>> 1) == 7    // bitwise unsigned right shift
assert (3 | 6) == 7       // bitwise or
assert (3 & 6) == 2       // bitwise and
assert (3 ^ 6) == 5       // bitwise xor
assert (~0xFFFFFFFF) == 1 // bitwise negation
```

Builders

This page last changed on Apr 15, 2007 by bruce@iterative.com.

Tree Based Syntax

Groovy has special syntax support for List and Maps. This is great because it gives a concise representation of the actual object being defined, so its easier to keep track of what a program or script is doing. But what about programs which contain arbitrary nested tree structures. Surely, they are the hardest ones to keep track of what is going on. Isn't that an area where syntactic help will be most beneficial?

The answer is definitely yes and Groovy comes to the party with its **builder** concept. You can use it for DOM-like APIs or Ant tasks or Jelly tags or Swing widgets or whatever. Each may have their own particular factory mechanism to create the tree of objects - however they can share the same builder syntax to define them - in a concise alternative to XML or lengthy programming code.

Example

[Note: the syntax in these examples is slightly out-dated. See chapter 8 of [GINA](#) in the mean-time until these examples are updated.]

Here's an example syntax

```
def f = framesize:[300,300], text:'My Window' {
  labelbounds:[10,10,290,30], text:'Save changes'
  panelbounds:[10,40,290,290] {
    buttontext:'OK', action:{ save close }
    buttontext:'Cancel', action:{ close }
  }
}
```

The above invokes a number of methods on the owner class using named-parameter passing syntax. Then the button method would create JButton etc. The { } is used to define a closure which adds its content to the newly created node. Also notice that the action parameter is passed as a closure - which is ideal for working with UI centric listeners etc.

Note that within the 'markup' you can embed normal expressions - i.e. this markup syntax is a normal part of the Groovy language. e.g.

```
def f = frametext: calculateFieldNamefoo, 1234

// lets iterate through some map
map = [1:"hello", 2:"there"]

for e in map {
  labelname:e.value
  textfieldname:e.value
}
}
```

Using this simple mechanism we can easily create any structured tree of data - or provide an event based

model too. Note in Groovy you can just overload the invokeMethodName, arguments to have a simple polymorphic tree creation - such as for DOM structures or Ant tasks or Jelly tags etc.

Here's an example of some HTML using some mixed content which is typically hard to do neatly in some markup languages

```
html {
  head {
    title"XML encoding with Groovy"
  }
  body {
    h1"XML encoding with Groovy"
    p"this format can be used as an alternative markup to XML"

    / an element with attributes and text content /
    ahref:'http://groovy.codehaus.org' ["Groovy"]

    / mixed content /
    p [
      "This is some",
      b"mixed",
      "text. For more see the",
      ahref:'http://groovy.codehaus.org' ["Groovy"],
      "project"
    ]
    p"some text"
  }
}
```

Finally here's an example of creating some namespaced XML structure XSD...

```
def xsd = xmlns.namespace'http://www.w3.org/2001/XMLSchema'
xsd.schemaxmlns=[xmlns.xsd:'http://www.w3.org/2001/XMLSchema'] {
  xsd.annotation {
    xsd.documentationxmlns=[xml.lang:'en'] ["Purchase order schema for Example.com."]
  }
  xsd.elementname:'purchaseOrder', type:'PurchaseOrderType'
  xsd.elementname:'comment', type:'xsd:string'
  xsd.complexTypename:'PurchaseOrderType' {
    xsd.sequence {
      xsd.elementname:'shipTo', type:'USAddress'
      xsd.elementname:'billTo', type:'USAddress'
      xsd.elementminOccurs:'0', ref:'comment'
      xsd.elementname:'items', type:'Items'
    }
    xsd.attributename:'orderDate', type:'xsd:date'
  }
  xsd.complexTypename:'USAddress' {
    xsd.sequence {
      xsd.elementname:'name', type:'xsd:string'
      xsd.elementname:'street', type:'xsd:string'
      xsd.elementname:'city', type:'xsd:string'
      xsd.elementname:'state', type:'xsd:string'
      xsd.elementname:'zip', type:'xsd:decimal'
    }
    xsd.attribute:'US', name:'country', type:'xsd:NMTOKEN'
  }
  xsd.complexTypename:'Items' {
    xsd.sequence {
      xsd.elementmaxOccurs:'unbounded', minOccurs:'0', name:'item' {
        xsd.complexType {
          xsd.sequence {
            xsd.elementname:'productName', type:'xsd:string'
            xsd.elementname:'quantity' {
              xsd.simpleType {
                xsd.restrictionbase:'xsd:positiveInteger' {
                  xsd.maxExclusivevalue:'100'
                }
              }
            }
          }
        }
      }
    }
  }
}
```

```

        }
        xsd.elementname:'USPrice', type:'xsd:decimal'
        xsd.elementminOccurs:'0', ref:'comment'
        xsd.elementminOccurs:'0', name:'shipDate', type:'xsd:date'
    }
    xsd.attributename:'partNum', type:'SKU', use:'required'
}
}
}
}
}
/ Stock Keeping Unit, a code for identifying products /
xsd.simpleTypeName:'SKU' {
    xsd.restrictionbase:'xsd:string' {
        xsd.patternvalue:'\d{3}-[A-Z]{2}'
    }
}
}
}

```

There's a converter org.codehaus.groovy.tools.xml.DomToGroovy from XML to groovy markup so you can try out this new markup language on any XML documents you have already.

References

List references if any

Comments

Comments below -

Having a format output for Excel would be "groovy". One could plug in HSSF from the jakarta poi project.

The html example above does not run using groovy 1.0 beta 5. It does not seem to like the mixed content a'link' ["The Text"] syntax.

To output elements or attributes with a '-' in their name, you need to use '_' in Groovy. For example, to generate a web-app descriptor for a Servlet app:

```

def builder = new groovy.xml.MarkupBuilder
builder.web_app {
    display_name"My Web Application"
}

```

generates:

```

<web-app>
  <display-name>My Web Application</display-name>
</web-app>

```

Which leaves the question of how to generate elements with '-' in the name.

Closures

This page last changed on Dec 21, 2006 by [blackdrag](#).

Informal Guide

When using the Java programming language most executable code is enclosed in either static class methods or instance methods. (Code can also be enclosed in constructors, initializers, and initialization expressions, but those aren't important here.) A method encloses code within curly brackets and assigns that block of code a method name. All such methods must be defined inside of a class of some type. For example, if you were to write a method that returned the square of any integer it may look like this:

```
package example.math;

public class MyMath {
    public static int square(int numberToSquare){
        return numberToSquare * numberToSquare;
    }
}
```

Now in order to use the `square()` method you need to reference the class and the method by name as follows:

```
import example.math.MyMath;
...
int x, y;
x = 2;
y = MyMath.square(x); // y will equal 4.
```

You can do the same thing in Groovy, but in groovy you can alternatively define the code without having to declare a class and a method as follows:

```
{ numberToSquare -> numberToSquare * numberToSquare }
```

In Groovy, this anonymous code block is referred to as a **closure** definition (see the Formal Guide section below for a more elaborate definition of terms). A closure definition is one or more program statements enclosed in curly brackets. A key difference between a closure and method is that closures do not require a class or a method name.

As you can see, the executable code is the same except you didn't need to declare a class or assign the code a method name. While illustrative, the previous example is not all that useful because there is no way to use that closure once its created. It has no identifier (method name) so how can you call it? To fix that you assign the closure to a variable when it's created. You can then treat that variable as the identifier of the closure and make calls on it.

The following shows the `square()` method re-written as a closure:

```
def x = 2
```

```
// define closure and assign it to variable 'c'
def c = { numberToSquare -> numberToSquare * numberToSquare }

// using 'c' as the identifier for the closure, make a call on that closure
def y = c(x)           // shorthand form for applying closure, y will equal 4
def z = c.call(x)      // longhand form, z will equal 4
```

What is really nice about closures is that you can create a closure, assign it to a variable, and then pass it around your program like any other variable. At first this seems a bit, well useless, but as you learn more about Groovy you'll discover that closures are used all over the place.

As an example, let's extend the `java.util.Vector` class from Java by adding a single method that allows you to apply a closure to every element in the vector. My new class, `GVector`, looks as follows:

```
package example

public class GVector extends java.util.Vector {
    public void apply( c ){
        for (i in 0..<size()){
            this[i] = c(this[i])
        }
    }
}
```

The `apply()` method takes a closure as an input parameter. For each element in the `GVector`, the closure is called passing in the element. The resulting value is then used to replace the element. The idea is that you can modify the contents of the `GVector` in place using a closure which takes each element and converts into something else.

Now we can call our new `apply()` method with any closure we want. For example, we will create a new `GVector`, populate it with some elements, and pass in the closure we created earlier, the one that squares an integer value.

```
import example
def gVect = new GVector()
gVect.add(2)
gVect.add(3)
gVect.add(4)

def c = { numberToSquare -> numberToSquare * numberToSquare }

gVect.apply(c) // the elements in the GVector have all been squared.
```

Because the `apply()` method on the `GVector` can be used with any closure, you can use any closure. For example, the following uses a closure that simply prints out the item its passed.

```
import example
def gVect = new GVector()
gVect.add(2)
gVect.add(3)
gVect.add(4)

def c2 = { value -> println(value) }

gVect.apply(c2) // the elements in the GVector have all been printed.
```

If you were to run the above script, assuming `GVector` from earlier is on your classpath, the output would

look like this:

```
C:/> groovy myscript.groovy
4
9
16
C:/>
```

In addition to assigning closures to variables, you can also declare them directly as arguments to methods. For example, the above code could be re-written in the following manner:

```
import example
def gVect = new GVector()
gVect.add(2)
gVect.add(3)
gVect.add(4)

gVect.apply{ value -> println(value) } // elements in GVector have been printed.
```

This example accomplishes the same thing as the first, but the closure is defined directly as an argument to the apply method of GVector.

The other important difference of a closure to a normal method is that a closure can refer to variables from the scope in which it is called (in fact this is where this language construct gets its name). Here is an example:

```
class Employee {
    def salary
}
def highPaid(emps) {
    def threshold = 150
    return emps.findAll{ e -> e.salary > threshold }
}

def emps = [180, 140, 160].collect{ val -> new Employee(salary:val) }

println emps.size() // prints 3
println highPaid(emps).size() // prints 2
```

In this example, the closure block { e -> e.salary > threshold } refers to the threshold variable defined in the highPaid() method. The example also used a closure to create the emps list.

Closures vs. Code Blocks

A closure looks a lot like a regular Java or Groovy code block, but actually it's not the same. The code within a regular code block (whether its a method block, static block, synchronized block, or just a block of code) is executed by the virtual machine as soon as it's encountered. With closures the statements within the curly brackets are not executed until the call() is made on the closure. In the previous example the closure is declared in line, but it's not executed at that time. It will only execute if the call() is explicitly made on the closure. This is an important differentiator between closures and code blocks. They may look the same, but they are not. Regular Java and Groovy blocks are executed the moment they are encountered; closures are only executed if the call() is invoked on the closure.

Formal Guide

A closure in Groovy is an anonymous chunk of code that may take arguments, return a value, and reference and use variables declared in its surrounding scope. In many ways it resembles anonymous inner classes in Java, and closures are often used in Groovy in the same way that Java developers use anonymous inner classes. However, Groovy closures are much more powerful than anonymous inner classes, and far more convenient to specify and use.

In functional language parlance, such an anonymous code block might be referred to as an anonymous lambda expression in general or lambda expression with unbound variables or a closed lambda expression if it didn't contain references to unbound variables (like `threshold` in the earlier example). Groovy makes no such distinction.

Strictly spoken a closure can't be defined. You can define a block of code that refers to local variables or fields/properties, but it becomes a closure only when you "bind" (give it a meaning) this block of code to variables. The closure is a semantic concept, like an instance, which you cannot define, just create. Strictly spoken a closure is only a closure if all free variables are bound. Unless this happens it is only partially closed, hence not really a closure. Since Groovy doesn't provide a way to define a closed lambda function and a block of code might not be a closed lambda function at all (because it has free variables), we refer to both as closure - even as syntactic concept. We are talking about it as syntactic concept, because the code of defining and creating an instance is one, there is no difference. We very well know that this terminology is more or less wrong, but it simplifies many things when talking about code in a language that doesn't "know" the difference.

Syntax for Defining a Closure

A closure definition follows this syntax:

```
{ [closureArguments->] statements }
```

Where `[closureArguments->]` is an optional comma-delimited list of arguments, and `statements` are 0 or more Groovy statements. The arguments look similar to a method's parameter list, and these arguments may be typed or untyped. When a parameter list is specified, the `->` character is required and serves to separate the arguments from the closure body. The *statements* portion consists of 0, 1, or many Groovy statements.

Some examples of valid closure definitions:

```
{ item++ }  
  
{ println it }  
  
{ ++it }  
  
{ name -> println name }  
  
{String x, int y -> println "hey $x the value is $y"}  
  
{ reader ->  
  while (true) {  
    line = reader.readLine()  
  }  
}
```



```
}
```

++++ Note: The examples could definitely be made more real-life MWS

Closure semantics

Closures appear to be a convenient mechanism for defining something like an inner class, but the semantics are in fact more powerful and subtle than what an inner class offers. In particular, the properties of closures can be summarized in this manner:

1. They have one implicit method (which is never specified in a closure definition) called `doCall()`
2. A closure may be invoked via the `call()` method, or with a special syntax of an unnamed `()` invocation. Either invocation will be translated by Groovy into a call to the Closure's `doCall()` method.
3. Closures may have 1...N arguments, which may be statically typed or untyped. The first parameter is available via an implicit untyped argument named *it* if no explicit arguments are named. If the caller does not specify any arguments, the first parameter (and, by extension, *it*) will be null.
4. The developer does not have to use *it* for the first parameter. If they wish to use a different name, they may specify it in the parameter list.
5. Closures always return a value. This may occur via either an explicit *return* statement, or as the value of the last statement in the closure body (e.g. an explicit return statement is optional).
6. A closure may reference any variables defined within its enclosing lexical scope. Any such variable is said to be bound to the closure
7. Any variables bound to a closure are available to the closure even when the closure is returned outside of the enclosing scope.
8. Closures are first class objects in Groovy, and are always derived from the class *Closure*. Code which uses closures may reference them via untyped variables or variables typed as *Closure*.
9. The body of a closure is not executed until it is explicitly invoked e.g. a closure is not invoked at its definition time
10. A closure may be *curried* so that one a copy the closure is made with one or more of its parameters fixed to a constant value

These properties are explained further in the following sections.

Closures are anonymous

Closures in Groovy are always represented as anonymous blocks. Unlike a Java or Groovy class, you cannot have a named closure. You may however reference closures using untyped variables or variables of type *Closure*, and pass such references as method arguments and arguments to other closures.

Implicit method.

Closures are considered to have one implicitly defined method, which corresponds to the closure's arguments and body. You cannot override or redefine this method. This method is always invoked by the `call()` method on the closure, or via the special unnamed `()` syntax. The implicit method name is `doCall()`.

Closure Arguments

A closure always has at least one argument, which will be available within the body of the closure via the implicit parameter *it* if no explicit parameters are defined. The developer never has to declare the *it* variable - like the *this* parameter within objects, it is implicitly available.

If a closure is invoked with zero arguments, then *it* will be null.

Explicit closure arguments may be specified by the developer as defined in the syntax section. These arguments are a list of 1 or more argument names which are comma separated. The parameter list is terminated with a `->` character. Each of these arguments may be specified "naked" e.g. without a type, or with an explicit static type. If an explicit parameter list is specified, then the *it* variable is not available.

For arguments that have a declared type, this type will be checked *at runtime*. If a closure invocation has 1 or more arguments which do not match the declared argument type(s), then an exception will be thrown at runtime. Note that this argument type checking always occurs at runtime; there is no static type checking involved, so the compiler will not warn you about mis-matched types.

Groovy has special support for excess arguments. A closure may be declared with its last argument of type *Object[]*. If the developer does this, any excess arguments at invocation time are placed in this array. This can be used as a form of support for variable numbers of arguments. For example:

```
def c = {  
    format, Object[] args ->  
        aPrintfLikeMethod (format, args)}  
c ("one", "two", "three");  
c ("1");
```

Both invocations of *c* are valid. Since the closure defines two arguments (*format* and *args*) and the last argument is of type *Object[]*, the first parameter in any call to *c* will be bound to the *format* argument and the remaining parameters will be bound to the *args* argument. In the first call of *c* the closure will receive the parameter *args* with 2 elements ("two", "three") while the *format* parameter will contain the string "one". In the second call the closure will receive the parameter *args* with no elements and the *format* parameter will contain the string "1".

++++ *What Exception is thrown? MWS*

Closure Return Value

Closures always have a return value. The value may be specified via one or more explicit *return* statement in the closure body, or as the value of the last executed statement if *return* is not explicitly specified. If the last executed statement has no value (for example, if the last statement is a call to a void method), then null is returned.

There is currently no mechanism for statically declaring the return type of a closure.

References to External Variables

Closures may reference variables external to their own definition. This includes local variables, method parameters, and object instance members. However, a closure may only reference those variables that

the compiler can lexically deduce from the physical location of the closure definition within the source file.

Some examples might serve to clarify this. The following example is valid and shows a closure using a method's local variables and a method parameter:

```
public class A {
    private int member = 20;

    private String method()
    {
        return "hello";
    }

    def publicMethod (String name_)
    {
        def localVar = member + 5;
        def localVar2 = "Parameter: ${name_}";
        return {
            println "${member} ${name_} ${localVar} ${localVar2} ${method()}"
        }
    }
}

A sample = new A();
def closureVar = sample.publicMethod("Xavier");
closureVar();
```

The above code will print out:

```
20 Xavier 25 Parameter: Xavier hello
```

Looking at the definition of class *A*, the closure inside of *publicMethod* has access to all variables that *publicMethod* may legally access. This is true whether the variables are local variables, parameters, instance members, or method invocations.

When a closure references variables in this way, they are bound to the closure. At the same time, the variables are still available normally to the enclosing scope, so the closure may read/change any such values, and code from the outer scope may read/change the same variables.

If such a closure is returned from its enclosing scope, the variables bound with the closure also live on. This binding occurs when the closure is instantiated. If an object method or instance member is used within a closure, then a reference to that object is stored within the closure. If a local variable or parameter is referenced, then the compiler re-writes the local variable or parameter reference so that the local variable or parameter is taken off the stack and stored in an heap based object.

It's important to keep in mind that these references only are ever allowed according to the lexical structure available to the compiler (in this case, the *A* class). This process does *not* occur dynamically by looking at the call stack. So the following will not work:

```
class A {
    private int member = 20;

    private void method()
    {
        return "hello";
    }
}
```

```

def publicMethod (String name_)
{
    def localVar = member + 5;
    def localVar2 = "Parameter: name_";
    return {
        // Fails!
        println "${member} ${name_} ${localVar} ${localVar2} ${method()} ${bMember}"
    }
}

class B {
    private int bMember = 12;

    def bMethod (String name_)
    {
        A aInsideB = new A();
        return (aInsideB.publicMethod (name_));
    }
}

B aB = new B();
closureVar = aB.publicMethod("Xavier");
closureVar();

```

The above code is similar to the first example, except that we now have a class *B* which dynamically instantiates an object of type *A* and then calls *A*.publicMethod(). However, in this code the closure within publicMethod() is trying to reference a member from *B*, and this is not allowed since the compiler cannot statically determine that this is available. Some older languages allowed this sort of reference to work, by dynamically examining the call stack at runtime, but this is disallowed in Groovy.

Groovy supports the special *owner* variable which can be used when a closure argument is hiding an object member variable. For example:

```

class HiddenMember {
    private String name;

    getClosure (String name)
    {
        return { name -> println (name)}
    }
}

```

In the above code the *println (name)* call is referencing the parameter *name*. If the closure needs to access the name instance variable of class HiddenMember, it can use the owner variable to indicate this:

```

class HiddenMember {
    private String name;

    getClosure (String name)
    {
        return { name -> println ("Argument: ${name}, Object: ${owner.name}")}
    }
}

```

The Closure Type

All closures defined in Groovy are derived from the type *Closure*. Each unique closure definition with a Groovy program creates a new unique class which extends *Closure*. If you wish to specify the type of a closure in a parameter, local variable, or object member instance, then you should use the *Closure* type.

The exact type of a closure is not defined unless you are explicitly subclasses the Closure class. Using this example:

```
def c = { println it }
```

The exact type of the closure referenced by `c` is not defined, we know only that it is a subclass of *Closure*.

Closure creation and invocation

Closures are created implicitly when their surrounding scope encounters them. For example, in the following code two closures are created:

```
class A {
    private int member = 20;

    private method()
    {
        println ("hello");
    }

    def publicMethod (String name_)
    {
        def localVar = member + 5
        def localVar2 = "Parameter: name_";
        return {
            println "${member} ${name_} ${localVar} ${localVar2} ${method()}"
        }
    }
}

A anA = new A();
closureVar = anA.publicMethod("Xavier");
closureVar();
closureVar2 = anA.publicMethod("Xavier");
closureVar2();
```

In the above example, *closureVar* holds a reference to a different closure object than *closureVar2*. Closures are always implicitly created in this manner - you cannot *new* a closure programmatically.

Closures may be invoked using one of two mechanisms. The explicit mechanism is to use the `call()` method:

```
closureVar.call();
```

You may also use the implicit nameless invocation approach:

```
closureVar();
```

If you are looking at the Closure javadoc, you may notice that the `call` method within the Closure class is defined as:

```
public Object call (Object[] args);
```

Despite this method signature, you do not have to manually write code to turn parameters into the `Object[]` array. Instead, invocations use the normal method argument syntax, and Groovy converts such calls to use an object array:

```
closure ("one", "two", "three")
closure.call ("one", "two", "three")
```

Both calls above are legal Groovy. However, if you are dealing with a Closure from Java code you will need to create the `Object[]` array yourself 😊

Fixing Closure Arguments to Constant Values Via Currying

You can fix the values for one or more arguments to a closure instance using the `curry()` method from the *Closure* type. In fact, this action is often referred to as currying in functional programming circles, and the result is generally referred to as a *Curried Closure*. Curried closures are very useful for creating generic closure definitions, and then creating several curried versions of the original with differing parameters bound to them.

When the `curry()` method is called on a closure instance with one or more arguments, a copy of the closure is first made. The incoming arguments are then bound permanently to the new closure instance so that the parameters 1..*N* to the `curry()` call are bound to the 1..*N* parameters of the closure. The new *curried closure* is then returned the caller.

Callers to the new instance will have their invocation parameters bound to the new closure in the *N*+1 parameter position of the original closure.

A simple example of this would be:

```
def c = { arg1, arg2-> println "${arg1} ${arg2}" }
def d = c.curry("foo")
d("bar")
```

The above code defines a closure *c*, and then calls *c.curry("foo")*. This returns a curried closure with the *arg1* value permanently bound to the value "foo". On the invocation *d("bar")*, the "bar" parameter comes into the closure in the *arg2* argument. The resulting output would be *foo bar*.

See also: [Functional Programming](#)

Special Case: Passing Closures to Methods

Groovy has a special case for defining closures as method arguments to make the closure syntax easier to read. Specifically, if the last argument of a method is of type *Closure*, you may invoke the method with an explicit closure block outside of the parenthesis. For example, if a class has a method:

```
class SomeCollection {
    public void each (Closure c)
}
```

Then you may invoke `each()` with a closure definition outside of the parenthesis:

```
SomeCollection stuff = new SomeCollection();
stuff.each() { println it }
```

The more traditional syntax is also available, and also note that in Groovy you can elide parenthesis in many situations, so these two variations are also legal:

```
SomeCollection stuff = new SomeCollection();
stuff.each { println it }      // Look ma, no parens
stuff.each ({ println it })    // Strictly traditional
```

The same rule applies even if the method has other arguments. The only restriction is that the Closure argument must be last:

```
class SomeCollection {
    public void inject (x, Closure c)
    }

    stuff.inject(0) {count, item -> count + item }    // Groovy
    stuff.inject(0, {count, item -> count + item })    // Traditional
```

This syntax is only allowed when explicitly defining a closure within the method call. You cannot do this with a variable of type closure, as this example shows:

```
class SomeCollection {
    public void inject (x, Closure c)
    }

    counter = {count, item -> count + item }
    stuff.inject(0) counter                        // Illegal! No Groovy for you!
```

When you are not defining a closure inline to a method call, you cannot use this syntax and must use the more verbose syntax:

```
class SomeCollection {
    public void inject (x, Closure c)
    }

    def counter = {count, item -> count + item }
    stuff.inject(0,counter)
```

Comparing Closures to Anonymous Inner Classes

Groovy includes closures because they allow the developer to write more concise and more easily understood code. Where Java developers may use single-method interfaces (Runnable, the Command pattern) combined with anonymous inner classes, Groovy allows you to accomplish the same sort of tasks in a less verbose manner. In addition, closures have fewer constraints than anonymous inner classes and include extra functionality.

Most closures are relatively short, isolated, and anonymous snippets of code that accomplish one specific

job. Their syntax is streamlined to make closure definitions very short and easy to read without additional clutter. For example, in Java code you might see code like this for an imaginary GUI system:

```
Button b = new Button ("Push Me");
b.onClick (new Action() {
    public void execute (Object target)
    {
        buttonClicked();
    }
});
```

The same code in Groovy would look like this:

```
Button b = new Button ("Push Me");
b.onClick { buttonClicked() }
```

The Groovy code accomplishes the same task but is much clearer and without extra syntactical clutter. This is the first

rule of Groovy closures - closures are trivially easy to write. In addition, closures may reference any variables in its outer

defining scope without the restrictions of anonymous inner classes - in particular, such variables do not need to be final.

Closures also carry their state around with them, even when they reference local variables and parameters. Closures may also take advantage of Groovy's optional dynamic typing so that you don't have to statically declare all of your closure arguments or return types (in fact, a Groovy closure can take varying numbers of parameters from invocation to invocation).

What Groovy closures lack compared to an approach using Command-like interfaces is the level of static typing involved. A Java interface rigidly enforces what type of objects can be used and the method(s) that may be called in it. In Groovy, all closures type equally as *Closure* and type checking of arguments (if specified in the closure definition) is deferred until Runtime.

Closures as map keys and values

It's possible to put closures in a map, both as keys and values.

Closures as keys

You can use a closure as a key. However, when putting it into the map you must "escape" it (as you would any other identifier you don't want treated as a string) by enclosing it in parens, like so:

```
f = { println "f called" }
m = [ (f): 123 ]
```

When accessing the value of the closure in the map you must use `get(f)` or `m[f]` as `m.f` will treat `f` as a string.


```
println m.get(f)      // 123
println m[f]          // 123
println m.f           // null
```

Closures as values

You can use a closure as a value. When invoking it though you must parenthesize the access, else it's treated as a call to a method on the map. If you don't like this syntax you might opt for using an `Expando`.

```
m = [ f: { println 'f called' } ]
//m.f()    // MissingMethodException
(m.f)()    // f called

m = new Expando( f: { println 'f called' } )
m.f()      // f called
```

Extending groovy with the use directive

You can provide your own specialized methods supporting closures by implementing a Java class containing such methods. These methods must be static and contain at least two parameters. The *first* parameter to the method must be the type on which the method should operate, and the *last* parameter must be a Closure type.

Consider the example below, which is a variant of the `eachFile` method which simply ignores files, and just prints the directories within the `dir` object on which the method operates.

```
dir = new File("/tmp")
use(ClassWithEachDirMethod.class) {
    dir.eachDir {
        println it
    }
}
```

Take note of the `use()` directive. This will tell groovy where the `eachDir` method is implemented. Below is the Java code required to support the `eachDir` method on the `File` object, as shown.

```
public class ClassWithEachDirMethod {
    public static void eachDir(File self, Closure closure) {
        File[] files = self.listFiles();
        for (int i = 0; i < files.length; i++) {
            if (files[i].isDirectory()) {
                closure.call(files[i]);
            }
        }
    }
}
```

To support additional parameters, these should be placed between the first and last.

Collections

This page last changed on Apr 10, 2007 by [tomstrummer](#).

Groovy has native language support for collections, lists, maps and arrays.

Lists

You can create lists as follows. Notice that [] is the empty list expression.

```
def list = [5, 6, 7, 8]
assert list.get(2) == 7
assert list[2] == 7
assert list instanceof java.util.List

def emptyList = []
assert emptyList.size() == 0
emptyList.add(5)
assert emptyList.size() == 1
```

Each list expression creates an implementation of [java.util.List](#).

See [Groovy Lists and Sets](#) for more indepth information.

Ranges

Ranges allow you to create a list of sequential values. These can be used as Lists since [Range](#) extends [java.util.List](#)

Ranges defined with the .. notation are inclusive (that is the list contains the from and to value).

Ranges defined with the ..< notation are exclusive, they include the first value but not the last value.

```
// an inclusive range
def range = 5..8
assert range.size() == 4
assert range.get(2) == 7
assert range[2] == 7
assert range instanceof java.util.List
assert range.contains(5)
assert range.contains(8)

// lets use an exclusive range
range = 5..<8
assert range.size() == 3
assert range.get(2) == 7
assert range[2] == 7
assert range instanceof java.util.List
assert range.contains(5)
assert ! range.contains(8)
```

Note that ranges are implemented efficiently, creating a lightweight Java object containing a from and to value.

Ranges can be used for any Java object which implements [java.lang.Comparable](#) for comparison and also have methods next() and previous() to return the next / previous item in the range.

e.g. you can use Strings in a range

```
// an inclusive range
def range = 'a'..'d'
assert range.size() == 4
assert range.get(2) == 'c'
assert range[2] == 'c'
assert range instanceof java.util.List
assert range.contains('a')
assert range.contains('d')
assert ! range.contains('e')
```

Ranges can be used to iterate using the `for` statement.

```
for (i in 1..10) {
    println "Hello ${i}"
}
```

but alternatively you can achieve the same effect, by iterating a range with *each* method:

```
(1..10).each { i ->
    println "Hello ${i}"
}
```

Ranges can be also used in the `switch` statements:

```
switch (years) {
    case 1..10: interestRate = 0.076; break;
    case 11..25: interestRate = 0.052; break;
    default: interestRate = 0.037;
}
```

Maps

Maps can be created using the following syntax. Notice that `[:]` is the empty map expression.

Map keys are strings by default: `[a:1]` is equivalent to `["a":1]`. But if you really want a variable to become the key, you have to wrap it between parentheses: `[(a):1]`.

```
def map = [name:"Gromit", likes:"cheese", id:1234]
assert map.get("name") == "Gromit"
assert map.get("id") == 1234
assert map["name"] == "Gromit"
assert map['id'] == 1234
assert map instanceof java.util.Map

def emptyMap = [:]
assert emptyMap.size() == 0
emptyMap.put("foo", 5)
assert emptyMap.size() == 1
assert emptyMap.get("foo") == 5
```

Maps also act like beans so you can use the property notation to get/set items inside the Map provided that the keys are Strings which are valid Groovy identifiers.

```
def map = [name:"Gromit", likes:"cheese", id:1234]
assert map.name == "Gromit"
assert map.id == 1234

def emptyMap = [:]
assert emptyMap.size() == 0
emptyMap.foo = 5
assert emptyMap.size() == 1
assert emptyMap.foo == 5
```

Note: by design map.foo will always look for the key foo in map. This means foo.class will return null on an empty map and not result in calling the method getClass()

See [Groovy Maps Indepth](#) for more information on maps and sorted maps.

Getting efficient with the star-dot '*' operator

You can perform operations on all the members of a collection using the '*' operator, e.g.:

```
assert [1, 3, 5] == ['a', 'few', 'words']*.size()
```

Slicing with the subscript operator

You can index into Strings, Lists, arrays, Maps, regexs and such like using the subscript expression.

```
def text = "nice cheese gromit!"
def x = text[2]

assert x == "c"
assert x.class == String

def sub = text[5..10]
assert sub == 'cheese'

def map = [name:"Gromit", likes:"cheese", id:1234]

assert map["name"] == "Gromit"
assert map.name == "Gromit"

def list = [10, 11, 12]
def answer = list[2]
assert answer == 12
```

Notice that you can use ranges to extract part of a List/array/String/regex. This is often referred to as *slicing* in scripting languages like Python. You can also use a list of indexes too.

```
def list = 100..200
def sub = list[1, 3, 20..25, 33]
assert sub == [101, 103, 120, 121, 122, 123, 124, 125, 133]
```

You can update items using the subscript operator too

```
def list = ["a", "b", "c"]
list[2] = "d"
list[0] = list[1]
list[3] = 5
assert list == ["b", "b", "d", 5]
```

You can use negative indices to count from the end of the List, array, String etc.

```
def text = "nice cheese gromit!"
def x = text[-1]
assert x == "!"

def name = text[-7..-2]
assert name == "gromit"
```

Also if you use a backwards range (the starting index is greater than the end index) then the answer is reversed.

```
def text = "nice cheese gromit!"
def name = text[3..1]
assert name == "eci"
```

Dynamic objects (Expandos)

The Expando is not a collection in the strictest sense, but in some ways it is similar to a Map, or objects in JavaScript that do not have to have their properties defined in advance. It allows you to create dynamic objects by making use of Groovy's [closure mechanisms](#). An [Expando](#) is different from a map in that you can provide synthetic methods that you can call on the object.

```
def player = new Expando()
player.name = "Dierk"
player.greeting = { "Hello, my name is $name" }

println player.greeting()
player.name = "Jochen"
println player.greeting()
```

The player.greeting assignment passes in a [closure](#) to execute when greeting() is called on the [Expando](#). Notice that the closure has access to the properties assigned to the [Expando](#), even though these values may change over time, using Groovy's [GString](#) "\$variableOrProperty" notation.

Control Structures

This page last changed on Sep 27, 2006 by [paulk_asert](#).

- [Logical Branching](#)
- [Looping](#)

Logical Branching

This page last changed on Sep 27, 2006 by [paulk_asert](#).

Groovy supports the usual if - else syntax from Java

```
def x = false
def y = false

if ( !x ) {
    x = true
}

assert x == true

if ( x ) {
    x = false
} else {
    y = true
}

assert x == y
```

Groovy also supports the ternary operator

```
def y = 5
def x = (y > 1) ? "worked" : "failed"
assert x == "worked"
```

switch statement

The switch statement in Groovy is backwards compatible with Java code; so you can fall through cases sharing the same code for multiple matches.

One difference though is that the Groovy switch statement can handle any kind of switch value and different kinds of matching can be performed.

```
def x = 1.23
def result = ""

switch ( x ) {
    case "foo":
        result = "found foo"
        // lets fall through

    case "bar":
        result += "bar"

    case [4, 5, 6, 'inList']:
        result = "list"
        break

    case 12..30:
        result = "range"
        break

    case Integer:
        result = "integer"
        break
}
```

```
case Number:
    result = "number"
    break

default:
    result = "default"
}

assert result == "number"
```

Switch supports the following kinds of comparisons

- Class case values matches if the switchValue is an instance of the class
- Regular expression case value matches if the string of the switchValue matches the regex
- Collection case value matches if the switchValue is contained in the collection. This also includes ranges too (since they are Lists)
- if none of the above are used then the case value matches if the case value equals the switch value

How switch works

The case statement performs a *match* on the case value using the *isCase(switchValue)* method, which defaults to *call equals(switchValue)* but has been overloaded for various types like Class or regex etc.

So you could create your own kind of matcher class and add an *isCase(switchValue)* method to provide your own kind of matching.

Looping

This page last changed on Mar 05, 2007 by [sylphy](#).

Groovy supports the usual while {...} loops like Java.

```
def x = 0
def y = 5

while ( y-- > 0 ) {
    x++
}

assert x == 5
```

for loop

The for loop in Groovy is much simpler and works with any kind of array, collection, Map etc.

Note: the standard for loop is not implemented by beta-10.

// for (int i = 0; i < 5; ++i) // not implemented by beta-10.

```
// iterate over a range
def x = 0
for ( i in 0..9 ) {
    x += i
}
assert x == 45

// iterate over a list
x = 0
for ( i in [0, 1, 2, 3, 4] ) {
    x += i
}
assert x == 10

// iterate over an array
array = (0..4).toArray()
x = 0
for ( i in array ) {
    x += i
}
assert x == 10

// iterate over a map
def map = ['abc':1, 'def':2, 'xyz':3]
x = 0
for ( e in map ) {
    x += e.value
}
assert x == 6

// iterate over values in a map
x = 0
for ( v in map.values() ) {
    x += v
}
assert x == 6

// iterate over the characters in a string
def text = "abc"
def list = []
for (c in text) {
    list.add(c)
}
assert list == ["a", "b", "c"]
```

closures

In addition, you can use closures in place of most for loops, using `each()` and `eachWithIndex()`:

```
def stringList = [ "java", "perl", "python", "ruby", "c#", "cobol",
                  "groovy", "jython", "smalltalk", "prolog", "m", "yacc" ];

def stringMap = [ "Su" : "Sunday", "Mo" : "Monday", "Tu" : "Tuesday",
                  "We" : "Wednesday", "Th" : "Thursday", "Fr" : "Friday",
                  "Sa" : "Saturday" ];

stringList.each() { print " ${it}" }; println "";
// java perl python ruby c# cobol groovy jython smalltalk prolog m yacc

stringMap.each() { key, value -> println "${key} == ${value}" };
// Su == Sunday
// We == Wednesday
// Mo == Monday
// Sa == Saturday
// Th == Thursday
// Tu == Tuesday
// Fr == Friday

stringList.eachWithIndex() { obj, i -> println " ${i}: ${obj}" };
// 0: java
// 1: perl
// 2: python
// 3: ruby
// 4: c#
// 5: cobol
// 6: groovy
// 7: jython
// 8: smalltalk
// 9: prolog
// 10: m
// 11: yacc

stringMap.eachWithIndex() { obj, i -> println " ${i}: ${obj}" };
// 0: Su=Sunday
// 1: We=Wednesday
// 2: Mo=Monday
// 3: Sa=Saturday
// 4: Th=Thursday
// 5: Tu=Tuesday
// 6: Fr=Friday
```

Functional Programming

This page last changed on Nov 10, 2006 by [paulk_asert](#).

[Functional programming](#) is a style of programming that emphasizes the application of functions to solve computing problems. This is in contrast with imperative programming, which emphasizes changes in state and the execution of sequential commands. If you want use a functional-only programming language, you should consider something like [Haskell](#). If however you like Groovy but want to apply some functional style magic, read on.

Functional Basics

Groovy's functions (like Java's) can be used to define functions which contain no imperative steps, e.g. a factorial function may look like:

```
def fac(n) { n == 0 ? 1 : n * fac(n - 1) }
assert 24 == fac(4)
```

In Groovy, we gain some slight syntactic sugar over Java in that we can leave out the *return* statements (the last evaluated expression is the default return value).

We can of course start to mix and match functional and imperative coding styles as in this quicksort example:

```
def sort(list) {
    if (list.isEmpty()) return list
    anItem = list[0]
    def smallerItems = list.findAll{it < anItem}
    def equalItems = list.findAll{it == anItem}
    def largerItems = list.findAll{it > anItem}
    sort(smallerItems) + equalItems + sort(largerItems)
}

assert [1, 3, 4, 5] == sort([1, 4, 5, 3])
assert [1, 1, 3, 4, 4, 5, 8] == sort([4, 1, 4, 1, 8, 5, 3])
assert ['a', 'b', 'c'] == sort(['c', 'b', 'a'])
```

Curry functions

You can fix the values for one or more arguments to a closure instance using the `curry()` method as follows:

```
def joinTwoWordsWithSymbol = { symbol, first, second -> first + symbol + second }
assert joinTwoWordsWithSymbol('#', 'Hello', 'World') == 'Hello#World'

def concatWords = joinTwoWordsWithSymbol.curry(' ')
assert concatWords('Hello', 'World') == 'Hello World'

def prependHello = concatWords.curry('Hello')
// def prependHello = joinTwoWordsWithSymbol.curry(' ', 'Hello')
assert prependHello('World') == 'Hello World'
```

If you supply one argument to the *curry()* method you will fix the first argument. If you supply *N* arguments you will fix arguments *1..N*. See reference 1 or Chapter 5 of [GINA](#) for further details.

Lazy evaluation

One particular style of functional programming of particular merit is to make use of lazy evaluation. This allows you to define infinite structures (see the next section), devise particularly efficient solutions to certain kinds of problems, and come up with very elegant solutions to otherwise hard problems. The good news is that several parts of Groovy already make use of this style and they typically hide away the hard bits so you don't need to know what magic is happening on your behalf. Here's some examples:

- `XmlSlurper` allows arbitrary GPath expressions to be crafted. As you create the expressions, you might think that XML parsing is going on behind the covers pulling XML nodes into and out of lists to match what your expressions are asking for. This is not the case. Instead a lazy representation of your GPath is stored away. When you need to evaluate the final result of a GPath expression, it calculates just what it needs to determine the expressions resulting value. [See chapter 12 of [GINA](#) for more information about `XmlSlurper`.]
- Groovy's `DataSet` feature does the same thing for data stored in relational databases. As you build up your dataset queries, no connections or operations to the database are happening under the covers. At the time when you need the result, an optimised query minimising SQL traffic is invoked to return the required result. [See section 10.2 of [GINA](#) for more information about `DataSets`.]

Infinite structures

See reference 2 below for all the details, but to give you a flavour, first you must define some lazy list handling functions, then you can define and use infinite streams. Here is an example:

```
// general purpose lazy list class
class LazyList {
    def car
    private Closure cdr
    LazyList(def car, Closure cdr) { this.car=car; this.cdr=cdr }
    def LazyList getCdr() { cdr ? cdr.call() : null }
    def List take(n) {
        def r = []; def l = this
        n.times { r.add(l.car); l = l.cdr }
        r
    }
    def LazyList filter(Closure pred) {
        if (pred(car)) return pred.owner.cons(car, { getCdr().filter(pred) })
        else return getCdr().filter(pred)
    }
}

// general purpose lazy list function
def cons(val, Closure c) { new LazyList(val, c) }

// now define and use infinite streams
def integers(n) { cons(n, { integers(n+1) }) }
def naturalnumbers = integers(1)
assert '1 2 3 4 5 6 7 8 9 10' == naturalnumbers.take(10).join(' ')
def evennumbers = naturalnumbers.filter{ it % 2 == 0 }
assert '2 4 6 8 10 12 14 16 18 20' == evennumbers.take(10).join(' ')
```

More Information

See also:

1. [Practically Groovy: Functional programming with curried closures](#)
2. [Infinite Streams in Groovy](#)
3. [Functional Programming Languages](#)
4. [Why Functional Programming Matters](#)
5. [Functional programming in the Java language](#)
6. [Post on functional programming in Java - maybe a tad verbose](#)
7. [FunctionalJ - A library for Functional Programming in Java](#)
8. [Weak versus strong languages, who wins the fight?](#)
9. [Programming Languages:Application and Interpretation](#)
10. [Beyond Groovy 1.0: Groovy goes Lisp](#)

GPath

This page last changed on Nov 04, 2006 by [paulk_asert](#).

GPath is a path expression language integrated into Groovy which allows parts of nested structured data to be identified. In this sense, it has similar aims and scope as XPath does for XML. The two main places where you use GPath expressions is when dealing with nested POJOs or when dealing with XML.

As an example, you can specify a path to an object or element of interest:

a.b.c -> for XML, yields all the <c> elements inside inside <a>

a.b.c -> all POJOs, yields the <c> properties for all the properties of <a> (sort of like a.getB().getC() in JavaBeans)

For XML, you can also specify attributes, e.g.:

a["@href"] -> the href attribute of all the a elements

a.'@href' -> an alternative way of expressing this

a.@href -> an alternative way of expressing this when using XmlSlurper

Example

The best example of GPath for xml is test-new/groovy/util/XmlSlurperTest.groovy.

```
package groovy.util

class XmlSlurperTest extends GroovyTestCase {

void testXmlParser() {
    def text = """
<characters>
  <props>
    <prop>dd</prop>
  </props>
  <character id="1" name="Wallace">
    <likes>cheese</likes>
  </character>
  <character id="2" name="Gromit">
    <likes>sleep</likes>
  </character>
</characters>
"""

    def node = new XmlSlurper().parseText(text);

    assert node != null
    assert node.children().size() == 3 //, "Children ${node.children()}"

    characters = node.character
    println "node:" + node.children().size()
    println "characters:" + node.character.size()
    for (c in characters) {
        println c['@name']
    }

    assert characters.size() == 2

    assert node.character.likes.size() == 2 //, "Likes ${node.character.likes}"

    // lets find Gromit
    def gromit = node.character.find { it['@id'] == '2' }
    assert gromit != null //, "Should have found Gromit!"
    assert gromit['@name'] == "Gromit"
}
```

```
// lets find what Wallace likes in 1 query
def answer = node.character.find { it['@id'] == '1' }.likes.text()
assert answer == "cheese"
}
```

Outline

1.Accessing element as property

```
def characters = node.character
def gromit = node.character[1]
```

2.Accessing attributes

```
println gromit['@name']
or
println gromit.@name
```

3.Accessing element body

```
println gromit.likes[0].text()
println node.text()
```

If the element is a father node,it will print all children's text.

3.Explore the DOM use children() and parent()

```
def characters = node.children()
for (c in characters) {
    println c.@name
}
```

4.Find elements use expression

```
def gromit = node.character.find { it.@id == '2' }
```

Another Example

Here is a two line example of how to get a list of all the links to .xml files listed on a web page. The Neko parser is used to parse non-well formed html; it ships as part of the standard Groovy distribution.

```
def myDocument = new XmlParser( new org.cyberneko.html.parsers.SAXParser()
).parse("http://myUrl.com")
def links = myDocument.depthFirst().A['@href'].findAll{ it.endsWith(".xml") }
```

More Information

See also: [Processing XML](#)

Groovy Ant Task

This page last changed on Oct 09, 2006 by [mguillem](#).

Groovy Ant Task

Description

Executes a series of Groovy statements. Statements can either be read in from a text file using the *src* attribute or from between the enclosing Groovy tags.

Required taskdef

Assuming groovy-all-VERSION.jar is in *my.classpath* you will need to declare this task at some point in the build.xml prior to using this task.

```
<taskdef name="groovy"
         classname="org.codehaus.groovy.ant.Groovy"
         classpathref="my.classpath" />
```

<groovy> attributes

Attribute	Description	Required
src	File containing Groovy statements. The directory containing the file is added to the classpath (since RC-1)	Yes, unless statements enclosed within tags
classpath	the classpath to use (since RC-1)	No
classpathref	the classpath to use, given as reference to a PATH defined elsewhere (since RC-1)	No

Parameters specified as nested elements

classpath (since RC-1)

Groovy's classpath attribute is a PATH like structure and can also be set via a nested classpath element.

available bindings

A number of bindings are in scope for use within your Groovy statements.

Name	Description
ant	an instance of AntBuilder that knows about the current ant project
project	the current ant project
properties	a Map of ant properties
target	the owning target that invoked this groovy script
task	the wrapping task, can access anything needed in org.apache.tools.ant.Task

Examples

```
<groovy>
  println("Hello World")
</groovy>
```

```
<groovy>
  ant.echo("Hello World")
</groovy>
```

```
<groovy src="/some/directory/some/file.groovy">
  <classpath>
    <pathelement location="/my/groovy/classes/directory"/>
  </classpath>
</groovy>
```

References

- [Groovyc Task](#)
- [Ant Scripting with AntBuilder](#)
- [Developing Custom Tasks](#)
- [Ant Task Troubleshooting](#)

Groovy Categories

This page last changed on Apr 14, 2007 by bruce@iterative.com.

There are many situations where you might find that it would be useful if a class not under your control had additional methods that you define. In order to enable this capability, Groovy implements a feature borrowed from [Objective-C](#), called Categories. There are a few categories that are included in the system for adding functionality to classes that make them more usable within the Groovy environment.

- [DOMCategory](#)
- [ServletCategory](#)

The first category allows you to treat DOM objects as arrays and maps so that you can use them in conjunction with the Groovy path expression language and treat them like JavaBeans. Here is an example from the tests of using the DOMCategory:

```
import groovy.xml.*

def html = DOMBuilder.newInstance().html {
  head {
    title (class:'mytitle', 'Test')
  }
  body {
    p (class:'mystyle', 'This is a test.')
  }
}

use (groovy.xml.dom.DOMCategory.class) {
  assert html.head.title.text() == 'Test'
  assert html.body.p.text() == 'This is a test.'
  assert html.find{ it.tagName == 'body' }.tagName == 'body'
  assert html.getElementsByTagName('*').grep{ it.@class }.size() == 2
}

try {
  html.head
} catch (MissingPropertyException mpe) {
  println "Categories wear off"
}
```

As you can see here we are treating DOM objects just as if they were JavaBeans and are accessing them with GPath. The ServletCategory is similarly used when we want to treat the attributes of Servlet API objects as if they were properties since they don't follow the typical conventions for JavaBeans or Maps either. In the GroovyServlet that lets you use scripts as servlets we call GroovyCategorySupport from Java in order to make it possible to use property accessors against the request:

```
Closure closure = new Closure(gse) {
  public Object call() {
    try {
      return ((GroovyScriptEngine) getDelegate()).run(scriptUri, binding);
    } catch (ResourceException e) {
      throw new RuntimeException(e);
    } catch (ScriptException e) {
      throw new RuntimeException(e);
    }
  }
};
GroovyCategorySupport.use(ServletCategory.class, closure);
```

This allows users to access things like Session attributes and request Attributes by name instead of

through the API within their Groovy servlet scripts. For example, without this you would have to do:

```
if (session.getAttribute("count") == null) then session.setAttribute("count", 1);
```

With this you can say it more tersely as:

```
if (session.count == null) session.count = 1;
```

In order to create your own Categories and extend classes yourself you'll need to understand what the "use" keyword expects to be defined within the class you pass to it. To add a method to a class T, simply define a new class with a static method that whose first parameter is of type T. Here is a simple example from the tests:

```
class StringCategory {
    static String lower(String string) {
        return string.toLowerCase()
    }
}

use (StringCategory.class) {
    assert "test" == "TeSt".lower()
}
```

This code will print out the string "test". This facility is extremely powerful and essentially lets you change the way any class in the system works when it is called from Groovy code. Note though that you can't add methods to classes, pass them to Java code, and expect the Java code to be able to call them. Since most people use statically typed Java with little reflection I doubt this case would come up much anyway.

Here is an example of using this as an end user in order to add methods to Apple's own NSDictionary and NSArray class in order to manipulate their Cocoa objects as if they were native Groovy objects:

```
#!/Users/sam/bin/groovy
// Put /System/Library/Java in your CLASSPATH
import groovy.xml.*;
import groovy.xml.dom.*;
import java.io.*;
import com.apple.cocoa.foundation.*;

class PropertyListCategory {
    static Object get(NSDictionary dictionary, String key) {
        return dictionary objectForKey(key);
    }
    static Object getAt(NSArray array, int i) {
        return array objectAtIndex(i);
    }
    static void each(NSArray array, Closure closure) {
        for (i in 0..array.count()-1) {
            closure.call(array[i]);
        }
    }
}

filename = "${System.getProperty("user.home")}/Library/Safari/Bookmarks.plist";
data = new NSData(new File(filename));
errorString = new String[1];
format = new int[1];
plist = NSPropertyListSerialization.propertyListFromData(data,
    NSPropertyListSerialization.PropertyListImmutable, format, errorString);
```

```

if (errorString[0]) {
    println "Error: ${errorString[0]}";
    System.exit(1);
}

def getURLs(NSArray array, list) {
    array.each {
        getURLs(it, list);
    }
}

def getURLs(NSDictionary dict, list) {
    if (dict.Children != null) getURLs(dict.Children, list);
    if (dict.URIDictionary != null) {
        list.add([title:dict.URIDictionary.title, url:dict.URLString]);
    }
}

def getURLs(NSDictionary dict) {
    use (PropertyListCategory.class) {
        def list = [];
        getURLs(dict, list);
    }
    return list;
}

println getURLs(plist);

```

Notice how we can even create Category classes in Groovy code. They essentially look just like built-in ones within `DefaultGroovyMethods`. Define them by creating a static method that takes the type you want to extend, then the additional parameters that the new method will take.

Groovy CLI

This page last changed on Sep 27, 2006 by [jbaumann](#).

Using Groovy from the command line

The Groovy command line (groovy or groovy.bat) is the easiest way to start using the Groovy Language.

```
$groovy -help
usage: groovy
  -a,--autosplit <splitPattern>  automatically split current line
                                  (defaults to '\s')
  -c,--encoding <charset>        specify the encoding of the files
  -e <script>                     specify a command line script
  -h,--help                       usage information
  -i <extension>                 modify files in place
  -l <port>                       listen on a port and process inbound lines
  -n                               process files line by line
  -p                               process files line by line and print result
  -v,--version                    display the Groovy and JVM versions
```

If you have a groovy script, you can edit and run the script immediately.

```
$ cat test.groovy
println 'Hello Bonson'

$ groovy test.groovy
Hello Bonson
```

Here is an example with your own command line arguments.

```
$ cat test.groovy
println 'Hello ' + args[0]

$ groovy test.groovy Jeeves
Hello Jeeves
```

However you can also run such a simple groovy program by providing the script in the command line arguments.

```
$ groovy -e "println 'Hello Bob'"
Hello Bob
```

This may not look useful, but it fits in with the UNIX tradition of chaining simple programs together to build powerful commands. Tools like perl, sed, awk and grep do these jobs very well. But many users have limited experience with these tools' arcane syntax and will be more familiar with Java and therefore Groovy.

```
$ grep -i ^groov /usr/share/dict/words | groovy -e 'print System.in.text.toUpperCase()'
GROOVE
GROOVELESS
GROOVELIKE
GROOVER
GROOVERHEAD
GROOVINESS
GROOVING
GROOVY
```

Because looping through STDIN or input files tends to be a common thing to do, groovy (and ruby, perl etc) provide shortcuts for this. **currently broken, groovy not flushing output (still so 060927?)**

-n will loop through each line of the input, and provide it to your script in the *line* variable.

```
grep -i ^groov /usr/share/dict/words | groovy -n -e 'println line.toUpperCase()'
```

If we definitely want to print the output of each line we can use -p and shorten it to

```
grep -i ^groov /usr/share/dict/words | groovy -p -e 'line.toUpperCase()'
```

We can use the looping constructs along with -i, which writes the output back to the original files (and creates a backup copy with the given extension). And wreak havoc on our local file system, with wide-scale search and replace.

```
groovy -p -i .bak -e '(line =~ "<h\\d>(.*?)</h\\d>").replaceAll("$1")' ~/Desktop/cooluri.html
```

TIP: Never ever use the option -i without a backup extension.

Or to really get into groovy (literally)

```
find . -name \*.java | xargs groovy -p -i -e '(line =~ "@author James Strachan").replaceAll("@author Bobby Bonson")'
```

Additionally you have access to the line number in the current file you are reading via the variable *count*. This can be used for a number of convenient groovy one-liners.

Let us assume you want to prefix every line in a file with the line number. Doing this requires next to no work in Groovy (we additionally create a copy of the original file with the extension .bak).

```
groovy -pi .bak -e "count + ': ' + line"
```

Or let us create a grep-like command that prints the line number where it found matching strings for a regular expression.

```
groovy -p -e "if(line =~ /groovy/)count + ': ' + line"
```

Print the first 50 lines of all files:

```
groovy -p -e "if(count < 50) line"
```

until one file is longer than 50 lines:

```
groovy -p -e "if(count >= 50)System.exit(0);line"
```

Add a Groovy-Shebang (the string '#!/usr/bin/groovy') to all Groovy files:

```
groovy -i .bak -pe "if(count == 1) println '#!/usr/bin/groovy' " *.groovy
```

Another very convenient option is `-a`, which splits the current input line into the array *split*. By default the split pattern is " " (one space). The option `-a` optionally takes another split pattern which is then used instead.

Print processes owned by root:

```
ps aux|groovy -ane "if(split[0] =~ 'root')println split[10..-1]"
```

Print all logins from `/etc/passwd` that are not commented:

```
groovy -a':' -ne "if(!(split[0] =~ /^#/))println split[0]" /etc/passwd
```

Add the first and the penultimate column of a file:

```
groovy -ape "split[0].toInteger()+split[-2].toInteger()" accounts.txt
```

For more examples or inspiration browse through the search results for [Perl One Liners](#)

listen mode

Another groovy command line option is the ability to startup groovy in listen mode, which will attach groovy to a TCP port on your machine (`-l <port>` with a default port of 1960).

For each connection that is made to this port, groovy executes the supplied script on a line by line basis.

This oneliner will reverse every line that is thrown at it, try telnet to your machine on port 1960 to interact with this script.

```
groovy -l -e "println line.reverse()"
```

you can combine the `-p` option from earlier, to automatically print the result of your script

The following one liner is equivalent to the one liner immediately above.

```
groovy -l -p -e "line.reverse()"
```

More examples of useful command line scripts in [SVN](#)

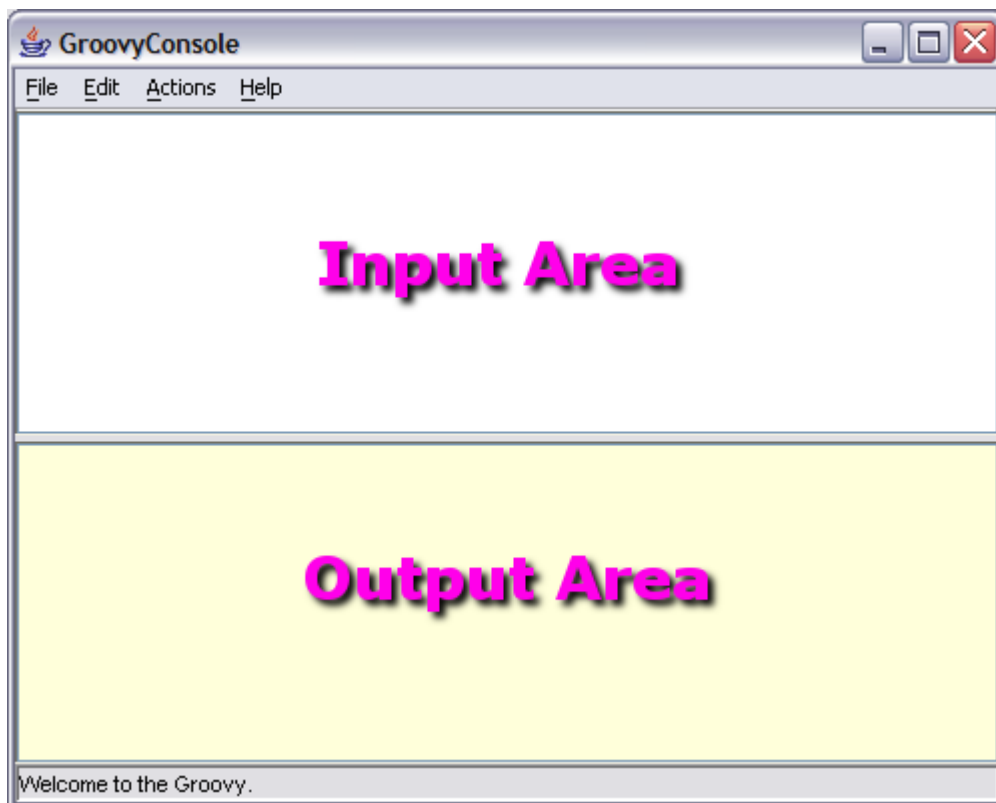
Groovy Console

This page last changed on Sep 27, 2006 by [paulk_asert](#).

The Groovy Swing Console allows a user to enter and run Groovy scripts. This page documents the features of this user interface.

Basics

The Groovy Console:



1. The Console has an input area and an output area.
2. You type a Groovy script in the input area.
3. When you select "Run" from the "Actions" menu, the console compiles the script and runs it.
4. Anything that would normally be printed on System.out is printed in the output area.
5. If the script returns a non-null result, that result is printed.

Features

Running Scripts

Handy tips for running scripts:

- Ctrl+Enter and Ctrl+R are both shortcut keys for "Run Script".
- If you highlight just part of the text in the input area, then Groovy runs just that text.
- The result of a script is the the value of the last expression executed.
- You can turn the System.out capture on and off by selecting "Capture System.out" from the "Actions" menu

Editing Files

You can open any text file, edit it, run it (as a Groovy Script) and then save it again when you are finished.

- Select File -> Open (shortcut key ctrl+O) to open a file
- Select File -> Save (shortcut key ctrl+S) to save a file
- Select File -> New File (shortcut key ctrl+Q) to start again with a blank input area

History and results

- You can pop-up a gui inspector on the last (non-null) result by selecting "Inspect Last" from the "Actions" menu. The inspector is a convenient way to view lists and maps.
- The console remembers the last ten script runs. You can scroll back and forth through the history by selecting "Next" and "Previous" from the "Edit" menu. Ctrl-N and ctrl-P are convenient shortcut keys.
- The last (non-null) result is bound to a variable named '_' (an underscore).
- The last result (null and non-null) for every run in the history is bound into a list variable named '__' (two underscores). The result of the last run is `__[-1]`, the result of the second to last run is `__[-2]` and so forth.

And more

- You can attempt to interrupt a long running task by clicking the "interrupt" button on the small dialog box that pops up when a script is executing.
- You can change the font size by selecting "Smaller Font" or "Larger Font" from the "Actions menu"

Embedding the Console

To embed a Swing console in your application, simply create the Console object, load some variables, and then launch it. The console can be embedded in either Java or Groovy code. The Java code for this is:

```
import groovy.ui.Console;

...

Console console = new Console();
console.setVariable("var1", getValueOfVar1());
console.setVariable("var2", getValueOfVar2());
console.run();

...
```

Once the console is launched, you can use the variable values in Groovy code.

Groovy Math

This page last changed on Mar 08, 2007 by [gavingrover](#).

Groovy supports access to all Java math classes and operations. However, in order to make scripting math operations as intuitive as possible to the end user, the groovy math model supports a 'least surprising' approach to literal math operations for script programmers. To do this, groovy uses exact, or decimal math for default calculations.

This means that user computations like:

```
1.1 + 0.1 == 1.2
```

will return true rather than false (using float or double types in Java returns a result of 1.2000000000000002).

Numeric literals

To support the 'least surprising' approach, groovy literals with decimal points are instantiated as *java.math.BigDecimal* types rather than binary floating point types (Float, Double). Float and Double types can of course be created explicitly or via the use of a suffix (see table below). Exponential notation is supported for decimal types (BigDecimal, Double Float) with or without a signed exponent (1.23e-23). Hexadecimal and octal literals are also supported. Hexadecimal numbers are specified in the typical format of "0x" followed by hex digits (e.g. 0x77).

Integral numeric literals (those without a decimal point) which begin with a 0 are treated as octal. Both octal and hexadecimal literals may have an integral suffix (G,L,I). Integral numeric literals without a suffix will be the smallest type into which the value will fit (Integer, Long, or BigInteger). See the numeric literal grammar at the end of this page for more details on syntax.

Type	Suffix
BigInteger	G
Long	L
Integer	I
BigDecimal	G
Double	D
Float	F

Examples:

```
assert 42I == new Integer("42");
assert 123L == new Long("123");
assert 2147483648 == new Long("2147483648"); //Long type used, value too large for an Integer
assert 456G == new java.math.BigInteger("456");
assert 123.45 == new java.math.BigDecimal("123.45"); //default BigDecimal type used
assert 1.200065D == new Double("1.200065");
assert 1.234F == new Float("1.234");
```

```
assert 1.23E23D == new Double("1.23E23");
```

Math operations

While the default behavior is to use decimal math, no attempt is made to preserve this if a binary floating point number is introduced into an expression (i.e. groovy never automatically promotes a binary floating point number to a BigDecimal). This is done for two reasons: First, doing so would imply a level of exactness to a result that is not guaranteed to be exact, and secondly, performance is slightly better under binary floating point math, so once it is introduced it is kept.

Finally, Groovy's math implementation is as close as practical to the Java 1.5 BigDecimal math model which implements precision based floating point decimal math (ANSI X3.274-1996 and ANSI X3.274-1996/AM 1-2000 (section 7.4)).

Therefore, binary operations involving subclasses of java.lang.Number automatically convert their arguments according to the following matrix (except for division, which is discussed below).

	BigDecimal	BigInteger	Double	Float	Long	Integer
BigDecimal	BigDecimal	BigDecimal	Double	Double	BigDecimal	BigDecimal
BigInteger	BigDecimal	BigInteger	Double	Double	BigInteger	BigInteger
Double	Double	Double	Double	Double	Double	Double
Float	Double	Double	Double	Double	Double	Double
Long	BigDecimal	BigInteger	Double	Double	Long	Long
Integer	BigDecimal	BigInteger	Double	Double	Long	Integer

Note - Byte, Character, and Short arguments are considered to be Integer types for the purposes of this matrix.

Division

The division operators "/" and "/"= produce a Double result if either operand is either Float or Double and a BigDecimal result otherwise (both operands are any combination of Integer, Long, BigInteger, or BigDecimal). BigDecimal Division is performed as follows:

```
BigDecimal.divide(BigDecimal right, <scale>, BigDecimal.ROUND_HALF_UP)
```

where <scale> is MAX(this.scale(), right.scale(), 10). Finally, the resulting BigDecimal is normalized (trailing zeros are removed).

For example:

```
1/2 == new java.math.BigDecimal("0.5");
1/3 == new java.math.BigDecimal("0.333333333");
2/3 == new java.math.BigDecimal("0.6666666667");
```

Integer division can be performed on the integral types by casting the result of the division. For example:

```
assert (int)(3/2) == 1I;
```

Future versions of Groovy may support an integer division operator such as `div` and/or `÷`.

Power Operator

Since groovy 1.0 beta 10 release, the power operator `**` is supported for math calculation. For example, `5**3` equals to `Math.pow(5,3)`.

Java code:

```
// y = 2 x^3 + 5 x^2 - 3 x + 2
def x = 5.0;
def y = 2.0 * Math.pow(x,3) + 5.0 * Math.pow(x,2) - 3.0*x + 2.0
```

Groovy code:

```
// y = 2 x^3 + 5 x^2 - 3 x + 2
def x = 5.0;
def y = 2.0*x**3 + 5.0*x**2 - 3.0*x + 2.0
```

More In-depth Information

Groovy and Java Math is explained in far more depth in these pages:

[Groovy Integer Math](#)

[Groovy BigDecimal Math](#)

[Groovy Floating Point Math](#)

Numeric literal grammar

```
IntegerLiteral:
    Base10IntegerLiteral
    HexIntegerLiteral
    OctalIntegerLiteral

Base10IntegerLiteral:
    Base10Numeral IntegerTypeSuffix (optional)

HexIntegerLiteral:
    HexNumeral IntegerTypeSuffix (optional)

OctalIntegerLiteral:
```

```

    OctalNumeral IntegerTypeSuffix (optional)

IntegerTypeSuffix: one of
    i I l L g G

Base10Numeral:
    0
    NonZeroDigit Digits (optional)

Digits:
    Digit
    Digits Digit

Digit:
    0
    NonZeroDigit

NonZeroDigit: one of
    \1 2 3 4 5 6 7 8 9

HexNumeral:
    0 x HexDigits
    0 X HexDigits

HexDigits:
    HexDigit
    HexDigit HexDigits

HexDigit: one of
    0 1 2 3 4 5 6 7 8 9 a b c d e f A B C D E F

OctalNumeral:
    0 OctalDigits

OctalDigits:
    OctalDigit
    OctalDigit OctalDigits

OctalDigit: one of
    0 1 2 3 4 5 6 7

DecimalPointLiteral:
    Digits . Digits ExponentPart (optional) DecimalTypeSuffix (optional)
    . Digits ExponentPart (optional) DecimalTypeSuffix (optional)
    Digits ExponentPart DecimalTypeSuffix (optional)
    Digits ExponentPart (optional) DecimalTypeSuffix (optional)

ExponentPart:
    ExponentIndicator SignedInteger

ExponentIndicator: one of
    e E

SignedInteger:
    Signopt Digits

Sign: one of
    + -

DecimalTypeSuffix: one of
    f F d D g G

```

Groovy Maven Plugin

This page last changed on Mar 24, 2007 by [user57](#).

Groovy Maven Plugin

Description

Allows Groovy scripts to be used from within the [Maven 2](#) environment.

Current release: 1.0-alpha-2

Execute a Groovy Script

```
<plugin>
  <groupId>org.codehaus.mojo</groupId>
  <artifactId>groovy-maven-plugin</artifactId>
  <executions>
    <execution>
      <phase>generate-resources</phase>
      <goals>
        <goal>execute</goal>
      </goals>
      <configuration>
        <source>
          <body>
            if (project.packaging != "pom") {
              log.info("Copying some stuff...")

              def ant = new AntBuilder()

              def dir = "${project.basedir}/target/classes/META-INF"

              ant.mkdir(dir: dir)
              ant.copy(todir: dir) {
                fileset(dir: "${project.basedir}") {
                  include(name: "LICENSE.txt")
                  include(name: "NOTICE.txt")
                }
              }
            }
          </body>
        </source>
      </configuration>
    </execution>
  </executions>
</plugin>
```

For more details see the [executing examples](#).

Compile Groovy Sources

```
<plugin>
  <groupId>org.codehaus.mojo</groupId>
  <artifactId>groovy-maven-plugin</artifactId>
  <executions>
```



```
    <execution>
      <goals>
        <goal>compile</goal>
      </goals>
    </execution>
  </executions>
</plugin>
```

And test sources too:

```
<plugin>
  <groupId>org.codehaus.mojo</groupId>
  <artifactId>groovy-maven-plugin</artifactId>
  <executions>
    <execution>
      <goals>
        <goal>testCompile</goal>
      </goals>
    </execution>
  </executions>
</plugin>
```

For more details more see the [compiling examples](#).

References

- [Groovy Maven Plugin](#) - Home page

Groovyc Ant Task

This page last changed on Jan 10, 2007 by [mguillem](#).

Groovyc Ant Task

Description

Compiles groovy source files

Required taskdef

Assuming groovy-all-VERSION.jar is in *my.classpath* you will need to declare this task at some point in the build.xml prior to using this task.

```
<taskdef name="groovyc"
  classname="org.codehaus.groovy.ant.Groovyc"
  classpathref="my.classpath" />
```

<groovyc> attributes

Attribute	Description	Required
srcdir	directories containing Groovy source files	Yes
destdir	directory used to store the compiled groovy files	Yes
classpath	classpath used for compilation	No
stacktrace	if true each compile error message will contain a stacktrace	No
encoding	encoding of source files	No

References

- [Groovy Task](#)
- [Ant Scripting with AntBuilder](#)
- [Developing Custom Tasks](#)
- [Ant Task Troubleshooting](#)

Input Output

This page last changed on Oct 19, 2006 by nakuja@yahoo.com.

Groovy provides a number of

[helper methods](#) for working with IO. All of these work with standard Java Reader/Writer and InputStream/OutputStream and File and URL classes.

The use of closures allows resources to be processed ensuring that things are properly closed irrespective of exceptions. e.g. to iterate through each line of a file the following can be used...

```
new File("foo.txt").eachLine { line -> println(line) }
```

If for whatever reason the *doSomething()* method were to throw an exception, the *eachLine()* method ensures that the file resource is correctly closed. Similarly if an exception occurs while reading, the resource will be closed too.

If you wish to use a reader/writer object or an input/output stream object there are helper methods to handle the resource for you via a closure - which will automatically close down any resource if an exception occurs. e.g.

```
new File("foo.txt").withReader { reader ->
    while (true) {
        def line = reader.readLine()
    }
}
```

Using processes

Groovy provides a simple way to execute command line processes.

```
def process = "ls -l".execute()
println "Found text ${process.text}"
```

The expression returns a `java.lang.Process` instance which can have the in/out/err streams processed along with the exit value inspected etc.

e.g.

```
def process = "ls -l".execute()
process.in.eachLine { line -> println line }
```

Remember that many commands are shell built-ins and need special handling (just like java). So if you want a listing of directory on a windows machine and if you write

```
Process p = "dir".execute()
```

```
println "${p.text}"
```

you will get IOException saying Cannot run program "dir": CreateProcess error=2, The system cannot find the file specified

You will need to write

```
Process p = "cmd /c dir".execute()  
println "${p.text}"
```

Logging

This page last changed on Apr 25, 2006 by xavier.mehaut@free.fr.

Logging in Groovy is based on the JDK logging facilities.
Please read the JDK logging documentation if you are new to the topic.

In order to enable tracing of how Groovy calls MetaMethods, use the following settings:

in file %JAVA_HOME%/jre/lib/logging.properties or equivalent

- make sure your log handler is configured to show level 'FINER' at least, e.g.

```
java.util.logging.ConsoleHandler.level = ALL
```

- set MetaClass logging to 'FINER' at least, e.g.

```
groovy.lang.MetaClass.level = FINER
```

- set the appropriate Level for the Classes and optionally method names that you want to trace. The name for the appropriate logger starts with 'methodCalls' and optionally ends with the method name, e.g.

```
# trace all method calls
methodCalls.level = FINER

# trace method calls to the 'String' class
methodCalls.java.lang.String.level = FINER

# trace method calls to Object.println()
methodCalls.java.lang.Object.println.level = FINER
```

Example:

with tracing enabled for all method calls a Groovy command line script appears as follows (German locale)

```
$ groovy -e "println 'hi'"
13.09.2005 14:33:05 script_from_command_line run()
FEINER: called from MetaClass.invokeMethod
13.09.2005 14:33:05 script_from_command_line println('hi')
FEINER: called from MetaClass.invokeMethod
hi
```

Migration From Classic to JSR syntax

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Here is a checklist of changes you'll need to make to a Groovy classic codebase to ensure compatibility with the new Groovy JSR syntax.

Safe navigation

In Classic Groovy we used to use this syntax

```
class Person = { String name }
y = null
println "${y->name}"    // -> was the optional gpath operator with Classic Groovy syntax
```

Instead of using the arrow operator for safe navigation to avoid `NullPointerException`, we're now using the `?.` operator

Now in the JSR we use this syntax

```
class Person = { String name }
def y = null
println "${y?.name}"    // Now, ?. is the optional gpath operator the new Groovy JSR
```

Parameter separator in the closure syntax

This allows us to use one single token for the separator between the closure in Classic Groovy we used to use this syntax

```
c1 = {a| ...}
c1 = {|a| ...}
```

Now in the JSR we use this syntax

```
def c1 = {a -> ...}
```

This allows us to use one single token for the separator between the closure parameters and the code in the closure which works with arbitrarily complex parameter list expressions and default values. e.g.

```
def c1 = {String x = "hey", int y = a|b -> println "Values are $x and $y"}
collection.each {int item -> println item}
```

Property keyword

- property keyword has been replaced with an annotation

```
class Foo {
    property foo
}
```

```
class Foo {
    @Property foo
}
```

Introduction of the 'def' keyword

- local variable declarations and fields currently need to be specified with 'def', a modifier, and/or a type. e.g.

```
def foo() {
    int x = 123
    y = 456 // classic
}

def foo() {
    int x = 123
    def y = 456 // JSR
}

class Foo {
    telson // classic
    int sharna
}

class Foo {
    def telson // JSR
    int sharna
}
```

(Syntactically, the new keyword 'def' acts for methods as a modifier like 'public'.)

For Scripts (as opposed to explicitly declared classes) the syntax is not changed, i.e. variable declarations without 'def' are still allowed, because those variables are automatically created in the script binding if they don't already exist.

Introduction of the 'as' keyword

- We can change types of objects with using the 'as' keyword, e.g.

```
def d0 = new Date(2005-1900, 5-1, 7) // in classic Groovy or Java
println d0

def d1 = [2005-1900, 5-1, 8] as Date // since jsr-01
println d1

Date d2 = [2005-1900, 5-1, 9] as Date // since jsr-01
println d2

Date d3 = [2005-1900, 5-1, 10] // since jsr-01
println d3
```

```
// def n0 = new int[] { 1, 3, 5, 6 } // Not work. This style is not supported since
groovy-1.0-jsr-01.

def n1 = [ 1, 3, 5, 7 ] as int[]
println n1.class
println n1.size()
println n1.length
println n1[0]
println n1[-1]

// int[] n2 = [ 2, 4, 6, 8,10 ] as int[] // work
int[] n2 = [ 2, 4, 6, 8, 10 ] // work
println n2.class
println n2.size()
println n2.length
println n2[0]
println n2[-1]

// String[] n3 = [ "a", "ab", "abc", "abcd", "abcde", "abcdef" ] as String[] // work
String[] n3 = [ "a", "ab", "abc", "abcd", "abcde", "abcdef" ] // work
println n3.class
println n3.size()
println n3.length
println n3[0]
println n3[-1]
```

Default access level of class members

The default access level for members of Groovy classes has changed from "public" to "protected"

Classic Groovy

```
class Foo {
    readMe_a;
    readMe_b
}
xyz = new Foo(readMe_a:"Hello",readMe_b:"World")
println xyz.readMe_a
println xyz.readMe_b
```

Now in JSR Groovy

```
class Foo {
    public readMe_a;
    def readMe_b //def is now required because of the "def keyword" change mentioned earlier
}
xyz = new Foo(readMe_a:"Hello",readMe_b:"World")
println xyz.readMe_a
println xyz.readMe_b //errors in JSR Groovy
```

Array creation

- no special array syntax. To make the language much cleaner, we now have a single syntax to work with lists and arrays in the JSR. Also note that we can now easily coerce from any collection or array to any array type


```
// classic
args = new String[] { "a", "b" }

// JSR
String[] args = ["a", "b"]
def x = [1, 2, 3] as int[]
long[] y = x
```

- **Be careful:** we don't support native multi-dimensional array creation right now.

float and double notation

- float and double literals cannot start with dot. So

```
x = .123 // classic
def x = 0.123 // JSR
```

This is to avoid ambiguity with things like ranges (1..2) and so forth

Explicit method pointer syntax

In classic Groovy you could access method pointers automatically if there was no java bean property of the given method name.

e.g.

```
// classic
methodPointer = System.out.println
methodPointer("Hello World")
```

This often caused confusion; as folks would use a property access to find something and get a method by accident (e.g. typo) and get confused. So now we make getting a method pointer explicit as follows

```
// JSR
def methodPointer = System.out.&println
methodPointer("Hello World")

def foo = ...
def p = foo.&bar

// lets call the bar method on the foo object
p(1, 2, 3)
```

No 'do ... while()' syntax as yet.

Due to ambiguity, we've not yet added support for do .. while to Groovy

'No Dumb Expression' rule

- no dumb expression rule, so we will catch dumb expressions (where a carriage return has broken the script). e.g.

```
def foo() {  
  def x = 1  
  +5 // dumb expression!  
  return 8  
}
```

Markup and builders

- markup / builders will change a little, but the classic syntax still applies. Not sure of the new syntax, but we'll have some kinda start/stop syntax to denote a markup block. Maybe a keyword, like

```
markup (builder) {  
  // same stuff as before goes here  
}  
  
// or something like this  
builder.{  
  // same stuff as before goes here  
}
```

Strings and GStrings

- single and double quote strings can only span one line; for multiple lines use triple quotes
- heredocs removal - they are kinda ugly anyway 😊. If you want to use them, just use treble quote instead

```
def foo = """  
this  
is  
a very  
long  
string on many  
lines  
"""
```

- escaping of \$ inside GStrings must use \\$

```
println 'amount is $100'  
// same as  
println "amount is \$100"
```

- A new string definition is also supported which is escaping friendly, and thus particularly friendly for regex notation:

```

if ('abc' =~ /.../) {}
if ('abc' =~ /.../) {}
'abc'.eachMatch(/.../) {}
['a','b','c'].grep(/a/)

switch('abc'){
    case ~/.../ : whatever
}

assert 'EUOUAE'.matches(/^[aeiou]*$/ )
assert 'EUOUAE' =~ /^[aeiou]*$/
assert 'football'.replaceAll(/foo/, "Bar") == 'Bartball'

```

Assertions

- assert uses comma instead of colon to delimit the two parameter form of assertion statement

```
assert 0 <= value : "Must be non-negative" // classic
```

```
assert 0 <= value , "Must be non-negative" // JSR
```

return/break/continue semantics in closures

NOT YET IMPLEMENTED

- return/break/continue to behave inside closures like these statements work in other blocks (such as the block on a for() or while() loop. More details [here](#)

Integer division

Previously, in Groovy Classic, we used the backward slash as the integer division operator. This operator being confusing with escaping sequences was removed. So instead of \ please use the `intdiv()` method.

```
int result = 5 \ 3 // classic
```

Becomes

```
int result = 5.intdiv(3) // JSR
```

JDK5 for loop not supported

Groovy already supports a fair number of looping mechanisms, and in Classic, both for (... : ...) and for (... in ...) were supported. For the moment, only the for (... in ...) notation is allowed.

```
for (e : myList) { } // not allowed anymore  
for (Element e : myList) { } // not allowed anymore  
for (e in myList) { } // JSR  
for (Element e in myList) { } // JSR
```

Exclusive range

The operator for creating ranges with the upper bound excluded from the range has changed.

Instead of:

```
range = 0...10
```

The syntax is now:

```
def range = 0..<10
```

Operator Overloading

This page last changed on Jan 26, 2007 by [glaforge](#).

Groovy supports operator overloading which makes working with Numbers, Collections, Maps and various other data structures easier to use.

Various operators in Groovy are mapped onto regular Java method calls on objects.

This allows you the developer to provide your own Java or Groovy objects which can take advantage of operator overloading. The following table describes the operators supported in Groovy and the methods they map to.

Operator	Method
a + b	a.plus(b)
a - b	a.minus(b)
a * b	a.multiply(b)
a / b	a.divide(b)
a % b	a.mod(b)
a b	a.or(b)
a & b	a.and(b)
a++ or ++a	a.next()
a-- or --a	a.previous()
a[b]	a.getAt(b)
a[b] = c	a.putAt(b, c)
a << b	a.leftShift(b)

Note that all the following comparison operators handle nulls gracefully avoiding the throwing of [java.lang.NullPointerException](#)

Operator	Method
a == b	a.equals(b)
a != b	! a.equals(b)
a <=> b	a.compareTo(b)
a > b	a.compareTo(b) > 0
a >= b	a.compareTo(b) >= 0
a < b	a.compareTo(b) < 0
a <= b	a.compareTo(b) <= 0

Notes about operations

Also in Groovy comparison operators handle nulls gracefully. So that a == b will never throw a

NullPointerException whether a or b or both are null.

```
def a = null
def b = "foo"

assert a != b
assert b != a
assert a == null
```

In addition when comparing numbers of different types then type coercion rules apply to convert numbers to the largest numeric type before the comparison. So the following is valid in Groovy

```
Byte a = 12
Double b = 10

assert a instanceof Byte
assert b instanceof Double

assert a > b
```

Processing XML

This page last changed on Oct 16, 2006 by [paulk_asert](#).

Processing existing XML

Groovy provides special XML processing support through the following classes:

Technology	When/Why to use	Requirements
XmlParser	supports GPath expressions for XML documents and allows updating	-
XmlSlurper	lower overheads than XmlParser due to lazy evaluation but only supports read operations	-
DOMCategory	low-level tree-based processing where you want some syntactic sugar	place <code>use(DOMCategory)</code> around your code

If you have special needs, you can use one of the many available Java APIs for XML processing. You should consult the documentation of individual APIs for the details, but some examples to get you started are included here:

Technology	When/Why to use	Requirements
DOM	low-level tree-based processing	-
SAX	event-based push-style parsing can be useful for streaming large files	-
StAX	event-based pull-style parsing can be useful for streaming large files	requires stax.jar
DOM4J	nicer syntax over DOM processing plus can be useful for large files if you use prune capability	requires dom4j.jar
XOM	nicer syntax over DOM processing plus a strong emphasis on compliancy	requires xom.jar
JDOM	nicer syntax over DOM processing	requires jdom.jar
XPath	use XPath expressions	requires xalan.jar
Jaxen	use XPath expressions with slightly more efficiency than built-in XPath	requires jaxen.jar
XSLT with Java	When your transformation is	-

	more easily expressed using XSLT than code	
--	--	--

Creating new XML

The most commonly used approach for creating XML with Groovy is to use a builder, i.e. one of:

Technology	When/Why to use	Requirements
MarkupBuilder	supports Groovy's builder pattern with XML/HTML	-
StreamingMarkupBuilder	for larger files	-

Groovy also has some low-level helper classes you typically won't need to use directly but you may sometimes see in older examples of using XML with Groovy.

Technology	When/Why to use	Requirements
SAXBuilder	support class when using SAX	-
StreamingSAXBuilder	streaming version of SAXBuilder	-
DOMBuilder	support class when using DOM	-
StreamingDOMBuilder	streaming version of DOMBuilder	-

You can also use Java API's which support XML document creation:

Technology	When/Why to use	Requirements
DOM	low-level creation mechanism	-
JDOM	if you are an existing JDOM user	requires jdom.jar
DOM4J	if you are an existing DOM4J user	requires dom4j.jar
XOM	if you are an existing XOM user	requires xom.jar

More Information

For some more discussion of the pro's and con's of your XML Processing options and some additional details, see the following books:

- Chapter 12 of [GINA](#)
- [Processing XML with Java](#)
- [Pro XML Development with Java Technology](#)
- [Java and XML](#)

The following articles may also be of interest:

- [Getting Groovy with XML](#) by Jack Herrington.

- [XML and Java technologies: Document models, Part 1: Performance](#)
- [DOM, DOM4J, JDOM, XOM Comparison](#) (slightly outdated)
- [Dom4J performance versus Xerces / Xalan](#)

You may also be interested in how XML is applied in other parts of Groovy:

- [Groovy SOAP](#)
- [Testing Web Services](#)
- [Testing Web Applications](#)

Creating XML using Groovy's MarkupBuilder

This page last changed on Oct 07, 2006 by [paulk_asert](#).

Here is an example of using Groovy's MarkupBuilder to create a new XML file:

```
// require(groupId:'xmlunit', artifactId:'xmlunit', version:'1.0')
import groovy.xml.MarkupBuilder
import org.custommonkey.xmlunit.*

def writer = new StringWriter()
def xml = new MarkupBuilder(writer)
xml.records() {
    car(name:'HSV Maloo', make:'Holden', year:2006) {
        country('Australia')
        record(type:'speed', 'Production Pickup Truck with speed of 271kph')
    }
    car(name:'P50', make:'Peel', year:1962) {
        country('Isle of Man')
        record(type:'size', 'Smallest Street-Legal Car at 99cm wide and 59 kg in weight')
    }
    car(name:'Royale', make:'Bugatti', year:1931) {
        country('France')
        record(type:'price', 'Most Valuable Car at $15 million')
    }
}

XMLUnit.setIgnoreWhitespace(true)
def xmlDiff = new Diff(writer.toString(), XmlExamples.CAR_RECORDS)
assert xmlDiff.similar()
```

We have used [XMLUnit](#) to compare the XML we created with our sample XML. To do this, make sure the sample XML is available, i.e. that the following class is added to your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

You may also want to see [Using MarkupBuilder for Agile XML creation](#).

As a final example, suppose we have an existing XML document and we want to automate generation of the markup without having to type it all in? We just need to use DomToGroovy as shown in the following example:

```
import javax.xml.parsers.DocumentBuilderFactory
import org.codehaus.groovy.tools.xml.DomToGroovy

def builder = DocumentBuilderFactory.newInstance().newDocumentBuilder()
```

```
def inputStream = new ByteArrayInputStream(XmlExamples.CAR_RECORDS.bytes)
def document    = builder.parse(inputStream)
def output      = new StringWriter()
def converter    = new DomToGroovy(new PrintWriter(output))

converter.print(document)
println output.toString()
```

Running this will produce the builder code for us.

Creating XML using Groovy's StreamingMarkupBuilder

This page last changed on Oct 07, 2006 by [paulk_asert](#).

Here is an example of using StreamingMarkupBuilder to create a new XML file:

```
// require(groupId:'xmlunit', artifactId:'xmlunit', version:'1.0')
import groovy.xml.StreamingMarkupBuilder
import org.custommonkey.xmlunit.*

def xml = new StreamingMarkupBuilder().bind{
    records() {
        car(name:'HSV Maloo', make:'Holden', year:2006) {
            country('Australia')
            record(type:'speed', 'Production Pickup Truck with speed of 271kph')
        }
        car(name:'P50', make:'Peel', year:1962) {
            country('Isle of Man')
            record(type:'size', 'Smallest Street-Legal Car at 99cm wide and 59 kg in weight')
        }
        car(name:'Royale', make:'Bugatti', year:1931) {
            country('France')
            record(type:'price', 'Most Valuable Car at $15 million')
        }
    }
}

XMLUnit.setIgnoreWhitespace(true)
def xmlDiff = new Diff(xml.toString(), XmlExamples.CAR_RECORDS)
assert xmlDiff.similar()
```

We have used [XMLUnit](#) to compare the XML we created with our sample XML. To do this, make sure the sample XML is available, i.e. that the following class is added to your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

You may also want to see [Using MarkupBuilder for Agile XML creation](#).

Creating XML with Groovy and DOM

This page last changed on Oct 07, 2006 by [paulk_asert](#).

Here is an example of using Java's DOM facilities to create a new XML file:

```
// require(groupId:'xmlunit', artifactId:'xmlunit', version:'1.0')
import javax.xml.parsers.DocumentBuilderFactory
import org.custommonkey.xmlunit.*

def addCar(document, root, name, make, year, country, type, text) {
    def car = document.createElement('car')
    car.setAttribute('name', name)
    car.setAttribute('make', make)
    car.setAttribute('year', year)
    root.appendChild(car)
    def countryNode = document.createElement('country')
    countryNode.appendChild(document.createTextNode(country))
    car.appendChild(countryNode)
    def record = document.createElement('record')
    record.setAttribute('type', type)
    record.appendChild(document.createTextNode(text))
    car.appendChild(record)
}

def builder = DocumentBuilderFactory.newInstance().newDocumentBuilder()
def document = builder.newDocument()
def root = document.createElement('records')

document.appendChild(root)
addCar(document, root, 'HSV Maloo', 'Holden', '2006', 'Australia',
    'speed', 'Production Pickup Truck with speed of 271kph')
addCar(document, root, 'P50', 'Peel', '1962', 'Isle of Man',
    'size', 'Smallest Street-Legal Car at 99cm wide and 59 kg in weight')
addCar(document, root, 'Royale', 'Bugatti', '1931', 'France',
    'price', 'Most Valuable Car at $15 million')

// now load in our XML sample and compare it to our newly created document
def builder2 = DocumentBuilderFactory.newInstance().newDocumentBuilder()
def inputStream = new ByteArrayInputStream(XmlExamples.CAR_RECORDS.bytes)
def control = builder2.parse(inputStream)

XMLUnit.setIgnoreWhitespace(true)
def xmlDiff = new Diff(document, control)
assert xmlDiff.similar()
```

We have used [XMLUnit](#) to compare the XML we created with our sample XML. To do this, make sure the sample XML is available, i.e. that the following class is added to your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
    <records>
      <car name='HSV Maloo' make='Holden' year='2006'>
        <country>Australia</country>
        <record type='speed'>Production Pickup Truck with speed of 271kph</record>
      </car>
      <car name='P50' make='Peel' year='1962'>
        <country>Isle of Man</country>
        <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
      </car>
      <car name='Royale' make='Bugatti' year='1931'>
        <country>France</country>
        <record type='price'>Most Valuable Car at $15 million</record>
      </car>
    </records>
    '''
}
```

You may also want to see [Using MarkupBuilder for Agile XML creation](#).

Creating XML with Groovy and DOM4J

This page last changed on Oct 07, 2006 by [paulk_asert](#).

Here is an example of using JDOM to create a new XML file:

```
// require(groupId:'xmlunit', artifactId:'xmlunit', version:'1.0')
// require(groupId:'dom4j', artifactId:'dom4j', version:'1.6.1')
import javax.xml.parsers.DocumentBuilderFactory
import org.custommonkey.xmlunit.*
import org.dom4j.io.XMLWriter
import org.dom4j.*

def addCar(root, name, make, year, country, type, text) {
    def car = root.addElement('car')
    car.addAttribute('name', name)
    car.addAttribute('make', make)
    car.addAttribute('year', year)
    def countryNode = car.addElement('country').addText(country)
    def record = car.addElement('record').addText(text)
    record.addAttribute('type', type)
}

def document = DocumentHelper.createDocument()
def root      = document.addElement('records')

addCar(root, 'HSV Maloo', 'Holden', '2006', 'Australia',
        'speed', 'Production Pickup Truck with speed of 271kph')
addCar(root, 'P50', 'Peel', '1962', 'Isle of Man',
        'size', 'Smallest Street-Legal Car at 99cm wide and 59 kg in weight')
addCar(root, 'Royale', 'Bugatti', '1931', 'France',
        'price', 'Most Valuable Car at $15 million')

// convert resulting document to a string so that we can compare
XMLUnit.setIgnoreWhitespace(true)
def writer = new StringWriter()
new XMLWriter(writer).writeNode(document)
def xmlDiff = new Diff(writer.toString(), XmlExamples.CAR_RECORDS)
assert xmlDiff.similar()
```

We have used [XMLUnit](#) to compare the XML we created with our sample XML. To do this, make sure the sample XML is available, i.e. that the following class is added to your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

You may also want to see [Using MarkupBuilder for Agile XML creation](#).

Creating XML with Groovy and JDOM

This page last changed on Oct 07, 2006 by [paulk_asert](#).

Here is an example of using [JDOM](#) to create a new XML file:

```
// require(groupId:'xmlunit', artifactId:'xmlunit', version:'1.0')
// require(groupId:'jdom', artifactId:'jdom', version:'1.0')
import javax.xml.parsers.DocumentBuilderFactory
import org.custommonkey.xmlunit.*
import org.jdom.output.XMLOutputter
import org.jdom.*

def addCar(root, name, make, year, country, type, text) {
    def car = new Element('car')
    car.setAttribute('name', name)
    car.setAttribute('make', make)
    car.setAttribute('year', year)
    root.addContent(car)
    def countryCode = new Element('country').setText(country)
    car.addContent(countryCode)
    def record = new Element('record').setText(text)
    record.setAttribute('type', type)
    car.addContent(record)
}

def root = new Element('records')
def document = new Document(root)
document.setRootElement(root)

addCar(root, 'HSV Maloo', 'Holden', '2006', 'Australia',
        'speed', 'Production Pickup Truck with speed of 271kph')
addCar(root, 'P50', 'Peel', '1962', 'Isle of Man',
        'size', 'Smallest Street-Legal Car at 99cm wide and 59 kg in weight')
addCar(root, 'Royale', 'Bugatti', '1931', 'France',
        'price', 'Most Valuable Car at $15 million')

// convert resulting document to a string so that we can compare
XMLUnit.setIgnoreWhitespace(true)
def writer = new StringWriter()
new XMLOutputter().output(document, writer)
def xmlDiff = new Diff(writer.toString(), XmlExamples.CAR_RECORDS)
assert xmlDiff.similar()
```

We have used [XMLUnit](#) to compare the XML we created with our sample XML. To do this, make sure the sample XML is available, i.e. that the following class is added to your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

You may also want to see [Using MarkupBuilder for Agile XML creation](#).

Creating XML with Groovy and XOM

This page last changed on Oct 07, 2006 by [paulk_asert](#).

Here is an example of using [XOM](#) to create a new XML file:

```
// require(groupId:'xmlunit', artifactId:'xmlunit', version:'1.0')
// require(groupId:'xom', artifactId:'xom', version:'1.1')
import javax.xml.parsers.DocumentBuilderFactory
import org.custommonkey.xmlunit.*
import nu.xom.*

def addCar(root, name, make, year, country, type, text) {
    def car = new Element('car')
    car.addAttribute(new Attribute('name', name))
    car.addAttribute(new Attribute('make', make))
    car.addAttribute(new Attribute('year', year))
    root.appendChild(car)
    def countryNode = new Element('country')
    countryNode.appendChild(country)
    car.appendChild(countryNode)
    def record = new Element('record')
    record.appendChild(text)
    record.addAttribute(new Attribute('type', type))
    car.appendChild(record)
}

def root      = new Element('records')
def document = new Document(root)

addCar(root, 'HSV Maloo', 'Holden', '2006', 'Australia',
        'speed', 'Production Pickup Truck with speed of 271kph')
addCar(root, 'P50', 'Peel', '1962', 'Isle of Man',
        'size', 'Smallest Street-Legal Car at 99cm wide and 59 kg in weight')
addCar(root, 'Royale', 'Bugatti', '1931', 'France',
        'price', 'Most Valuable Car at $15 million')

// convert resulting document to a string and compare with expected
XMLUnit.setIgnoreWhitespace(true)
def xmlDiff = new Diff(document.toXML(), XmlExamples.CAR_RECORDS)
assert xmlDiff.similar()
```

We have used [XMLUnit](#) to compare the XML we created with our sample XML. To do this, make sure the sample XML is available, i.e. that the following class is added to your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
    <records>
      <car name='HSV Maloo' make='Holden' year='2006'>
        <country>Australia</country>
        <record type='speed'>Production Pickup Truck with speed of 271kph</record>
      </car>
      <car name='P50' make='Peel' year='1962'>
        <country>Isle of Man</country>
        <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
      </car>
      <car name='Royale' make='Bugatti' year='1931'>
        <country>France</country>
        <record type='price'>Most Valuable Car at $15 million</record>
      </car>
    </records>
    '''
}
```

You may also want to see [Using MarkupBuilder for Agile XML creation](#).

Reading XML using Groovy's DOMCategory

This page last changed on Oct 21, 2006 by [paulk_asert](#).

Information

Java has in-built support for DOM processing of XML using classes representing the various parts of XML documents, e.g. *Document*, *Element*, *NodeList*, *Attr* etc. For more information about these classes, refer to the respective JavaDocs. Some of the key classes are:

DOM class	JavaDocs
Element	1.4.5
NodeList	1.4.5

Groovy syntax benefits can be applied when using these classes resulting in code which is similar to but more compact than the Java equivalent. In addition, Groovy supports the following built-in helper method for these classes.

DOM class	Method	Description/Equivalent longhand
<i>NodeList</i>	<i>.iterator()</i>	same as for loop, enables closures, e.g. <i>findAll</i> , <i>every</i> , etc.

In addition, the *DOMCategory* class provides numerous additional helper methods and syntax shortcuts:

DOM class	Method	Description/Equivalent longhand
<i>Element</i>	<i>.'child'</i> or <i>.child</i> or <i>['child']</i>	similar to <i>.getElementsByTagName('child')</i> but only gets direct children
<i>Element</i>	<i>.children()</i> or <i>.'*'</i> or <i>['*']</i>	special case of above which finds all children regardless of tagname (plus text nodes)
<i>Element</i>	<i>.'@attr'</i> or <i>['@attr']</i>	<i>.getAttribute('attr')</i>
<i>Element</i>	<i>.attributes()</i>	equivalent to <i>.attributes</i> returns a <i>NamedNodeMap</i>
<i>Element</i>	<i>.text()</i>	<i>.firstChild.nodeValue</i> (or <i>textContent</i> if you are using Xerces)
<i>Element</i>	<i>.name()</i>	<i>.nodeName</i>
<i>Element</i>	<i>.parent()</i> or <i>['..']</i> or <i>['..']</i>	<i>.parentNode</i>
<i>Element</i>	<i>.depthFirst()</i> or <i>.'**'</i>	depth-first traversal of nested children
<i>Element</i>	<i>.breadthFirst()</i>	breadth-first traversal of nested children

<i>Node</i>	<i>.toString()</i>	text node value as a <i>String</i>
<i>NodeList</i>	<i>.size()</i>	<i>.length</i>
<i>NodeList</i>	<i>.list()</i>	converted to a list of nodes
<i>NodeList</i>	<i>[n]</i>	<i>.item(n)</i>
<i>NodeList</i>	<i>.text()</i>	<i>.collect{ it.text() }</i>
<i>NodeList</i>	<i>.child</i>	flattened version of <i>.child</i> for each node in the <i>NodeList</i>
<i>NamedNodeMap</i>	<i>.size()</i>	<i>.length</i>
<i>NamedNodeMap</i>	<i>.'child' or .child or ['child']</i>	<i>.getNamedItem(elementName).nodeValue</i>

All these methods return standard Java classes (e.g. *String* and *List*) or standard DOM classes (e.g. *Element*, *NodeList*), so there are no new classes to learn, just some improved syntax.

Example

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
    <records>
      <car name='HSV Maloo' make='Holden' year='2006'>
        <country>Australia</country>
        <record type='speed'>Production Pickup Truck with speed of 271kph</record>
      </car>
      <car name='P50' make='Peel' year='1962'>
        <country>Isle of Man</country>
        <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
      </car>
      <car name='Royale' make='Bugatti' year='1931'>
        <country>France</country>
        <record type='price'>Most Valuable Car at $15 million</record>
      </car>
    </records>
    '''
}
```

Here is an example of using Groovy's DOMCategory:

```
import groovy.xml.DOMBuilder
import groovy.xml.dom.DOMCategory

messages = []

def processCar(car) {
    assert car.name() == 'car'
    def make = car.'@make'
    def country = car.country[0].text()
    def type = car.record[0]. '@type'
    messages << make + ' of ' + country + ' has a ' + type + ' record'
}

def reader = new StringReader(XmlExamples.CAR_RECORDS)
def doc = DOMBuilder.parse(reader)
def records = doc.documentElement

use (DOMCategory) {
```

```
assert 9 == records.'*'.size()
def cars = records.'car'
assert cars[0].parent() == records
assert 3 == cars.size()
assert 2 == cars.findAll{ it.'@year'.toInteger() > 1950 }.size()
def carsByCentury = cars.list().groupBy{
    it.'@year'.toInteger() >= 2000 ? 'this century' : 'last century'
}
assert 1 == carsByCentury['this century'].size()
assert 2 == carsByCentury['last century'].size()
cars.each{ car -> processCar(car) }
}

assert messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
    'Bugatti of France has a price record'
]
```

Reading XML using Groovy's XmlParser

This page last changed on Oct 09, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using XmlParser:

```
def records = new XmlParser().parseText(XmlExamples.CAR_RECORDS)
def allRecords = records.car.size()
assert allRecords == 3
def allNodes = records.depthFirst().size()
assert allNodes == 10
def firstRecord = records.car[0]
assert 'car' == firstRecord.name()
assert 'Holden' == firstRecord.@make
assert 'Australia' == firstRecord.country.text()
// 2 cars have an 'e' in the make
assert 2 == records.car.findAll{ it.@make.contains('e') }.size()
// makes of cars that have an 's' followed by an 'a' in the country
assert ['Holden', 'Peel'] == records.car.findAll{ it.country.text() =~ '.*s.*a.*' }.@make
// types of records
assert ['speed', 'size', 'price'] == records.depthFirst().grep{ it.@type }.@type
// update to show what would happen if 'New Zealand' bought Holden
firstRecord.country[0].value = ['New Zealand']
assert 'New Zealand' == firstRecord.country.text()
// names of cars with records sorted by year
assert ['Royale', 'P50', 'HSV Maloo'] == records.car.sort{ it.@year.toInteger() }.@name
```

Reading XML using Groovy's XmlSlurper

This page last changed on Oct 16, 2006 by [tug](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using XmlSlurper:

```
def records = new XmlSlurper().parseText(XmlExamples.CAR_RECORDS)
def allRecords = records.car
assert 3 == allRecords.size()
def allNodes = records.depthFirst().collect{ it }
assert 10 == allNodes.size()
def firstRecord = records.car[0]
assert 'car' == firstRecord.name()
assert 'Holden' == firstRecord.@make.text()
assert 'Australia' == firstRecord.country.text()
def carsWith_e_InMake = records.car.findAll{ it.@make.text().contains('e') }
assert carsWith_e_InMake.size() == 2
// alternative way to find cars with 'e' in make
assert 2 == records.car.findAll{ it.@make =~ '.*e.*' }.size()
// makes of cars that have an 's' followed by an 'a' in the country
assert ['Holden', 'Peel'] == records.car.findAll{ it.country =~ '.*s.*a.*' }.@make.collect{ it.text() }
def expectedRecordTypes = ['speed', 'size', 'price']
assert expectedRecordTypes == records.depthFirst().grep{ it.@type != '' }.@type*.text()
assert expectedRecordTypes == records.***.grep{ it.@type != '' }.@type*.text()
def countryOne = records.car[1].country
assert 'Peel' == countryOne.parent().@make.text()
assert 'Peel' == countryOne.***.parent().@make.text()
// names of cars with records sorted by year
def sortedNames = records.car.list().sort{ it.@year.toInteger() }.@name*.text()
assert ['Royale', 'P50', 'HSV Maloo'] == sortedNames
assert ['Australia', 'Isle of Man'] == records.***.grep{ it.@type =~ 's.*' }.parent().country*.text()
assert 'co-re-co-re-co-re' == records.car.children().collect{ it.name()[0..1] }.join('-')
assert 'co-re-co-re-co-re' == records.car.***.collect{ it.name()[0..1] }.join('-')
```

Reading XML with Groovy and DOM

This page last changed on Oct 03, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using DOM with Groovy to read an existing XML file:

```
import javax.xml.parsers.DocumentBuilderFactory

messages = []

def processCar(car) {
    if (car.nodeName != 'car') return
    def make = car.attributes.getNamedItem('make').nodeValue
    def country = car.getElementsByTagName('country').item(0).firstChild.nodeValue
    def type = car.childNodes.find{ 'record' ==
it.nodeName }.attributes.getNamedItem('type').nodeValue
    messages << make + ' of ' + country + ' has a ' + type + ' record'
}

def builder = DocumentBuilderFactory.newInstance().newDocumentBuilder()
def inputStream = new ByteArrayInputStream(XmlExamples.CAR_RECORDS.bytes)
def records = builder.parse(inputStream).documentElement

def cars = records.childNodes
(0..<cars.length).each{ processCar(cars.item(it)) }

assert messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
    'Bugatti of France has a price record'
]
```


Reading XML with Groovy and DOM4J

This page last changed on Oct 06, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using [DOM4J](#) with Groovy to process an existing XML file:

```
// require(groupId:'dom4j', artifactId:'dom4j', version:'1.6.1')
import org.dom4j.io.SAXReader

def reader = new StringReader(XmlExamples.CAR_RECORDS)
def records = new SAXReader().read(reader).rootElement
def messages = []

records.elementIterator().each{ car ->
    def make = car.attributeValue('make')
    def country = car.elementText('country')
    def type = car.element('record').attributeValue('type')
    messages << make + ' of ' + country + ' has a ' + type + ' record'
}

assert messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
    'Bugatti of France has a price record'
]
```

DOM4J also supports a streaming mode which lets you manually prune parts of the DOM tree during processing to facilitate processing large documents. Here is an example which uses DOM4J in that mode:

```
// require(groupId:'dom4j', artifactId:'dom4j', version:'1.6.1')
import org.dom4j.io.SAXReader
import org.dom4j.*

class PruningCarHandler implements ElementHandler {
    def messages = []
    public void onStart(ElementPath path) { }
    public void onEnd(ElementPath path) {
        def car = path.current
        def make = car.attributeValue('make')
        def country = car.elementText('country')
        def type = car.element('record').attributeValue('type')
        messages << make + ' of ' + country + ' has a ' + type + ' record'
        car.detach() // prune the tree
    }
}
```

```
}  
  
def xml      = new StringReader(XmlExamples.CAR_RECORDS)  
def reader  = new SAXReader()  
def handler = new PruningCarHandler()  
  
reader.addHandler('/records/car', handler)  
reader.read(xml)  
  
assert handler.messages == [  
    'Holden of Australia has a speed record',  
    'Peel of Isle of Man has a size record',  
    'Bugatti of France has a price record'  
]
```

In the above example, we actually did the processing as part of the `ElementHandler`. Instead, we could have used a hybrid approach which just pruned away parts of the tree we weren't interested in and then performed tree-walking/navigation style coding after that.

Reading XML with Groovy and Jaxen

This page last changed on Oct 06, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using [Jaxen](#) with Groovy to read an existing XML file:

```
// require(groupId:'jaxen', artifactId:'jaxen', version:'1.1-beta-10')
import org.jaxen.dom.DOMXPath
import javax.xml.parsers.DocumentBuilderFactory

messages = []

def processCar(car) {
    def make = new DOMXPath('@make').stringValueOf(car)
    def country = new DOMXPath('country/text()').stringValueOf(car)
    def type = new DOMXPath('record/@type').stringValueOf(car)
    messages << make + ' of ' + country + ' has a ' + type + ' record'
}

def builder = DocumentBuilderFactory.newInstance().newDocumentBuilder()
def inputStream = new ByteArrayInputStream(XmlExamples.CAR_RECORDS.bytes)
def records = builder.parse(inputStream).documentElement

new DOMXPath('//car').selectNodes(records).each{ processCar(it) }

assert messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
    'Bugatti of France has a price record'
]
```

Note: many libraries (e.g. DOM4J, JDOM, XOM) bundle or provide optional support for Jaxen. You may not need to download any additional jars to use it.

Reading XML with Groovy and JDOM

This page last changed on Oct 06, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using [JDOM](#) with Groovy to process an existing XML file:

```
// require(groupId:'jdom', artifactId:'jdom', version:'1.0')
import org.jdom.input.SAXBuilder

def reader    = new StringReader(XmlExamples.CAR_RECORDS)
def records  = new SAXBuilder().build(reader).rootElement
def messages = []

records.children.iterator().each{ car ->
    def make = car.getAttribute('make').value
    def country = car.getChildText('country')
    def type = car.getChild('record').getAttribute('type').value
    messages << make + ' of ' + country + ' has a ' + type + ' record'
}

assert messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
    'Bugatti of France has a price record'
]
```

Reading XML with Groovy and SAX

This page last changed on Oct 03, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using SAX with Groovy:

```
import javax.xml.parsers.SAXParserFactory
import org.xml.sax.helpers.DefaultHandler
import org.xml.sax.*

class RecordsHandler extends DefaultHandler {
    def messages = []
    def currentMessage
    def countryFlag = false
    void startElement(String ns, String localName, String qName, Attributes atts) {
        switch (qName) {
            case 'car':
                currentMessage = atts.getValue('make') + ' of '; break
            case 'country':
                countryFlag = true; break
            case 'record':
                currentMessage += atts.getValue('type') + ' record'; break
        }
    }
    void characters(char[] chars, int offset, int length) {
        if (countryFlag) {
            currentMessage += new String(chars, offset, length)
        }
    }
    void endElement(String ns, String localName, String qName) {
        switch (qName) {
            case 'car':
                messages << currentMessage; break
            case 'country':
                currentMessage += ' has a '; countryFlag = false; break
        }
    }
}

def handler = new RecordsHandler()
def reader = SAXParserFactory.newInstance().newSAXParser().XMLReader
reader.setContentHandler(handler)
def inputStream = new ByteArrayInputStream(XmlExamples.CAR_RECORDS.bytes)
reader.parse(new InputSource(inputStream))

assert handler.messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
]
```

```
] 'Bugatti of France has a price record'
```

Reading XML with Groovy and StAX

This page last changed on Oct 07, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of reading an existing XML file with Groovy and [StAX](#):

```
// require(groupId:'stax', artifactId:'stax-api', version:'1.0.1')
// require(groupId:'stax', artifactId:'stax', version:'1.2.0')
import javax.xml.stream.*

messages = []
currentMessage = ''

def processStream(inputStream) {
    def reader
    try {
        reader = XMLInputFactory.newInstance()
            .createXMLStreamReader(inputStream)
        while (reader.hasNext()) {
            if (reader.startElement())
                processStartElement(reader)
            reader.next()
        }
    } finally {
        reader?.close()
    }
}

def processStartElement(element) {
    switch(element.name()) {
        case 'car':
            currentMessage = element.make + " of "
            break
        case 'country':
            currentMessage += element.text() + " has a "
            break
        case 'record':
            currentMessage += element.type + " record"
            messages << currentMessage
            break
    }
}

class StaxCategory {
    static Object get(XMLStreamReader self, String key) {
        return self.getAttributeValue(null, key)
    }
    static String name(XMLStreamReader self) {
}
```

```
        return self.name.toString()
    }
    static String text(XMLStreamReader self) {
        return self.elementText
    }
}

def bytes = XmlExamples.CAR_RECORDS.bytes
def inputStream = new ByteArrayInputStream(bytes)
use (StaxCategory) { processStream(inputStream) }

assert messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
    'Bugatti of France has a price record'
]
```


Reading XML with Groovy and XOM

This page last changed on Oct 07, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using [XOM](#) with Groovy to process an existing XML file:

```
// require(groupId:'xom', artifactId:'xom', version:'1.1')
import nu.xom.Builder

def reader    = new StringReader(XmlExamples.CAR_RECORDS)
def records  = new Builder().build(reader).rootElement
messages = []

def processCar(car) {
    def make = car.getAttribute('make').value
    def country = car.getFirstChildElement('country').value
    def type = car.getFirstChildElement('record').getAttribute('type').value
    messages << make + ' of ' + country + ' has a ' + type + ' record'
}

def cars = records.childElements
(0..cars.size()).each{ processCar(cars.get(it)) }

assert messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
    'Bugatti of France has a price record'
]
```

Reading XML with Groovy and XPath

This page last changed on Oct 09, 2006 by [paulk_asert](#).

This example assumes the following class is already on your CLASSPATH:

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Here is an example of using XPath with Groovy to read an existing XML file:

```
// require(groupId:'xalan', artifactId:'xalan', version:'2.6.0')
import org.apache.xpath.XPathAPI
import javax.xml.parsers.DocumentBuilderFactory

messages = []

def processCar(car) {
    def make = XPathAPI.eval(car, '@make').str()
    def country = XPathAPI.eval(car, 'country/text()').str()
    def type = XPathAPI.eval(car, 'record/@type').str()
    messages << make + ' of ' + country + ' has a ' + type + ' record'
}

def builder = DocumentBuilderFactory.newInstance().newDocumentBuilder()
def inputStream = new ByteArrayInputStream(XmlExamples.CAR_RECORDS.bytes)
def records = builder.parse(inputStream).documentElement

XPathAPI.selectNodeList(records, '//car').each{ processCar(it) }

assert messages == [
    'Holden of Australia has a speed record',
    'Peel of Isle of Man has a size record',
    'Bugatti of France has a price record'
]
```

XML Example

This page last changed on Oct 04, 2006 by [paulk_asert](#).

```
class XmlExamples {
    static def CAR_RECORDS = '''
        <records>
            <car name='HSV Maloo' make='Holden' year='2006'>
                <country>Australia</country>
                <record type='speed'>Production Pickup Truck with speed of 271kph</record>
            </car>
            <car name='P50' make='Peel' year='1962'>
                <country>Isle of Man</country>
                <record type='size'>Smallest Street-Legal Car at 99cm wide and 59 kg in weight</record>
            </car>
            <car name='Royale' make='Bugatti' year='1931'>
                <country>France</country>
                <record type='price'>Most Valuable Car at $15 million</record>
            </car>
        </records>
    '''
}
```

Regular Expressions

This page last changed on Dec 23, 2006 by [paulk_asert](#).

Groovy supports regular expressions natively using the `~"pattern"` expression, which compiles a Java Pattern object from the given pattern string. Groovy also supports the `=~` (create Matcher) and `==~` (matches regex) operators.

For matchers having groups, `matcher[index]` is either a matched String or a List of matched group Strings, since jsr-03 release.

```
import java.util.regex.Matcher
import java.util.regex.Pattern

assert "cheesecheese" =~ "cheese"
assert "cheesecheese" =~ /cheese/
assert "cheese" == /cheese/ /*they are both string syntaxes*/

// lets create a regex Pattern
def pattern = ~/foo/
assert pattern instanceof Pattern
assert pattern.matcher("foo").matches()

// lets create a Matcher
def matcher = "cheesecheese" =~ /cheese/
assert matcher instanceof Matcher
answer = matcher.replaceAll("edam")

// lets do some replacement
def cheese = ("cheesecheese" =~ /cheese/).replaceFirst("nice")
assert cheese == "nicecheese"

// simple group demo
// You can also match a pattern that includes groups. First create a matcher object, either
// using the Java API, or more simply with the =~ operator. Then, you can index the matcher
// object to find the matches. matcher[0][1] means the 0th match of the whole pattern (with
// the
// =~ operator the pattern may match the string in more than one place), and the 1st group
// within
// that match. Here's how it works:
def m = "foobarfoo" =~ /o(b.*r)f/
assert m[0][1] == "bar"

// fancier group demo
matcher = "\\$abc." =~ "\\$\\$(.*)\\$\\$."
matcher.matches(); // must be invoked [Question: is this still true? Not in my experience
with jsr-04.]
assert matcher.group(1) == "abc" // is one, not zero
// assert matcher[1] == "abc" // This has worked before jsr-03-release
assert matcher[0] == ["\\$abc.", "abc"] // But this should work since jsr-03-release
assert matcher[0][1] == "abc" // This should work since jsr-03-release
```

The pattern can be expressed more simply using the `/` delimiter for the pattern, so we don't have to double all the backslashes.

```
def matcher = "\\$abc." =~ /\$\\$(.*)\\$\\$./ // no need to double-escape!
assert "\\$\\$(.*)\\$\\$." == /\$\\$(.*)\\$\\$./
matcher.matches(); // must be invoked
assert matcher.group(1) == "abc" // is one, not zero
// assert matcher[1] == "abc" // This has worked before jsr-03-release
assert matcher[0] == ["\\$abc.", "abc"] // But this should work since jsr-03-release
assert matcher[0][1] == "abc" // This should work since jsr-03-release
```

Since a Matcher coerces to a boolean by calling its **find** method, the `=~` operator is consistent with the simple use of Perl's `=~` operator, when it appears as a predicate (in 'if', 'while', etc.). The

"stricter-looking" `==~` operator requires an exact match of the whole subject string.

Regular expression support is imported from Java. Java's regular expression language and API is documented [here](#).

More Examples

```
def before='''
apple
orange
banana
'''

def expected='''
Apple
Orange
Banana
'''

assert expected == before.replaceAll(/(?m)^\w+/, {it[0].toUpperCase() + it[1..-1]})
```

Scoping and the Semantics of "def"

This page last changed on Mar 31, 2007 by [paulk_asert](#).

Note: This page may not follow the explanations from the JLS.

Java has two basic informal rules for scoping:

Principle #1: "A variable is only visible in the block it is defined in and in nested blocks".

Principle #2: "A variable can't be visible more than one time".

Java does know classwide variables and local variables. Local variables are defined as method parameter or inside the method block. Classwide variables are defined as attributes of the class. Of course Java does violate this first principle I showed at top here a little since I can access class wide variables from outside the class, if the access modifier is for example public. A local variable of the same name as an attribute does not violate the second principle, as the attribute is hidden by the local variable and with this no longer visible without using a qualifier like "this".

Now, what about Groovy?

In Groovy we also have these two principles, but since we have different constructs, we may lay out these principles in a different way. Let us start with local variables.

- In Groovy you are neither allowed to define two local variables of the same name, just like in Java.
- You are allowed to hide an attribute by defining a local variable of the same name, just like in Java.

So what is different?

Scripts are. When you define a variable in a script it is always local. But methods are not part of that scope. So defining a method using different variables as if they were attributes and then defining these variables normally in the script leads to problems. Example:

```
String attribute = "bar"
void aMethod(){
    assert attribute == "bar" // Not allowed !
}
aMethod()
```

Executing this code you get an exception talking about a missing property or field.

The only things the method has access to are:

- the binding,
- attributes defined by the base class, and
- the dynamic properties defined by the MetaClass (explanations for these will follow).
"attribute" here is no field, no property, no dynamic defined property and not part of the binding.

When is something in the Binding and when not?

That's easy. When it is not defined, it is in the binding.

```
String localVar = "I am a local variable"
bindingVar = "I am a binding variable"
```

The trick is - and that is admittedly not easy for Java programmers - to **not** to define the variable before using it, and it will go into the binding. Any defined variable is local. **Please note: the binding exists only for scripts.**

What is this "def" I heard of?

"def" is a replacement for a type name. In variable definitions it is used to indicate that you don't care about the type. In variable definitions it is mandatory to either provide a type name explicitly or to use "def" in replacement. This is needed to make variable definitions detectable for the Groovy parser.

These definitions may occur for local variables in a script or for local variables and properties/fields in a class.



Rule of thumb

You can think of "def" as an alias of "Object" and you will understand it in an instant.

Future Groovy may give "def" an additional meaning in terms of static and dynamic typing. But this is post Groovy 1.0.

"def" can also replace "void" as the return type in a method definition.

```
def dynamic = 1
dynamic = "I am a String stored in a variable of dynamic type"
int typed = 2
typed = "I am a String stored in a variable of type int?" // throws ClassCastException
```

The assignment of a string, to a variable of type int will fail. A variable typed with "def" allows this.

A Closure is a block

In the terms of the principles above a closure is a block. A variable defined in a block is visible in that block and all blocks that are defined in that block. For example in Java:

```
{
    int i=1;
    {
        System.out.println (i);
    }
}
```

Such a block may be defined freely as in the example above, or by loops, synchronized statements,

try-catch, switch, ... all that has "{".

In Groovy we have an additional structure with "{", the closure. To follow the principles above, it is not allowed to define two variables of the same name in a closure.

```
def closure = { int i; int i }
```

And of course, the same for combinations with nested closures.

```
def outer = {  
    int i  
    def inner = { int i }  
}
```

A block ends with its corresponding "}". So it is allowed to reuse that name later in a different block.

```
def closure1 = { parameter ->  
    println parameter  
}  
def closure2 = { parameter ->  
    println parameter  
}
```

Both closures define a local variable named "parameter", but since these closures are not nested, this is allowed. **Note: unlike early versions of Groovy and unlike PHP, a variable is visible in the block, not outside. Just like in Java.**

And "it"?

"it" is a special variable name, that is defined automatically inside a closure. It refers always to the first parameter of the closure, or null, if the closure doesn't have any parameters.

```
def c = { it }  
assert c() == null  
assert c(1) == 1
```

When using nested closures (closures in closures) the meaning of "it" depends on the closure you are in.

```
def outer = {  
    def inner = { it+1 }  
    inner(it+1)  
}  
assert outer(1) == 3
```

You see, that "it" is used two times, the "it" in "inner" means the first parameter of the closure "inner", the following "it" means the first parameter of "outer". This helps a lot when copying code from one place to another containing closure that are using it.

The keyword "static"

"static" is a modifier for attributes (and methods, but this is not at issue here). It defines the "static scope". That means all variables not defined with "static" are not part of that static scope and as such not visible there. There is no special magic to this in Groovy. So for an explanation of "static" use any Java book.

Scripts and Classes

This page last changed on Apr 25, 2006 by xavier.mehaut@free.fr.

Classes are defined in Groovy similarly to Java. Methods can be class (static) or instance based and can be public, protected, private and support all the usual Java modifiers like synchronized. Package and class imports use the Java syntax (including static imports). Groovy automatically imports the following:

- java.lang
- java.io
- java.math
- java.net
- java.util
- groovy.lang
- groovy.util

One difference between Java and Groovy is that by default things are public unless you specify otherwise.

Groovy also merges the idea of fields and properties together to make code simpler, please refer to the [Groovy Beans](#) section for details of how they work.

Each class in Groovy is a Java class at the bytecode / JVM level. Any methods declared will be available to Java and vice versa. You can specify the types of parameters or return types on methods so that they work nicely in normal Java code. Also you can implement interfaces or overload Java methods using this approach.

If you omit the types of any methods or properties they will default to java.lang.Object at the bytecode/JVM level.

You can also use another class implemented in Groovy. e.g.

```
//Callee.groovy
class Callee {
    void hello() {
        println "hello, world"
    }
}
```

```
//Caller.groovy
c = new Callee()
c.hello()
```

```
groovy -cp . caller
```

Make sure the classpath is OK.

Scripts

Groovy supports plain scripts, which do not have a class declaration. Imports are supported at the front of a script in the same way that they can be at the front of a class. Here's the hello world script:

```
println "Nice cheese Gromit!"
```

You can [run](#) scripts in the [interactive terminal](#), from the [command-line](#), in your [IDE](#), as a [Unix script](#), or [embeded](#) in your own Java code.

If you compile the above script to bytecode using [groovyc](#), you get a single class named after the name of the script. e.g. if this was saved in `Foo.script` you'd get a `Foo.class` file.

You can run this Java code on the command line (assuming you're classpath has `groovy.jar` and `asm.jar`).

```
java Foo
```

This will execute the autogenerated `main(String[] args)` method in the bytecode which instantiates the `Foo` class, which extends the [Script](#) class and then call its `run()` method. You may also use this class directly in Java code, passing in variables to the script.

```
import groovy.lang.Binding;
import groovy.lang.Script;

public class UseFoo {
    public static void main(String[] args) {
        // lets pass in some variables
        Binding binding = new Binding();
        binding.setVariable("cheese", "Cheddar")
        binding.setVariable("args", args)

        Script foo = new Foo(binding);
        foo.run();
    }
}
```

There's no need to use a `Binding` if you don't want to; `Foo` will have a no-argument constructor as well. Though using a `Binding` you can easily pass in variables. After the end of the script any variables created will be in the `Binding` for you to access in Java.

Unlike classes, variables are not required to be declared (`def` is not required) in scripts. Variables referenced in a script are automatically created and put into the `Binding`.

Scripts and functions

If you just want to write some simple scripts and need some simple functions you can declare functions without writing a class.

One difference from normal class-based groovy is that the `def` keyword is required to define a function outside of a class.

Here's an example of a simple script with a function. Note that if ever you need things like static or instance variables and so forth then maybe its time to actually write a class 😊

```
def foo(list, value) {  
    println "Calling function foo() with param ${value}"  
    list << value  
}  
  
x = []  
foo(x, 1)  
foo(x, 2)  
assert x == [1, 2]  
  
println "Creating list ${x}"
```

Statements

This page last changed on Jan 12, 2007 by [catalan42](#).

Groovy uses a similar syntax to Java although in Groovy semicolons are optional. This saves a little typing but also makes code look much cleaner (surprisingly so for such a minor change). So normally if one statement is on each line you can omit semicolons altogether - though its no problem to use them if you want to. If you want to put multiple statements on a line use a semicolon to separate the statements.

```
def x = [1, 2, 3]
println x
def y = 5; def x = y + 7
println x
assert x == 12
```

If the end of the line is reached and the current statement is not yet complete it can be spanned across multiple lines. So for things like method parameters or creating lists or for complex if expressions you can span multiple lines.

```
def x = [1, 2, 3,
        4, 5, 6]
println(
    x
)
if (x != null &&
    x.size() > 5) {
    println("Works!")
}
else {
    assert false: "should never happen ${x}"
}
```

Comments

The characters `"/"` begin a comment that last for the rest of the line.

```
print "hello"    // This is a silly print statement
```

The characters `"/"` **begin a comment that lasts until the first `"/`**.

```
/* This is a long comment
   about our favorite println */
println "hello"
```

The character `"#"` is not a comment character.

```
// This doesn't work:
# Bad comment
```

Method calls

Method calling syntax is similar to Java where methods can be called on an object (using dot) or a method on the current class can be called. Static and instance methods are supported.

```
class Foo {
    calculatePrice() {
        1.23
    }

    static void main(args) {
        def foo = new Foo()
        def p = foo.calculatePrice()
        assert p > 0

        println "Found price: " + p
    }
}
```

Notice that the *return* statement is optional at the end of methods. Also you don't need to specify a return type (it will default to Object in the bytecode if none is specified).

Optional parenthesis

Method calls in Groovy can omit the parenthesis if there is at least one parameter and there is no ambiguity.

```
println "Hello world"
System.out.println "Nice cheese Gromit!"
```

Named parameter passing

When calling a method you can pass in named parameters. Parameter names and values are separated by a colon (like the Map syntax) though the parameter names are identifiers rather than Strings.

Currently this kind of method passing is only implemented for calling methods which take a Map or for constructing JavaBeans.

```
def bean = new Expando(name:"James", location:"London", id:123)
println "Hey " + bean.name
assert bean.id == 123
```

Passing closures into methods

Closures are described in more detail

[here](#). Closures can be passed into methods like any other object

```
def closure = { param -> param + 1 }
def answer = [1, 2].collect(closure)
assert answer == [2, 3]
```

Though there is some syntax sugar to make calling methods which take a closure easier. Instead of specifying parenthesis, you can just specify a closure. e.g.

```
answer = [1, 2].collect { param -> param + 1 }
assert answer == [2, 3]
```

The above code is equivalent to the previous code, just a little more groovy. If a method takes parameters you can leave the closure outside of the parenthesis (provided that the closure parameter is the last parameter on the underlying method).

```
def value = [1, 2, 3].inject(0) { count, item -> count + item }
assert value == 6
```

The above code is equivalent to the following (but just neater)

```
def value = [1, 2, 3].inject(0, { count, item -> count + item })
assert value == 6
```

Important Note

Note that when using the neater syntax for specifying closures either without parenthesis or by specifying the closure after the parenthesis, the closure must start on the same line. i.e. the { symbol must be on the same line as the method call statement. Otherwise the parser interprets the { as a start of a block.

Dynamic method dispatch

If a variable is not constrained by a type then dynamic method dispatch is used. This is often referred to as *dynamic typing* whereas Java uses *static typing* by default. You can mix and match both dynamic and static typing in your code by just adding or removing types. e.g.

```
def dynamicObject = "hello world".replaceAll("world", "Gromit")
dynamicObject += "!"
assert dynamicObject == "hello Gromit!"
String staticObject = "hello there"
staticObject += "!"
assert staticObject == "hello there!"
```

Properties

These are described in more detail in the [Groovy Beans](#) section. To access properties you use dot with the property name. e.g.

```
def bean = new Expando(name:"James", location:"London", id:123)
def name = bean.name
println("Hey ${name}")
bean.location = "Vegas"
println bean.name + " is now in " + bean.location
assert bean.location == "Vegas"
```

The above uses a special bean called Expando which allows properties to be added dynamically at runtime.

An Expando is a Map which behaves as a dynamic bean: adding new key/value pairs add the equivalent getter and setter methods, as if they were defined in a real bean.

Safe navigation

If you are walking a complex object graph and don't want to have NullPointerExceptions thrown you can use the ?. operator rather than . to perform your navigation.

```
def foo = null
def bar = foo?.something?.myMethod()
assert bar == null
```


Strings

This page last changed on Oct 01, 2006 by [etellman](#).

Groovy uses both " and ' for strings. Either can be used. Using either type of string allows you to use strings with quotations easily.

```
println "he said 'cheese' once"
println 'he said "cheese!" again'
```

The groovy parser supports the notation `\uab12` (i.e. a leading backslash and precisely four hex digits after the 'u').

This notation can be used in strings or anywhere in the program like the Java parser does.

Concatenation

Strings may be concatenated with "+". For example:

```
#!/usr/bin/env groovy

a = "world"
print "hello " + a + "\n"
```

Multi-line strings

Regular strings in Groovy cannot span multiple lines.

As an exception to this rule, a backslash at the end of a line disappears and joins the current line with the next.

```
// this is a compile error
def foo = "hello
```

If you have a block of text which you wish to use but don't want to have to encode it all (e.g. if its a block of HTML or something) then you can use the `"""` syntax.

```
def name = "James"
def text = """\
hello there ${name}
how are you today?
"""

assert text != null
println(text)
```

Because of the leading backslash, the string `text` contains exactly two newlines. There are always represented by the character `'\n'`, regardless of the line-termination conventions of the host system.

String literals

It is possible to use another notation for String literals with the added benefit of not needing additional backslashes to escape special characters. That is especially handy with regular expressions.

```
def s = /.foo.*/
def dirname = /^.*\//
def basename = /[^\s/]+$/
```

For more information, read about [regular expression](#).

Strings are immutable

This can be seen with these two code snips, which you can cut and paste into groovyConsole:

```
st = ["status":"test"]
sn = st
println sn
st.status = "tset"
println sn
```

Above both variables are references to the map.

If you do the same thing with Strings, the behavior is different:

```
st = "test"
sn = st
println sn
st = "tset"
println sn
```

Here is the explanation by Guillaume Laforge:

sn and st point at the very same map object in memory in the first example, while in the second snippet, at the end, st points at a different place in memory where there's the new immutable string.

GStrings

Strings that are declared inside double-quotes (i.e. either single double-quotes or tripled double-quotes for multi-line strings) can contain arbitrary expressions inside them as shown above using the `${expression}` syntax in a similar way to JSP EL, Velocity and Jexl. Any valid Groovy expression can be enclosed in the `${...}` including method calls etc. GStrings are defined the same way as normal Strings would be created in Java.

What actually happens is whenever a string expression contains a `${...}` expression then rather than a normal `java.lang.String` instance, a [GString](#) object is created which contains the text and values used inside the String. GString uses lazy

evaluation so its not until the `toString()` method is invoked that the `GString` is evaluated.

This lazy evaluation is useful for things like logging as it allows the calculation of the string, the calls to `toString()` on the values and the concatenation of the different strings to be done lazily if at all.

Another use case for `GString` is [GroovySql](#) where parameters can be passed into SQL statements using this same mechanism which makes for a neat way to integrate Groovy with other languages like SQL. `GroovySql` then converts the expressions to `?` and uses a `JDBC PreparedStatement` and passes the values in, preserving their types.

If you explicitly want to coerce the `GString` to a `String` you can use the `toString()` method. Groovy can also automatically coerce `GStrings` into `Strings` for you.

Things to remember

This page last changed on Apr 10, 2007 by [tomstrummer](#).

Strings

- Strings are not Lists. In the JVM `java.lang.String` does not implement `java.util.List`.
- Arrays are not Lists. In the JVM arrays and `java.util.List` are quite different. In Groovy we support both as different types to ensure we interoperate cleanly with Java code. Though we try wherever possible to make them interchangeable and appear polymorphic.

Maps

- Maps override the dot operator, so `myMap.size` will return null unless you have a value for `map[size]`. Use `map.size()` or `map.@size` instead.
- In map literals, all keys are interpreted as strings by default! If you want to use a variable or other literal as a key, use parentheses like so: `myMap = [(var1):val, (var2):val]`
- See the [Maps user guide](#)

Using Static Imports

This page last changed on Apr 28, 2007 by [paulk_asert](#).

Groovy's *static import* capability allows you to reference imported classes as if they were static methods in your own class. This is similar to Java's *static import* capability but works with Java 1.4 and above and is a little more dynamic than Java in that it allows you to define methods with the same name as an imported method as long as you have different types. If you have the same types, the imported class takes precedence. Here is a sample of its usage:

```
import static java.awt.Color.LIGHT_GRAY
import static Boolean.FALSE as F
import static Calendar.getInstance as now
import static Integer.*

println LIGHT_GRAY
// => java.awt.Color[r=192,g=192,b=192]

println !F
// => true

println now().time
// => Sun Apr 29 11:12:43 EST 2007

println "Integers are between $MIN_VALUE and $MAX_VALUE"
// => Integers are between -2147483648 and 2147483647

def toHexString(int val, boolean upperCase) {
    def hexval = upperCase ? toHexString(val).toUpperCase() : toHexString(val)
    return '0x' + hexval
}
println toHexString(15, true)
// => 0xF
println toHexString(15, false)
// => 0xf
```

The first static import illustrates defining `LIGHT_GRAY` as if it was defined locally as a static field. The next two examples show renaming (called *aliasing*) of a field and a method respectively. The final example illustrates wild-carding for fields and methods and also selecting between the locally defined `toHexString` and imported `toHexString` based on parameter matching.

IDE Support

This page last changed on Sep 26, 2006 by [paulk_asert](#).

Groovy is supported by the following IDEs and related tools:

- [Debugging with JSwat](#)
- [Eclipse Plugin](#)
 - [Debugging with Eclipse](#)
 - [Eclipse GroovyConsole](#)
 - [Eclipse Plugin Development](#)
 - [Code Completion Proposal](#)
 - [GroovyEclipse Specifications and Technical Articles](#)
 - [The Classloader Conundrum](#)
 - [GroovyEclipse Wish List](#)
 - [Eclipse Plugin FAQ](#)
- [IntelliJ IDEA Plugin](#)
 - [GroovyJ Features and Wish List](#)
 - [GroovyJ Status](#)
 - [IDEA Open API](#)
- [IntelliJ IDEA Plugin \(JetBrains Edition\)](#)
 - [Wish List \(JetBrains Edition\)](#)
- [JEdit Plugin](#)
- [NetBeans Plugin](#)
- [Oracle JDeveloper Plugin](#)
- [Other Plugins](#)
 - [Emacs Plugin](#)
 - [UltraEdit Plugin](#)
- [TextMate](#)

Debugging with JSwat

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Overview

With Groovy 1.0 JSR-05, it is possible to use JSwat to step-debug with Groovy. JSwat is an open source debugger that uses the Java Platform Debugger Architecture. JSwat is available from the project home page at <http://www.bluemarsh.com/java/jswat/>. Version 2 is based on Swing and JDK 1.4. Version 2 is also available as a jEdit plugin. Version 3 of JSwat requires Java 5 and is build on the Netbeans Platform API. The instruction below pertain to using JSwat v3.9 .

You can use JSwat to debug uncompiled scripts as well compiled Groovy classes. You can step into Groovy methods and classes. You can also pull the Groovy runtime source and step from a script into the underlying Groovy runtime support classes.

Configuring JSwat

Running Windows XP, all configuration settings are stored in `%USERPROFILE%\jswat`. If you want to save the settings somewhere else, you can pass that directory on the command line. For example, if I was to save my settings in `c:\myCustomJswatDir`, type `jswat --userdir c:\myCustomJswatDir` .

Before you get started debugging, you have to configure JSwat classpath and source directory settings. In JSwat, you associate your runtime settings with *session* name. Groovy jars can be added to your debug session classpath by selecting *Session->Settings*. In the dialog box that comes up, you change the default session name to something more meaningful, like *Groovy Scripting* . Then click on the *Classes* tab and the *Add Jars/Folder* button to add the Groovy runtime jars. Navigate to your `GROOVY_HOME\lib` directory and *Shift-click* all of the jars to add them all at once. Click on the *Sources* tab and add the directory that contains the scripts you want to debug.

Debugging a Script

To simplest way to get started debugging is to open your script in JSwat, using *File->Open File*. Single click in the left gutter next the source line you want for a breakpoint. Then click on *Sesion->Start* . In the Launch Debuggee dialog, enter `groovy.lang.GroovyShell` for the Class Name:, and the name of your script, i.e. `HelloWorld.groovy` for Class Arguments:. Click the *Launch* button and you're now stepping through through your code.

Debugging Compiled Groovy Classes

Compile of your classes with `groovyc`. Add the directory with the compiled classes to the session classpath by clicking *Session->Settings->Classes->Add Jar/Folder*. Open your source file in JSwat using *File->Open File* and single click in the left gutter next the source line you want for a breakpoint. Then click on *Sesion->Start* . In the Launch Debuggee dialog, enter the name of the compiled Groovy class, i.e. `HelloWorld.class`, that has a `main()` in it. Click the *Launch* button and you're now stepping through through your code.

Stepping into the Groovy Runtime

Download the Groovy source archive and unzip it into %GROOVY_HOME%. Add %GROOVY_HOME%\src\main to the session sources by clicking *Session->Settings->Sources->Add Jar/Folder*. If click *Step Into* on a line of source in your script, you will then drop into Groovy runtime and be able to step through that Java code. This is a great way to see what is going on under the covers.

Stepping over the Java and Groovy Runtime

If you're only concerned with stepping into one Groovy script from another and want to bypass all the runtime code, click on *Tools->Options->Debugging->General->Stepping Excludes* and add the packages you want skip. The following list would probably be a good starting point: *groovy., org.codehaus.groovy., gjdk., java., sun.*,org.apache.**


Debugging Compiled JUnit Tests

Use *junit.textui.TestRunner* or *groovy.lang.GroovyShell* for the Class Name and your test class for the Class Arguments.




Eclipse Plugin

This page last changed on Mar 06, 2007 by [ogourment](#).

The Groovy Eclipse Plugin allows you to edit, compile and run groovy scripts and classes.

 Note that the plugin is work in progress. You can check the current status of the plugin here: [issues and bugs](#)

Eclipse version compatibility

-  Eclipse 3.0 : not working; there are dependencies to the 3.1 API.
-  Eclipse 3.1 : working
-  Eclipse 3.2 : working

Update Site

The update site containing the most recent release is here:
<http://dist.codehaus.org/groovy/distributions/update/>

- Go to: **Help -> Software Updates -> Find and Install -> Search For New Features**
- Click on **New Remote Site**
- Enter a name (eg: Groovy) in the **Name** field
- Copy the URL from above into the **URL** field and press **OK**
- **Check** the new Groovy repository and press **finish**
- Under **Select the Features to Install** check the Groovy check box (be sure to get the latest version) and press **Next**
- Accept the agreement and press **Next**
- If the default location looks okay press **Finish** (this will download the plugin)
- If you get a warning that the plugin is unsigned click **Install** or **Install All**

This should download and install the Groovy plugin. It may require a restart of Eclipse to make sure it is loaded okay.

Create a Groovy Project

To create a basic Groovy project in Eclipse perform the following steps:

- Go to: **File -> New -> Project**
- Select **Java Project** and press **Next**
- In the **Project Name** field enter the name of your project (GroovyJava for this example)
- Under **Project Layout** select **Create separate source and output folders** and press **Finish**
- In the **Package Explorer** find the newly created project, right click, and select **Groovy -> Add Groovy Nature**

So far you should have a **src** folder, a **bin-groovy** folder, and several libraries. There is also a **bin** folder that was created by Eclipse, but is hidden due to exclusion filters. The next steps are needed to make the

bin-groovy folder the default output folder, and to connect it to the **src** folder so that the debugger will know where to find the associated source and classes:

- In the **Package Explorer**, right click on the "GroovyJava" project, and select: **Build Path -> Configure Build Path**
- Use the **Browse** button to change the **Default Output Folder** from **bin** to **bin-groovy**
- Press **OK, OK**

This will expose the **bin** folder in the **Package Explorer**. I'm not sure why the plugin creates a **bin-groovy** directory. Perhaps there are other "bin" files that are best kept separate from the Groovy classes, or perhaps one of the original versions of Eclipse didn't create a "bin" directory automatically. Some day when someone has a clear idea of the usefulness of this, or lack thereof, we can clean up my instructions.

Download and build from Subversion

This section is for those who want to do development work on the Eclipse plugin. More specific information regarding the wish-list and standards can be found at [Eclipse Plugin Development](#).

See the [Codehaus Subversion page](#) for general information on how to access the repository.

See the [Subversion home page](#) if you are new to Subversion in general.

To simply view the plugin code, use [FishEye](#).

Checkout the plugin modules by running the following commands:

```
> svn co http://svn.codehaus.org/groovy/trunk/groovy/ide/groovy-eclipse/GroovyEclipse
> svn co http://svn.codehaus.org/groovy/trunk/groovy/ide/groovy-eclipse/GroovyBrowsing
```

The above folders already contain all the information Eclipse needs to create the project properly (i.e. .project, .classpath and other files). From Eclipse, "Import" the projects into your workspace.

Detailed description of how to checkout using the Eclipse Subclipse plugin:

1. Select the Window -> Open Perspective->Other -> SVN Repository Exploring.
2. In the context menu of the SVN Repository pane, select New Repository Location
3. Enter the following URL: <http://svn.codehaus.org/groovy/>
4. Open these folders: **/trunk/groovy/ide/groovy-eclipse/GroovyEclipse** and **/trunk/groovy/ide/groovy-eclipse/GroovyBrowsing**
5. Right-click to get its context menu and select **Check out** (not Check out as)
6. Now you should have two projects called GroovyEclipse and GroovyBrowsing in your package explorer view

Testing the plugin

It might be useful to test the plugin before you export it and use it in your main eclipse installation. To accomplish this

1. Simply select or double click the file called **plugin.xml** from the GroovyEclipse project. This should bring up an editor for the plugin description; the first page should be called **Overview**.
2. In this page, select the link **Launch an Eclipse application**. This should start a new Eclipse instance in which you have no projects.
 - You may optionally select **Launch an Eclipse application in Debug mode**. If you do, you will be able to edit the plugin code, and have your changes take effect immediately (hot code replacement). This is very useful if you are developing things and want to test your changes without stopping and restarting the runtime workbench. Note that there are certain limitations to this; it does not work with changing the plugin.xml file.
3. Create a new Java project and configure the project (perhaps adding a package first).
4. Create a new Groovy class named GTest. Do this on the context (right mouse button) menu of the package in which you want your groovy class; like so: New -> Other -> Groovy -> Groovy Class.
5. You will be asked if you wish to "Add runtime groovy support and auto build to project?". Say yes.
6. Fill in the groovy code of your desire, for example something like this:

```
class GTest {
    static void main(args) {
        def list = ["Rod", "Phil", "James", "Chris"]
        def shorts = list.findAll { it.size() < 5 }
        shorts.each { println it }
    }
}
```

Running the example above

1. In the Project Explorer, select GTest.groovy, then right mouse-click and Run -> Run
2. In the Run pop-up, select Groovy in the list of configurations, then click New, and click the Search button to search for the Main class.

The GTest class should appear in the list of Groovy classes to run. Select it and click OK.
3. Click Apply, then Run... check your console view, it should read Rod, Phil...

🟢 THAT'S IT!

Exporting the plugin

To export the plugin for use with your main eclipse installation follow these simple instructions:

1. Select the **plugin.xml** file in the GroovyEclipse project.
2. Select the link **Export Wizard**
3. In Available Plug-ins and Fragments, check both org.codehaus.groovy.eclipse and org.codehaus.groovy.eclipse.codebrowsing
4. In Export destination -> Archive file: enter a filename, e.g. org.codehaus.groovy.eclipse_1.0.0.zip
5. (Optionally, you may wish to check the 'Package plug-ins as individual jar archives' option under Export options. This is a new export format used by Eclipse 3.1, however the old format also works fine with Eclipse 3.1.)
6. Click Finish, and you are done.

Installing the plugin

The zip file you just created is now just like any other plugin zip file, that can be unzipped under the

eclipse root directory. To install the plugin:

1. Shutdown Eclipse
2. Open the zip file and extract its content to the eclipse root directory. You should check that either a folder or jar has been created under eclipse/plugin:
 - Either a directory `org.codehaus.groovy.eclipse_1.0.0`
 - or a jar file `org.codehaus.groovy.eclipse_1.0.0.jar` if you checked the 'Package plug-ins as individual jar archives' option when exporting the plugin.
3. Restart Eclipse to install the Groovy plugin

Debugging with Eclipse

This page last changed on Dec 12, 2006 by [jshickey](#).

It is possible to step through compiled Groovy classes in Eclipse using the Java Debugger by doing the following:

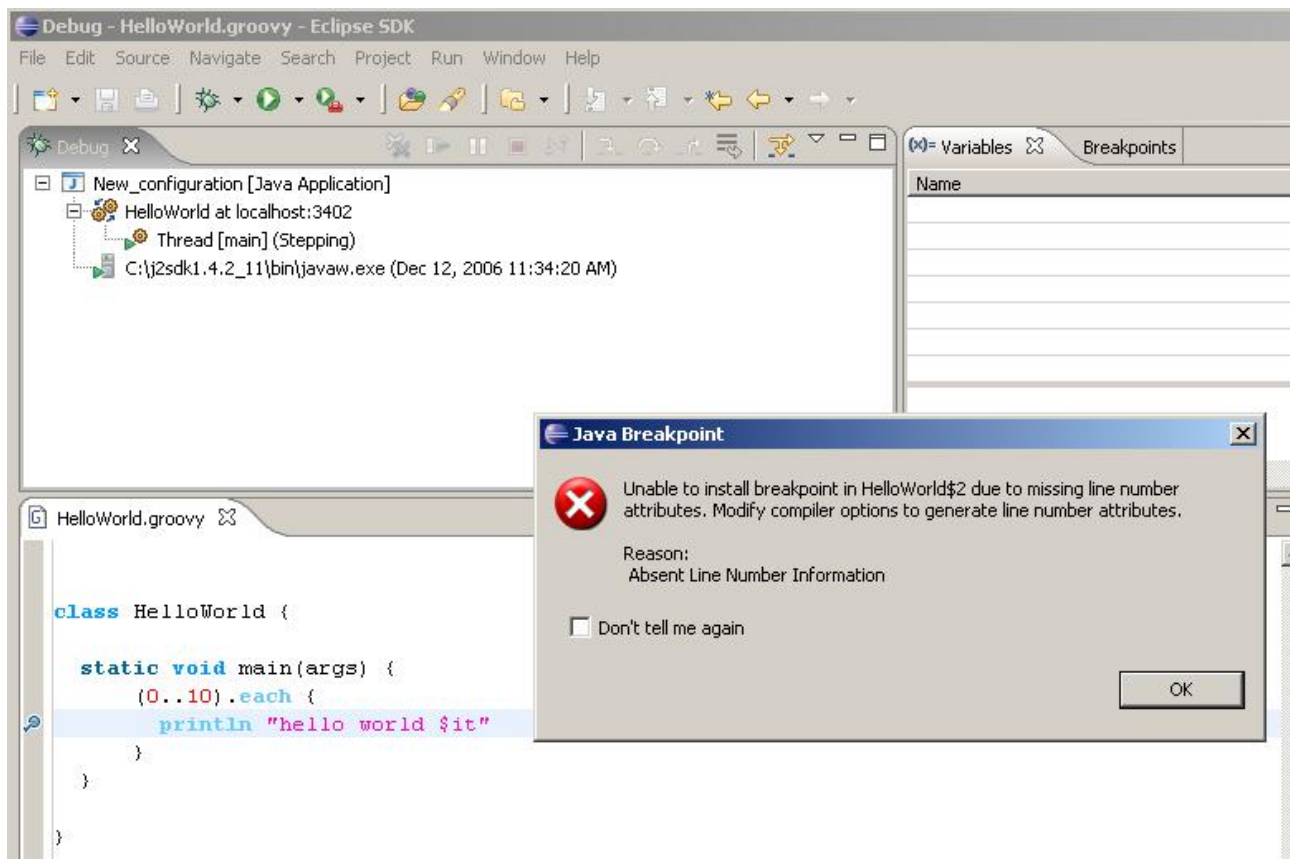
1. Setup "Step filtering" in Eclipse Window->Preferences->Java->Debug->Step Filtering to enable filtering the default packages and add filtering the following packages: `org.codehaus.*`, `groovy.*`
2. Select Project,Debug and in the popup screen
 - a. Select `Java Application` (not Groovy)
 - b. Select `New` at the bottom
 - Give an appropriate name (use the Class that you are about to debug)
 - Type the project name that has the class or select using the Browse button
 - Enter the name of the main class

Setup Debugging for JUnit Test Cases

1. This is the same process as above with the following exceptions:
 - In the Main tab, the main class is always `junit.textui.TestRunner`
 - In the Arguments tab, the program arguments is where the appropriate class name (use the Class that you are about to debug) is entered. (eg. - `mypackge.HelloWorld`).

Debugging isn't perfect yet in the plugin but it very usable. Note that you will have to "step into" in closures instead of stepping "over" them; even though they are in the same file, a separate class is created for each closure. Also, when inspecting variables, you may need to drill down through the metaclass to get to the object you are trying to inspect. Adding nicely formatted `toString()` methods to your Groovy objects greatly facilitates debugging.

The first time you try to debug a closure in Eclipse, you will receive a dialog box like the one below. Click



Eclipse GroovyConsole

This page last changed on Jan 14, 2007 by [tomstrummer](#).

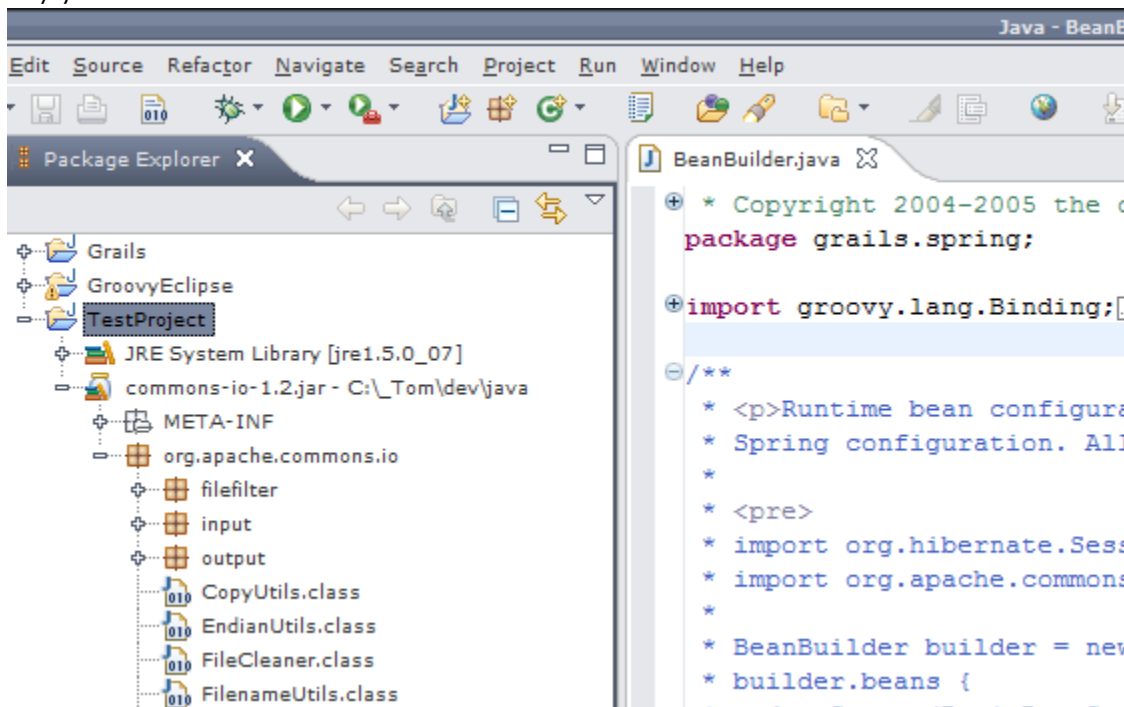
The [Eclipse Plugin](#) can be used to launch a Groovy Console or Groovy shell* from any Groovy **or** Java project. When the console is launched, *you will have access to all classes on the project's build path.*

This is an easy way to quickly test any Java or Groovy code and immediately view the output. The typical alternative would be to create a JUnit test, run the test, check the output, modify the code, run the test, check the output modify the code.... In any case, this is a lot easier because you can do it all without terminating the JVM.

Example Usage

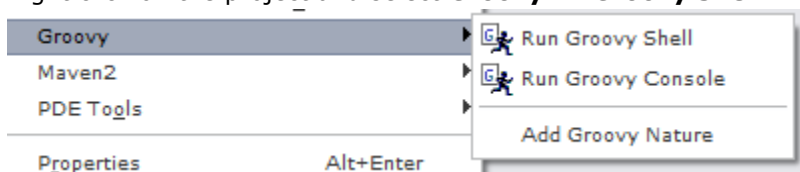
You can use the Groovy Console from Eclipse to quickly inspect the functionality of your Java code, or even to inspect the output of a not-so-well-documented third-party library. This is particularly convenient because you don't have to create a JUnit test.

Say you want to test the `FilenameUtils` class...

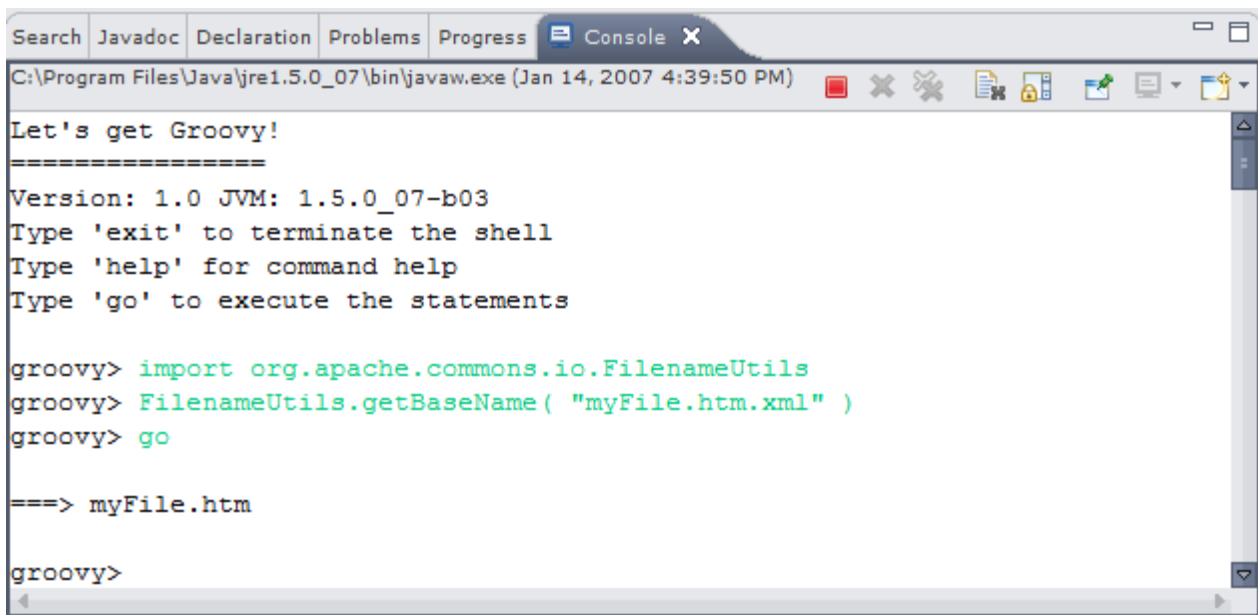


Note that this is a plain Java project.

Right click on the project and select **Groovy -> Groovy Shell**



Test the classes in the Eclipse console:

The screenshot shows the Eclipse IDE's Console window. The title bar indicates the path 'C:\Program Files\Java\jre1.5.0_07\bin\javaw.exe (Jan 14, 2007 4:39:50 PM)'. The console output starts with 'Let's get Groovy!' followed by a separator line. It then displays 'Version: 1.0 JVM: 1.5.0_07-b03' and instructions: 'Type \'exit\' to terminate the shell', 'Type \'help\' for command help', and 'Type \'go\' to execute the statements'. The user enters 'groovy> import org.apache.commons.io.FilenameUtils', 'groovy> FilenameUtils.getBaseName("myFile.htm.xml")', and 'groovy> go'. The output shows '===> myFile.htm' and the prompt returns to 'groovy>'.

```
Let's get Groovy!
=====
Version: 1.0 JVM: 1.5.0_07-b03
Type 'exit' to terminate the shell
Type 'help' for command help
Type 'go' to execute the statements

groovy> import org.apache.commons.io.FilenameUtils
groovy> FilenameUtils.getBaseName( "myFile.htm.xml" )
groovy> go

===> myFile.htm

groovy>
```

Note that you still had to type the **import ...** statement. That is because, as in any Groovy script, you need an import or a fully qualified class name. The important thing here, is that all project libraries and code are immediately accessible in the Groovy shell.

The Groovy Swing-based console can be used as well, but since it takes significantly longer to load the GUI, it is often more convenient to run the command-line shell for simple tests.

Future Improvements

A future goal is to integrate the Groovy console with the Eclipse debugger. One could then dynamically exercise code from the console, then modify the code. Through the magic of Eclipse's hot code replace, the developer could 'work it' until it demonstrates the correct behavior – all in one invocation of the JVM.

Notes:

- The Groovy shell is the class name for the console that runs on the command line, without Java Swing widgets.

Eclipse Plugin Development

This page last changed on Apr 12, 2007 by [emp](#).

Overview

This page is intended to make it easier for those who want to do development on the Eclipse Plugin. It's purpose is define what features should be available in the plugin, what source code modules are implement those features. It would also be good to include links to outside reference material that is directly relevant to the development of this type of plugin.

[Eclipse FAQ for implementing support for your own language](#)

Tracing

The Groovy plugin uses the built in tracing support to output debugging messages. While doing Eclipse plugin development, you can enable tracing in Eclipse by selecting Run->Debug->Tracing and selecting which plugins you want to see messages for. Use the static method `GroovyPlugin.trace("some message")` to output debug messages instead of `System.out.println` (or `log4j`).

Text Editor Syntax Color Highlighting

Features / Proposed Changes:

- Highlight GJDK keywords (could be done in `org.codehaus.groovy.eclipse.editor.GroovyTagScanner`)
- Highlight methods (requires accessing Document Model / Groovy AST)
- Highlight expressions inside of GStrings (requires accessing document model)
- Enable/Disable these features with a Groovy preferences page

Syntax color highlighting is accomplished in `org.codehaus.groovy.eclipse.editor.GroovyPartitionScanner.java` and `org.codehaus.groovy.eclipse.editor.GroovyTagScanner.java`.

Look at the Groovy outliner `org.codehaus.groovy.eclipse.editor.contentoutline.GroovyContentOutline.java` to understand how the Eclipse DOM works and how to access the Abstract Syntax Tree for a Groovy compilation unit.

Debugger

[Eclipse.org Article on writing your own debugger](#)

Features / Proposed Changes:

- Update the breakpoint code to create Java breakpoints to support using the Java debugger (`org.codehaus.groovy.eclipse.actions.ToggleGroovyBreakpointAction`)

- Enable the variable window to display user friendly values for Groovy reference objects to avoid drilling down to see the actual value

Builder / Nature

Features / Proposed Changes:

- Add preferences page option to enable/disable saving all compiled class files to project build directory after the source files are saved

Preferences Page

Features:

GroovyEclipse Wish List

[GroovyEclipse Wish List](#)

Code Completion

[Code Completion Proposal](#)

Specification and Technical Articles

[GroovyEclipse Specifications and Technical Articles](#)

Code Completion Proposal

This page last changed on Feb 07, 2007 by [emp](#).

Code Completion Proposal

The contents of this documents are subject to change at any time!

Note that the underscore `_` is used to indicate the current location of the caret.

Reconciling Changes

The Quick Path

In order to get up to speed with actual completions, we can take advantage of the dynamic nature of groovy. That is, any expression that looks like a variable or property will compile to an AST. So say we want to complete "toString", then `mystr.toS` is a valid Groovy expression and will compile.

The reconciler will attempt to recompile the Groovy class whenever a completion is requested. In many cases the class will compile without error, and an `ASTNode` is available with which to compute possible completions.

The Best Path

An error correcting parser is required to deal with cases where the source code cannot be compiled. For example:

```
for (my_) { } // for expression is not complete
for (i in my_) // no braces
for (i in my_) { // unclosed braces.
```

All of the above can be recovered from with various changes to the groovy.g grammar and custom error correcting code where needed.

Code Completion

Completion Contexts

Completion only makes sense in certain contexts: Outside a class: A package:

```
package com._
```

An import:

```
import a._
```

A variable access/method call/class name:

```
my_
```

A property access/method call:

```
a.my_
```

Inside a class:

Completion for overriding methods, super class fields and method calls. Inside a method: fields, methods, local, parameters Inside a closure: as in inside a method, but also specialized, for example, Grails constraints definitions.

Code completion

Given an ASTNode, we want to know its type. A single magic method, `getType(ASTNode node)`, is needed. This method returns the type if it is known, or request it from other sources. Some examples or type sources: a type inference engine, using a database of predefined completions for that name, or even asking the user. h3. Completion Processor Plug-ins The completion engine uses a collection of completion processor plugins to create a completion list. For any completion case, a completion processor which is linked to some completion context and some ASTNode class, can be implemented. For example:

```
class MyFrame extend JFrame {  
  int party;  
  getParty_ // completions: add getParty() getter, or override getPreferredSize()  
}
```

In this way, completions can be implemented by individuals without affecting the main code base, and when they are ready for release, they can be released as a plugin or rolled into a main completion plugin. Completion plugins will be sent the following information: If the completion is in the form of a single identifier (like a variable name or method name), then the ASTNode and the partial name will be sent to the completion processor. For example:

```
def myMethod() { do_ }
```

The completion processor will get the ASTNode representing 'do' as well as the string 'do'.

For completions that look like property accesses, the ASTNode of the parent will be sent to the processor:

```
def myMethod(){ thing.do_ }
```

The ASTNode for 'thing' and the prefix 'do' is sent to the processor. If there is not prefix like in the case

of 'thing._', then the prefix is null.

Completion Without Inference

This is quite easy: `getType(ASTNode node)` simply returns the type of the `ASTNode`. If the node represents a statically typed name, then the type is returned. Else `java.lang.Object` is returned.

Type Inference

Unless the Groovy code is being used from Java, quite often names are not statically typed. Luckily, at some point types can be found because of Groovy's close ties with Java.

Simple Inference

Local variable initializers and assignments:

```
def myInt = 10 // An Integer
```

```
myInt = "Twenty" // A String
```

Field initializers and assignments:

As above.

Return types of method calls.

Parameters:

```
def myMethod(a, b) { }
```

Searching for calls within the same class will often give us a type.

Conundrum: Methods may return different types in Groovy. Does `getType()` return an array?

The Fun Stuff aka, Not So Easy Inference

Complex assignments:

```
def myInt = 10 + 20 + thing[20] / otherThing
```

Keeping track of list types:

```
def list = [10]
```

```
list[0].toH_ // complete with toHexString()
```

Completing on Subtypes:

```
java.awt.Shape myShape = ...
```

```
myShape.width // assumes shape might be a Rectangle2D
```

How far does one go? How fast is this? What happens in this case:

```
Object myShape // Yikes, the whole class path can be a completion.
```

GroovyEclipse Specifications and Technical Articles

This page last changed on Apr 12, 2007 by [emp](#).

The Classloader Conundrum

An article describing the class loader problems faced by GroovyEclipse in order to support different versions of Groovy.

The Classloader Conundrum

This page last changed on Apr 12, 2007 by [emp](#).

GroovyEclipse and the ClassLoader Conundrum

Note that this document is likely to contain inaccuracies at this time - in its current form it should be thought of as a brain storm. This ClassLoader business has been known to explode heads, and so learning about it progresses at a slow and careful pace.

The Problem

A problem with implementing GroovyEclipse in Groovy is that development is tied to a single version of Groovy. If compilation is allowed with another version of Groovy, duplicate classes will occur which leads down the path of pain.

Example:

```
groovy-1.0.jar          groovy-1.0-all.jar
GroovyEclipse           /-----> SomeClass AST
Some Analysis-----/
```

Now the analysis which uses a ClassNode class loaded from groovy-1.0.jar is trying to analyze some AST which contains a ClassNode loaded from groovy-1.0-all.jar. These are not equal, and so the JVM will make that fact known in the most unpleasant way possible.

The Solutions

Do Nothing

GroovyEclipse is locked to the current release of Groovy. This sucks but it is the current state of affairs.

Maintain Multiple GroovyEclipses

Maintain multiple GroovyEclipses locked to the different Groovy versions. The programmer needs to enable different versions of GroovyEclipse and restart the IDE for the change to take place.

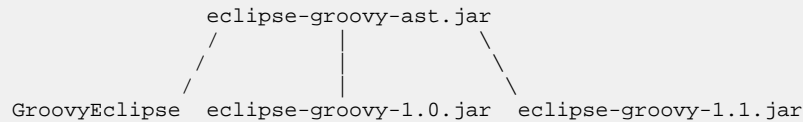
This is not very nice if working on different projects that depend on different versions of Groovy.

Create Plugins that Wrap groovy-*.jar

Enable whichever one you need and restart the IDE for the change to take place. The end result is similar to maintaining multiple GroovyEclipse versions.

Hope and pray that the `org.codehaus.groovy.ast.*` packages don't change

Extract these packages into their own jar. Maintain custom groovy versions that link to this common jar. These groovy versions also contain implementations of the compilation interface, `IGroovyCompiler`. The programmer can select a version per project/global scope. So:



The `eclipse-groovy-*.jars` implement `IGroovyCompiler` extending a compilation extension point. `GroovyEclipse` loads these extensions and can use which ever one is necessary. Multiple interfaces may be loaded by a class loader without problems.

This might even work. As long as extracting `eclipse-groovy-ast.jar` is feasible in the long term. For each version of Groovy, there is a little work to package it up as a `GroovyEclipse` plugin.

Code the plugin in Java

And drive `GroovyEclipse` developers to take up fishing ... forever. And there will still be class loader problems, just not as many.

Convince Groovy developers to extract interfaces for AST classes

Yes, that's it. No, probably not. However `GroovyEclipse` could have such interfaces and implementations that are simply proxies for the AST. This is a lot of work, but probably the most future proof. New features would be extension interfaces. And since this is only for analysis, the proxies would only be created on demand when analysis tools want an AST.

There is still the problem of ASTs containing references to classes in the groovy runtime. And also, how much work is really involved? AST interfaces. AST visitor interfaces, which means a new visitor implementation. What else? And will it never be necessary to dip into the groovy runtime itself?

Conclusion

There is still much to be understood and more schemes to think about. The solutions above are a first crack at trying to find a solid solution to the class loader problem. Hopefully a better solution and easy to integrate solution will surface with a little more brainstorming.

GroovyEclipse Wish List

This page last changed on Apr 16, 2007 by uwe.hartl@gmx.net.

This is a wish list to help guide further development of GroovyEclipse. Please add your own entries, and increment the vote count for features that interest you.

Refactoring

rename method/variables (+4)

extract method (+3)

extract variable

inline method/variable

Groovy Source Editor

Code Formatting (+7)

Typing

Automatically insert braces at the right position.

Quote insertion. Either automatically step over the second quote when typed or don't do it at all. Perhaps a disable property would work.

Tab indenting with spaces

Pressing the tab key to create an indent should honor the formatting settings, i.e. if "use spaces" is set, the tab key should insert space characters, not a tab.

Code Assist

Any type of automatic insertion of code falls under this category.

Code Complete

Complete within Method Scope (+2) (+3)

Need to be able to set tab length to 2 spaces

Complete - in the repository, prerelease coming soon.

This feature is in progress. Typed and simple inferred typed completions within method scope for types, properties and methods should be in the repository by the 3rd week of March.

Complete within Module Scope (+5)

This is where completions of packages and imports.

Code Assistance

Code Templates (+3)

As with Java, type 'for' and get 'for (i in 0..n) { }'.

Override Method (+3)

Complete - in the repository, prerelease coming soon.

Within the scope of the class, type the start of the method to override and hit ctrl+space.

Implement Getter/Setter (+1)

Type 'get' or 'set' and choose from a list of possible getters and setters to insert a default implementation.

Quickfixes for Compiler Errors (+4)

Auto Import on Completion (+8)

In the works

Organize Imports

Code Browsing

Hyperlink To Type (+5)

This features exists but does not function fully. Ctrl + Click sometimes works. It needs to be rewritten and 'done right'

Find All References (+4)

Type Hierarchy (+2)

Groovy Search (+2)

Much like Java search.

Outline View

Enable sorting (alphabetical order/Order of appearance in File) and filtering (show or hide: private, public, fields, getters & setters, constructors)

Testing

Ability to run Groovy based tests in a similar fashion to standard JUnit tests, with matching green/red runner results view.

This would be the familiar "Run as Groovy test" and has a view recording the test results.

Debugger

Filtering of Stack Traces (+3)

This should be selectable (somewhere something like a Checkbox or so) either you see the full stack or you see only Groovy classes in your project.

A Groovy-aware Display view (+2)

Like the Java "Display" view in the debugger, but able to evaluate groovy expressions within the current context.

Documentation

On-line Help (+1)

The definitive documentation for the Groovy Eclipse Plugin should be available in the Eclipse on-line help.

Showing documentation (+6)

Method documentation of the function or the class documentation while hovering over the word (just like in the Java plugin)

Add Doc in the style of the Java Plugin

When sitting on a method definition or class definition, and opening the popup-menu there should be an entry: "Create Block Comment", which should result in something like:

```
/**
 * @param
 * @param
 * @return
 */
```

There should be another popup-menu Entry: "Update Block Comment", which should check if the comment is there already it should check, if all parameters are there and add or delete if necessary (just dreaming 😊)

Miscellaneous

Running/managing groovy scripts

The IDE understands a groovy script that is not a class, showing it's attributes in the object browser, allowing the user to run it and see the results, etc.

Eclipse Plugin FAQ

This page last changed on Apr 16, 2007 by uwe.hartl@gmx.net.

1. **When I try to debug my application, the plugin says that it can't find the source?** This is most commonly caused by trying to debug the application with Groovy Launch configuration instead of a Java Launch configuration.
2. **When I load a Groovy file, the outline view is blank?** The outline uses information returned from the Groovy compiler. If something is preventing the file from being compiled, then the outline view will remain blank until a successful compilation takes place.
3. **When I edit a Groovy file, the outline view doesn't update?** The outline uses information returned from the Groovy compiler. The compiler is invoked when the Eclipse starts up and after each file change. If something is preventing the file from being compiled, then the outline view won't change until a successful compilation takes place.
4. **When my Application throws an Exception, the Stack Trace is not filtered for the Groovy Files:**

You can filter with this method:

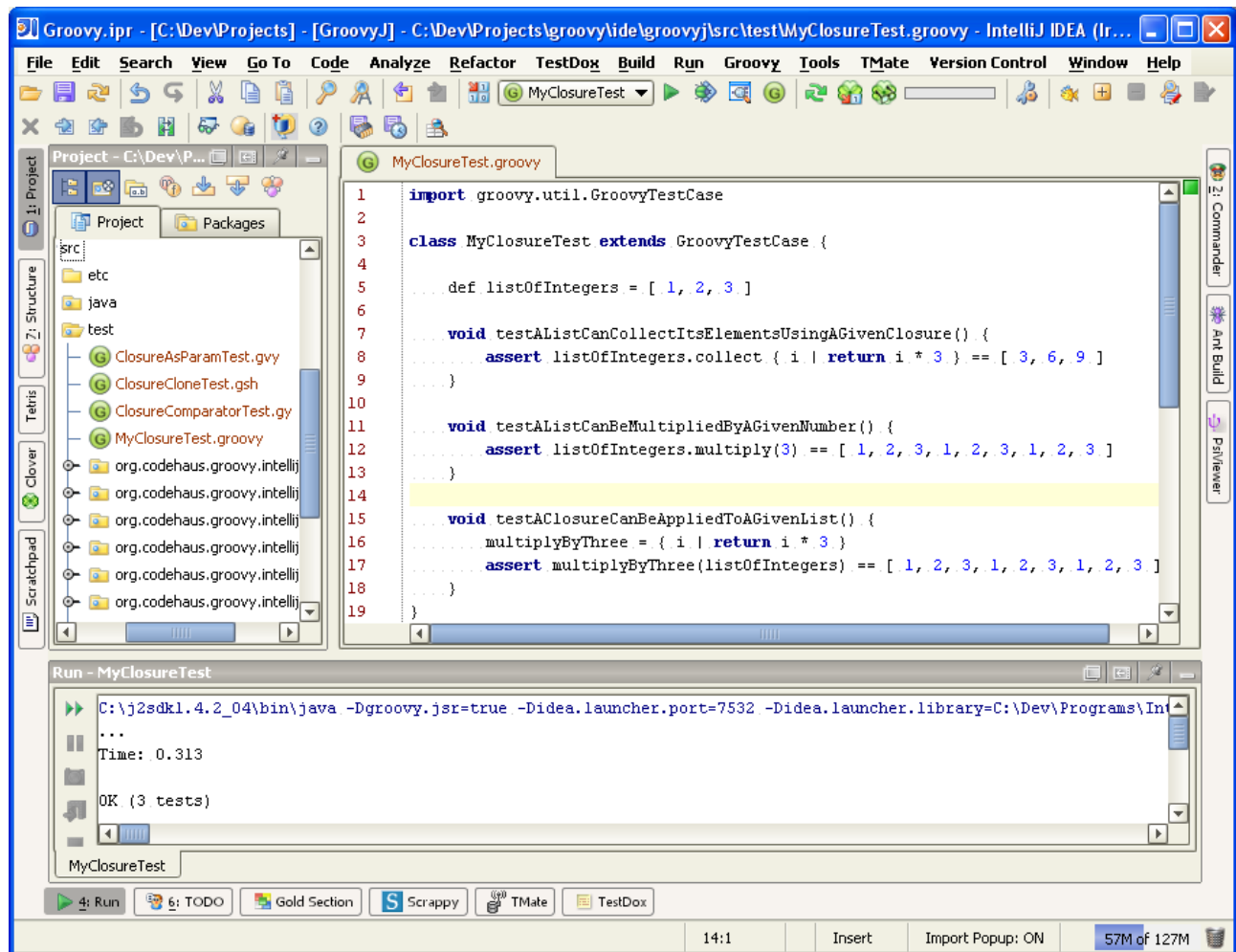
```
def pst(e){
    def newTrace = []
    e.stackTrace.each{te->
        if (te.toString() =~ /.*/groovy:\d*/) newTrace << te
    }
    e.stackTrace = newTrace
    e.printStackTrace()
}
```

5.

IntelliJ IDEA Plugin

This page last changed on Sep 24, 2006 by [paulk_asert](#).

With GroovyJ, we're aiming to offer full integration of Groovy into JetBrains' [IntelliJ IDEA](#).



Latest News



Availability

The first public release of *GroovyJ* is available through IDEA's plug-in manager under the **Custom Languages** category and requires IDEA 5.0 build #3378 or higher, which you can download from the [IntelliJ Early Access Program \(EAP\)](#) site and use with a free and time-limited license. *You will need to create an EAP account in order to download EAP builds.*

We provide a few pages to help you track the status of the plug-in:

- [GroovyJ Status](#)
- [GroovyJ Features and Wish List](#)
- [IDEA Open API](#)

Releases

New versions of *GroovyJ* will be released through IntelliJ IDEA's [Plug-in Repository](#) and will be announced on the [Plugins](#) forum.

Miscellaneous

In case you had previously copied the [Groovy Script Files.xml](#) syntax file to one of the following locations:

- <USER_HOME>/IntelliJ IDEA/config/filetypes (Unix/Windows)
- ~/Library/Preferences/IntelliJ IDEA/filetypes (Mac OSX)

you will need to shutdown IDEA and remove that file prior to downloading the plug-in.













CVS modules

The [groovy-intellij](#) module which targeted IDEA 4.5 has been superseded by the [groovyj](#) module which targets the forthcoming IDEA 5.0.






GroovyJ Features and Wish List

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Prioritised Features

1.  [GROOVY-602](#) Run groovy classes and scripts
2.  [GROOVY-607](#) Compile groovy classes and scripts
3.  [GROOVY-797](#) Groovy plugin should include a default runtime for scripts
4.  [GROOVY-601](#) Syntax highlighting
5.  [GROOVY-604](#) Provide parsing errors and warnings
6.  [GROOVY-605](#) Automatic imports
7.  [GROOVY-606](#) Add auto-completion facilities
8.  [GROOVY-608](#) Provide refactoring capabilities (within groovy, java to groovy, and groovy to java)
9.  [GROOVY-603](#) Run GroovyTestCases as unit tests with the integrated JUnit runner
10.  [GROOVY-614](#) Provide an Outline/File structure view

Wish List













1.  [GROOVY-610](#) Easy navigation between scripts and classes
2.  [GROOVY-774](#) code beautifier for groovy
3.  [GROOVY-611](#) Intention actions (light bulbs / quick fixes)
4.  [GROOVY-787](#) IDEA/File Explorer/New/Groovy File
5.  [GROOVY-784](#) Scratchpad tool window to play interactively with Groovy



Alternative

The [BSF Console](#) plug-in offers a console for executing Groovy scripts interactively.

Open JIRA Issues

jira.codehaus.org (22 issues)					
T	Key	Summary	Pr	Status	Res
	GROOVY-1776	GroovyJ 0.1.9 corrupts compiler caches in IDEA		 Open	UNRESOLVED
	GROOVY-914	Implement Groovy PSI tree construction		 In Progress	UNRESOLVED
	GROOVY-601	Syntax highlighting		 Open	UNRESOLVED
	GROOVY-954	Add Colours and Fonts tab for the Groovy file type		 Open	UNRESOLVED

	GROOVY-603	Run GroovyTestCases as unit tests		 Open	UNRESOLVED
	GROOVY-1607	Java version check fails for Java 6		 Open	UNRESOLVED
	GROOVY-605	Automatic imports		 Open	UNRESOLVED
	GROOVY-611	Intention actions		 Open	UNRESOLVED
	GROOVY-614	Add an Outline/File structure pane		 Open	UNRESOLVED
	GROOVY-608	Provide refactoring capabilities		 Open	UNRESOLVED
	GROOVY-606	Add auto-completion facilities		 Open	UNRESOLVED
	GROOVY-604	Provide parsing errors and warnings		 Open	UNRESOLVED
	GROOVY-610	Easy navigation between scripts and classes		 Open	UNRESOLVED
	GROOVY-1798	NoSuchMethod error in GroovyJ - Idea 6.0.5 beta		 Open	UNRESOLVED
	GROOVY-774	code beautifier for groovy		 Open	UNRESOLVED
	GROOVY-795	Cannot reference a Groovy class from a Java class		 Open	UNRESOLVED
	GROOVY-796	You can create duplicates of Java classes with Groovy classes		 Open	UNRESOLVED
	GROOVY-1738	Color settings not saving		 Open	UNRESOLVED
	GROOVY-1753	Cannot run Groovy script in IDEA 6.0.5 beta		 Open	UNRESOLVED
	GROOVY-784	Scratchpad tool window to play interactively with Groovy		 Open	UNRESOLVED
	GROOVY-827	test non fatal error messages		 Open	UNRESOLVED
	GROOVY-787	IDEA/File Explorer/New/Groovy File		 Open	UNRESOLVED

GroovyJ Status

This page last changed on Sep 24, 2006 by [paulk_asert](#).

This page gathers information about the status of GroovyJ and recaps the milestones of the development.

GROOVY-797 - Default Groovy Runtime

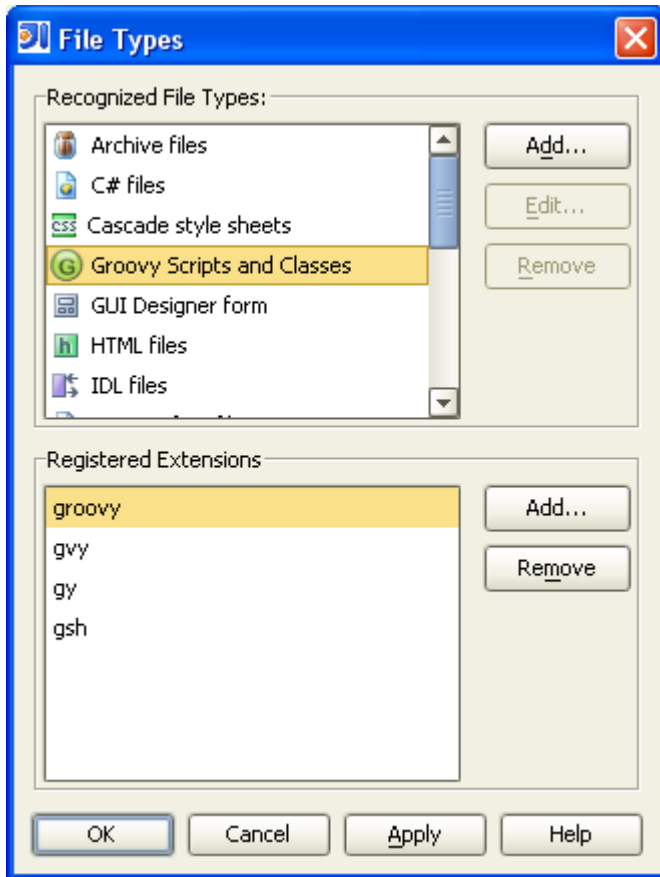
The plug-in automatically installs the Groovy runtime (*currently a snapshot of the forthcoming JSR-03 release*) as a **global library** prefixed with "**Groovy from GroovyJ**".

From then onwards, whenever a module is added to a given IDEA project, this Groovy runtime is automatically selected as a module dependency for your convenience. This facilitates the seamless execution and compilation of Groovy scripts and classes in very much the same way as ordinary Java classes.

As new versions of the plug-in are made available through IDEA's plug-in manager, installing upgrades will transparently update the default Groovy runtime. This mechanism **will not** interfere with your current IDEA setup, in particular if you would rather use a different version of Groovy to run your scripts.

FileType support

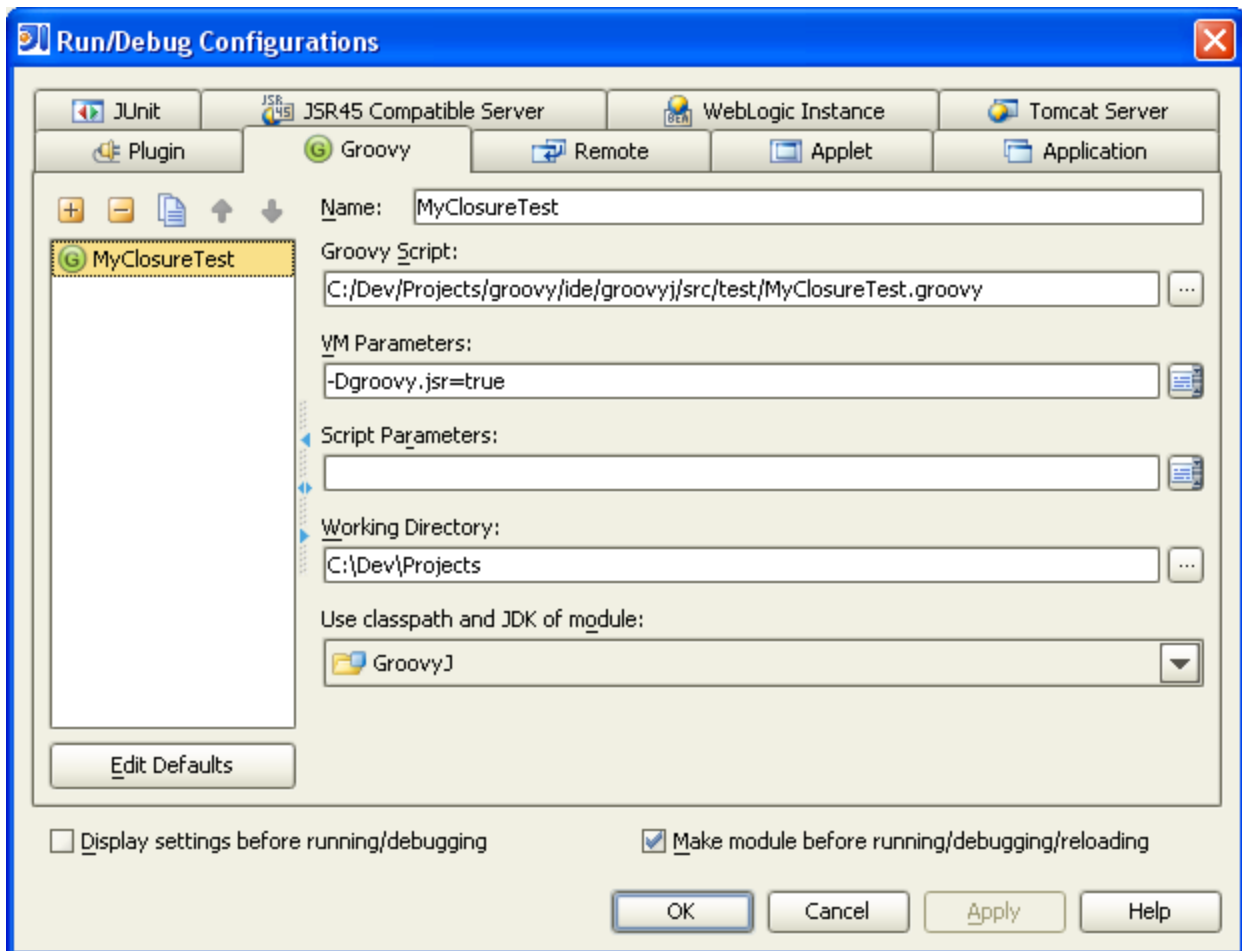
The plug-in automatically registers Groovy into IDEA's file type subsystem. Thus files with one of the **groovy**, **gvv**, **gy**, and **gsh** file extensions are recognised as Groovy scripts and treated as such as illustrated in the screenshot below:

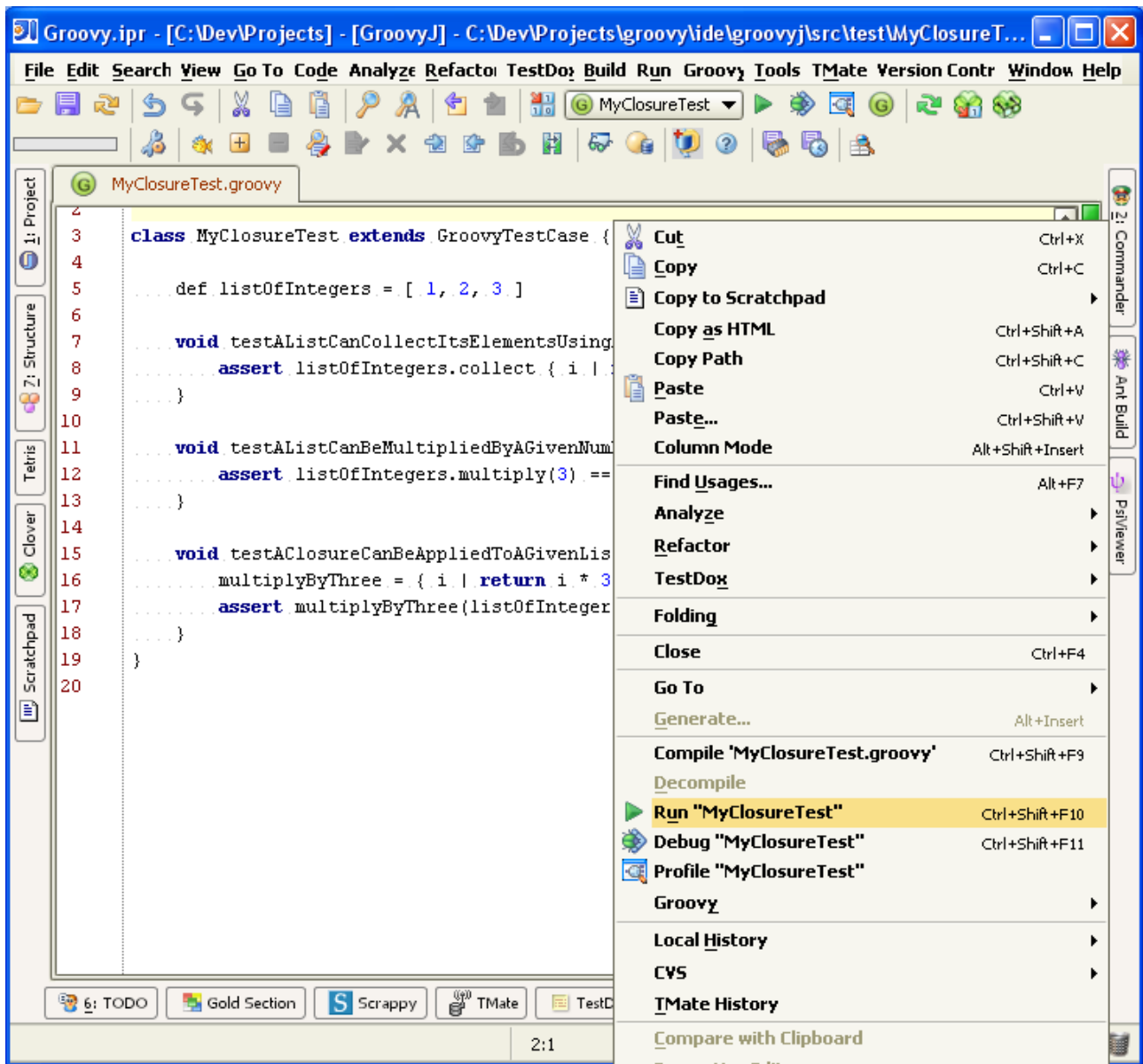


Currently, syntax highlighting (see [GROOVY-601](#)) is done using IDEA's built-in highlighter for J2SE 5. This is because Groovy's JSR grammar was itself derived from the ANTLR grammar for J2SE 5.

GROOVY-602 - Run Configuration

GroovyJ allows users to run scripts and classes, just like they would run Java programs in IDEA:

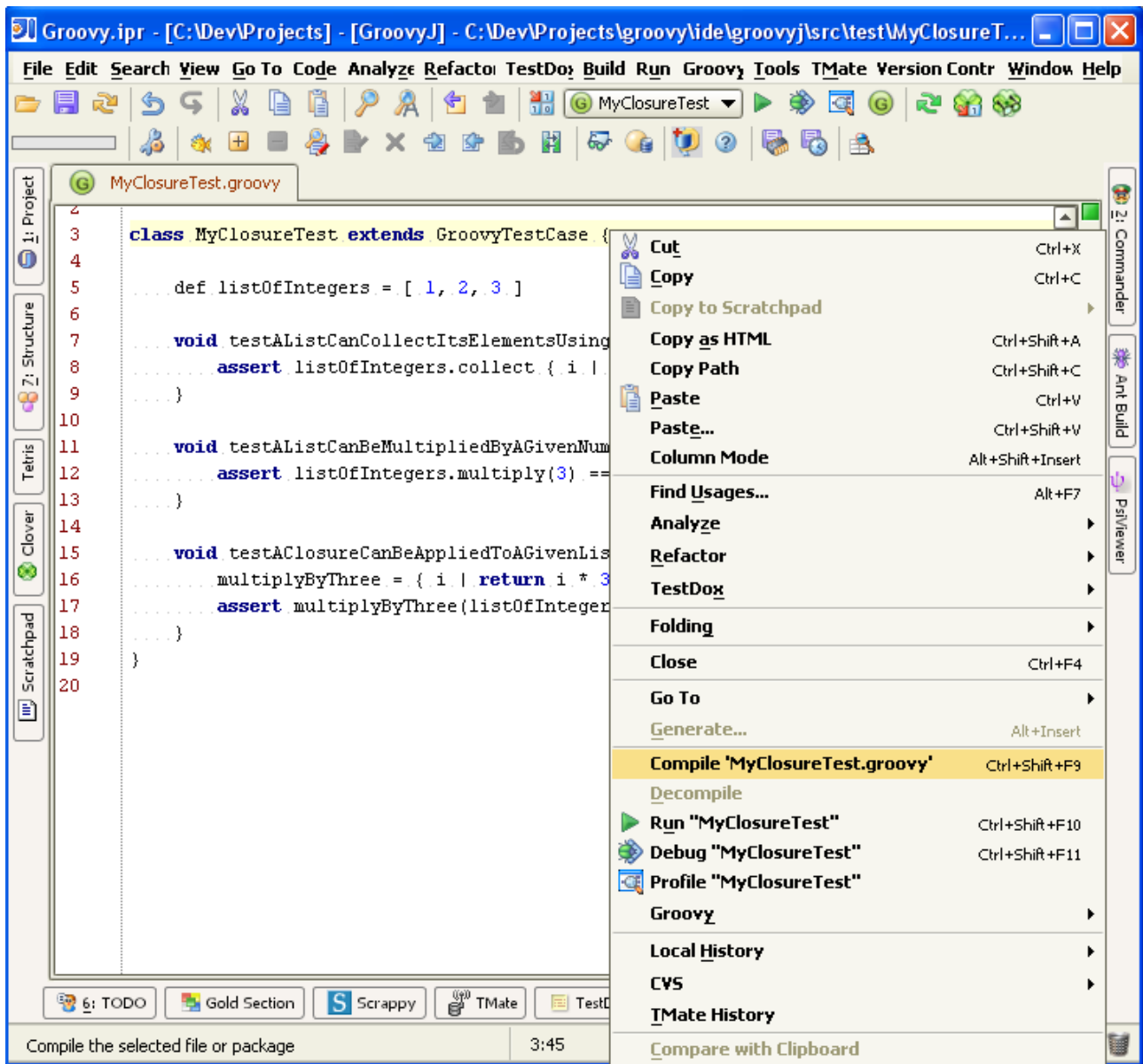




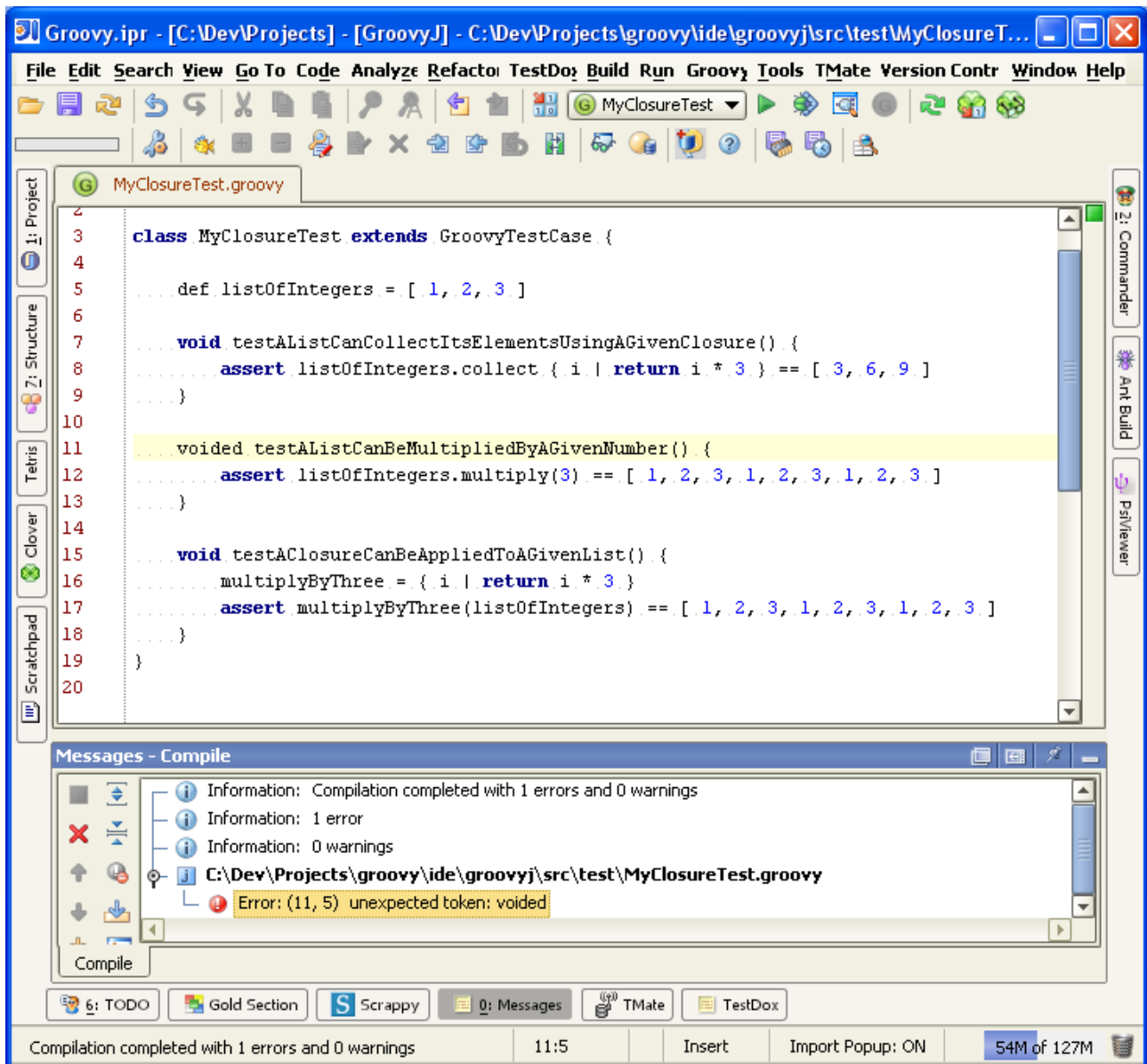
GROOVY-607 - Compilation

The compilation of Groovy scripts is seamlessly integrated into IDEA's build subsystem so that invoking any of the **Rebuild Project**, **Make Project**, **Make Module**, or **Compile** actions will also compile scripts found under the *source* and *test* folders.

It is also possible to compile individual Groovy scripts, that is, files ending in **.groovy**, **.gvy**, **.gy**, **.gsh**, as illustrated below:



Compilation results are displayed in the *Messages* window where double-clicking on errors and warnings jumps straight to the corresponding offending line of code:



Planned Features

For a list of planned (or wished) features, please look at the [GroovyJ Features and Wish List](#) page.

IDEA Open API

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Useful Links

This page should be used for sharing the many IDEA Open API tips and tricks that we will encounter along the road.

- The latest plug-in development kit can be found on the [EAP page](#) and is called **ideaXXXX-dev.zip**.
- [PsiViewer](#) is a very useful plug-in that renders the IDEA Program Structure Interface (PSI) tree representing the file being edited.
- IntelliJ IDEA forums are a source of valuable information:
 - [Open API forum](#)
 - [Plugins forum](#)
- Richard Osbaldeston shares some [plug-in authoring tips](#).

IntelliJ IDEA Plugin (JetBrains Edition)

This page last changed on Apr 19, 2007 by [salient1](#).

Wish List (JetBrains Edition)

This page last changed on Apr 27, 2007 by [mittie](#).

Please add your own entries, and increment the vote count for features that interest you. **IMPORTANT:** Please try and consider your suggestions from an IntelliJ design and terminology viewpoint rather than trying to insert ideas that are concepts from other IDEs that don't make sense in the IDEA world.

Debugging

- Full debugging support, including setting breakpoints, watch variables, view stack, view vars in scope, etc.
- Support for transitioning from Java to Groovy and vice versa.
- Ability to filter stack traces to show only Groovy classes.
- Ability to debug scripts in addition to classes.
- Allow Alt-F8 to evaluate Groovy expressions

Editing

- Code Formatting (as currently supported for Java code)
- Auto insertion of packages and imports (as currently supported for Java code)
- Code Completion (including support for Builders)
- Intentions support
- Syntax Highlighting (including the ability to color Groovy specific constructs differently)

Execution & Testing

- Ability to run Groovy based tests in a similar fashion to standard JUnit tests, with matching green/red runner results view.
- The ability to specify Groovy Run/Debug configurations for scripts and classes. (Scripts shows in the current editor should not require the developer to setup a run/debug config and should be executable via the standard shift-F10/F9 hotkeys.)
- Gant integration (from an editing perspective this is covered by builder support but it would be nice to have a Gant tab just like there is an Ant tab in IDEA).

- Allow starting the GroovyConsole with the current project's classpath being available
- Groovy scratchpad (interactive execution of Groovy code like in the GroovyConsole but with Idea's editor support)

Grails

Currently, Grails suggestions are being collected in a non-IDE specific [location](#).

Misc

- Groovy classes should appear in the "Go To Class" dialogue (CTRL-N). Groovy classes in the list should be discernible from Java classes by a unique icon.
- Other "Go To" support like Java code, eg, CTRL-B or CTRL-click to jump to a class definition
- Find All References
- Type Hierarchy
- Groovy Search
- Show javadoc
- Ability to specify Groovy specific code style
- Cross compiler allowing to reference Groovy classes from Java and Java classes from Groovy
- Per-directory control over which Groovy source trees should be compiled and which should not; this is especially important for Grails where compiling the Groovy code under project/grails-app can interfere with the application, whereas the code under src/groovy *is* compiled
- The ability to register Groovy SDKs just like you can with Java so you can keep different versions of Groovy available for testing at the same time and be able to easily switch between them.

Refactoring

- Rename/move class
- Rename method/variables
- Extract Method
- Extract Variable

- Inline method/variable
- New Groovy Refactoring: extract conditional to closure

```
if (a & b) {...}
```

becomes

```
Closure cond = { a & b }  
if (cond()) {...}
```

- New Groovy Refactoring: extract local closure

```
statement*
```

becomes

```
Closure localvar = { statements* }  
localvar()
```

Templating

- Live Templates support

JEdit Plugin

This page last changed on Aug 04, 2006 by [paulk_asert](#).

To use Groovy from inside jEdit download this

[plugin](#). You'll need a fairly recent jEdit distribution.

Right now BSF isn't yet released with inbuilt Groovy support so you have to add the following code to the startup script in

```
<jedit.home>/startup/startup.bsh
```

You can also add a startup.bsh script into your home directory at

```
<user.settings.home>/jedit/startup/startup.bsh
```

```
org.apache.bsf.BSFManager.registerScriptingEngine(  
    "groovy", "org.codehaus.groovy.bsf.GroovyEngine", new String[] { "groovy", "gv" }  
);
```

Also you'll need to copy the groovy-all-1.0-jsr-XXXX.jar file into the jedit/jars directory.

Restart jEdit.

Open SuperScript dockable from Plugins Menu or Dockable area and choose "groovy" from the languages dropdown.

To test if groovy works fine or not, just try running some expression in the textbox or open some groovy script in jEdit and try "Executing Script".

Alternative Groovy mode

Oliver Rutherford has developed a Groovy mode for jEdit...

<http://www.rutherford.net/jEdit/modes/groovy.xml>

```
~/jedit/catalog entry:  
  
<MODE NAME="groovy" FILE="groovy.xml"  
FILE_NAME_GLOB="*. {groovy,grv} " />
```

The Groovy mode for jEdit is in the SVN since July, 9th 2004.

It is included in standard jEdit setup.

In order to know if you have this mode, check that the file <jEdit_Home>/modes/groovy.xml exists.

NetBeans Plugin

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Groovy is supported in NetBeans via project Coyote:

<http://coyote.dev.java.net>

What works

Currently the following features are available in the Groovy plug-in for NetBeans:

- Script files can be created/edited/executed. The scripts are able to access the project's CLASSPATH.
- Syntax coloring for for Groovy
- Special scripting Groovy project type. Scripts are in a separate folder structure. For scripting projects, normal compile/execute works using Ant.
- Syntax error hyperlinking to the source after compile or execute.
- Support for Groovlets
- Support for writing unit tests in Groovy

Download and Installation

You can download nbms of project coyote which include Groovy support [here](#). Unzip the archive and simply install the nbms using update center from local disk.

More information

Additional information about Groovy support in NetBeans can be found on the project Coyote website:

<http://coyote.dev.java.net>

We welcome contributors - see also how to build coyote and let us know if you're interested in extending the Groovy support in NetBeans.

Oracle JDeveloper Plugin

This page last changed on Feb 18, 2007 by [tgrall](#).

Oracle JDeveloper is a free integrated development environment with end-to-end support for modeling, developing, debugging, optimizing, and deploying Java applications and Web services. Oracle JDeveloper can be downloaded from [Oracle Website](#).



Note tat the plugin is work in progress.

Installation

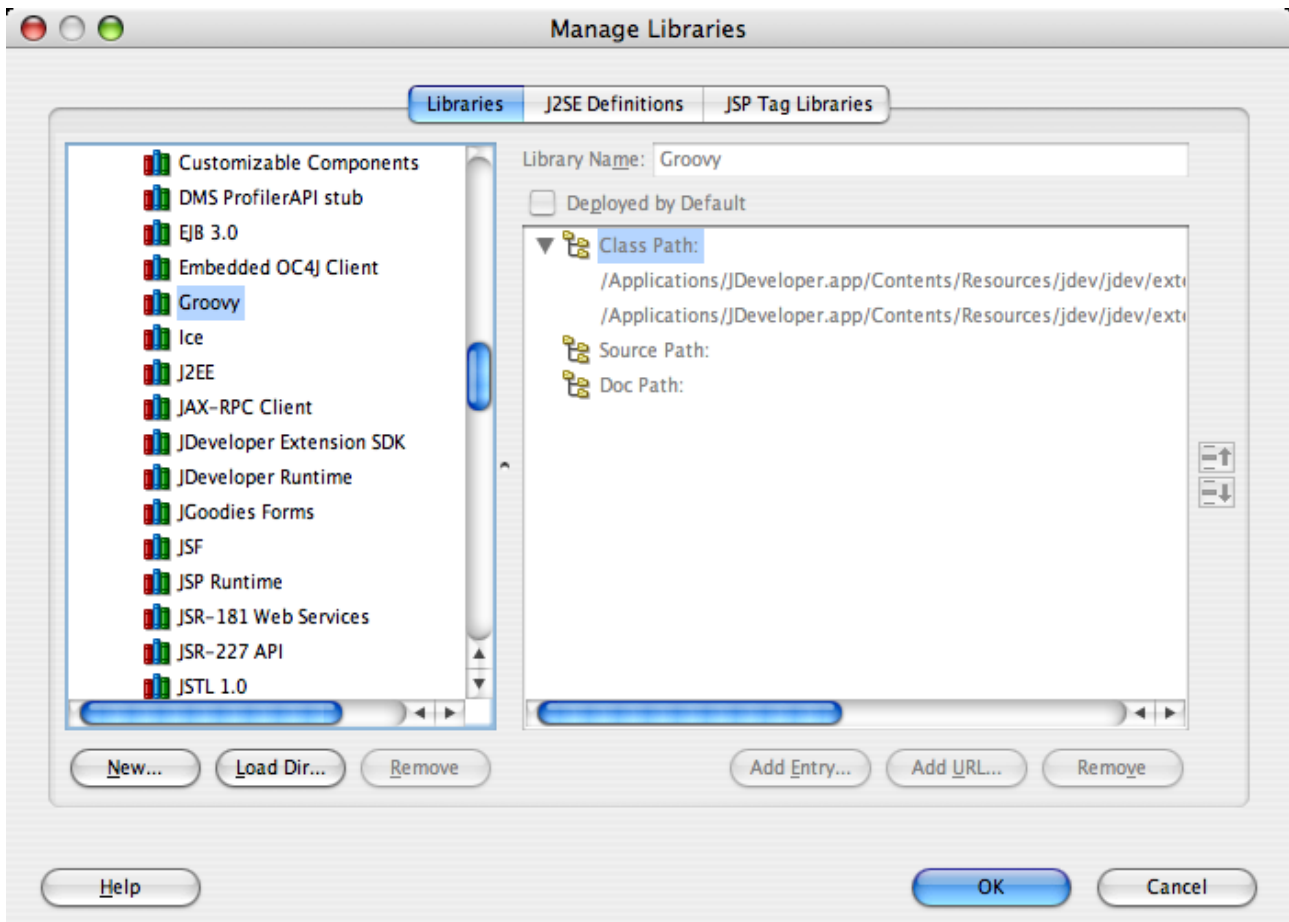
The Groovy extension is available through the Help->Check for Updates menu of JDeveloper. The Groovy plugin is registered in the "Open Source and Partners Extensions" update center.

- Go to: **Help -> Check for Update**
- Click **Next**
- Select the **Open Source and Partners Extensions** repository and click **Next**
- Select the features to install upgrade by selecting the Groovy check box and press **Next**
- Select if you want to make this extension available for All the user or only the current one.

This will automatically download the extension and ask you to restart JDeveloper. Once you restart JDeveloper the extension will be installed. To verify the installation visit the **Tools->Preferences->Extensions** menu and look for the Groovy extension entry.

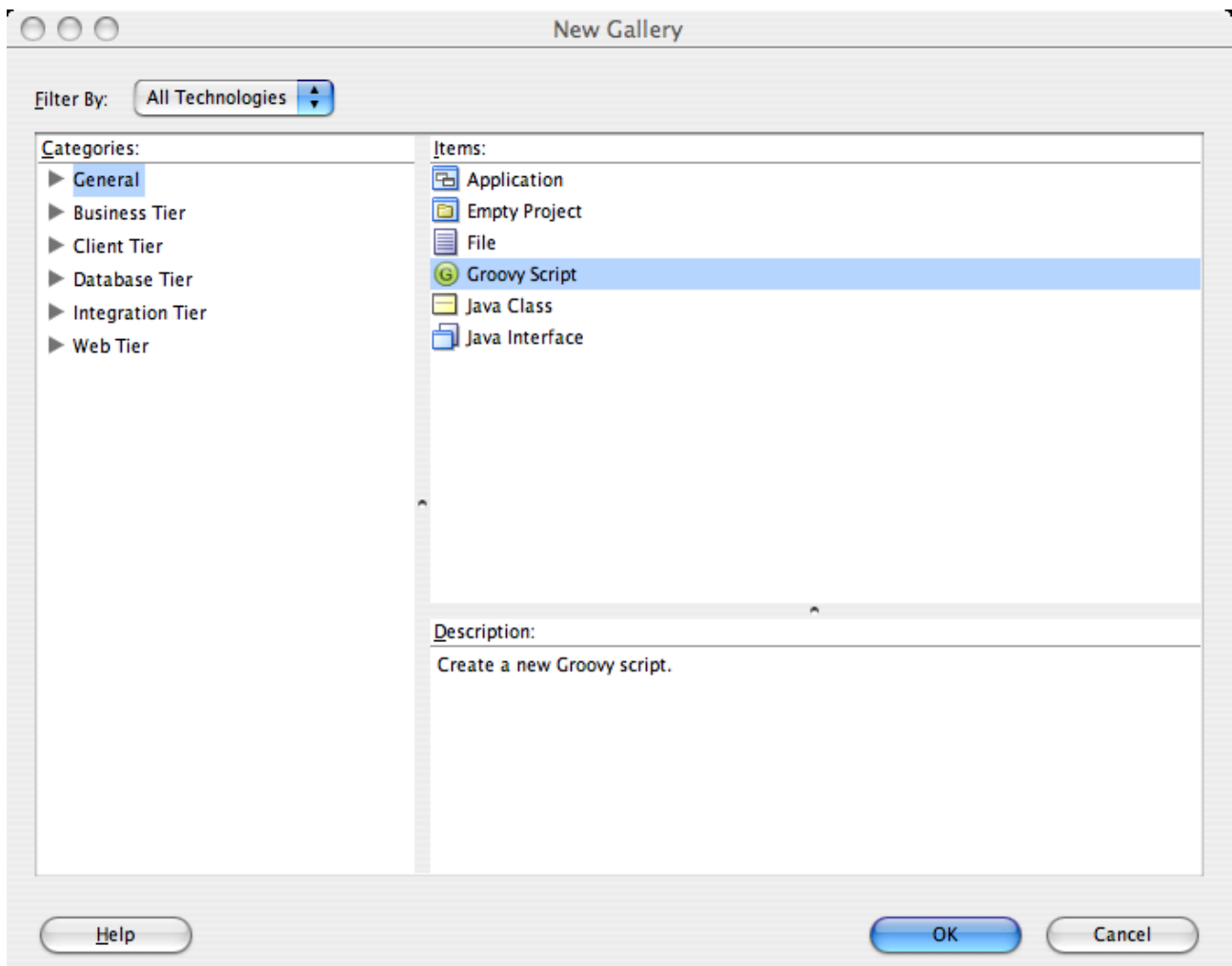
Groovy Library

The extension adds a new library to JDeveloper with the JAR files of the Groovy 1.0 language. You can access this library definition through the Tools->Manage Libraries menu option. The Groovy library would be added to your project automatically when you create a new script. You can also add it to project manually.



Groovy Script Creation Wizard

The Groovy extension adds a new wizard to JDeveloper that allows you to create scripts file and also automatically configures the project to include the Groovy library. Once the script is created you can start editing and running it from JDeveloper.



Other Plugins

This page last changed on Mar 28, 2007 by [mszklano](#).

TextMate (Mac OS X Only)

There is a Groovy plug-in for the popular TextMate editor on Mac OS X [here](#)

XCode (Mac OS X only)

<http://www.vengefulcow.com/groovy/>

SubEthaEdit 1.x

Brian McCallister has done a plugin for

[SubEthaEdit](#) which is

[here](#).

SubEthaEdit 2.x

A new-format language "mode" for SubEthaEdit 2.x is available

[here](#).

VIM

Syntax highlighting for VIM has been done by Alessio Pace

[here](#).

Here's a little plugin which allows to run scripts from within Vim. It has been originally created for python, but as the page says it's easy to adapt to probably any language.

http://www.vim.org/scripts/script.php%3Fscript_id=127

Download the latest version of the file, and save it in the /plugin folder of your Vim installation. Then edit it, and modify the line:

```
let s:PathToExecutable = 'c:\py21\python.exe'
```

with

```
let s:PathToExecutable = 'groovy'
```

Be sure to have the groovy executable in the system PATH, then simply follow the instruction from the original site for the usage. If you wish, you can search for the strings containing:

```
resize 7
```

and change the value to set the size of the output buffer "pop-up" (F9).

TO-DO:

implement complete support for groovy language, as it has be done for ruby:

<http://wiki.rubygarden.org/Ruby/page/show/VimRubySupport>

Xcode

A language specification for Apple's

[Xcode](#) IDE is available

[here](#).

TextPad 4

Guillaume Laforge wrote a syntax file for the TextPad text editor which can be downloaded

[here](#). This file should be installed in the Samples subdirectory of your TextPad installation.

EditPlus

[Michal Szklanowski](#) contributed a syntax file for the [EditPlus](#) text editor which can be downloaded [here](#).

Emacs

Jeremy Rayner has written a groovy-mode for emacs, details of which can be found on the [Emacs Plugin](#) page.

Russel Winder has started an alternative to Jeremy's based on CC Mode (Jeremy's was reworking of ruby-mode). Also Stuart Clayman has created a Groovy execution mode. See the [Emacs Plugin](#) page for details.

UltraEdit

Find more info on the [UltraEdit Plugin](#) page.

Crimson Editor

[Syntax files](#) have been created for

[Crimson Editor](#) by Jim Ruley.

PS PAD

Syntax file for [Ps PAD](#) is available [here](#)

by Marc DeXeT

Enscript

[State file](#) for [GNU enscript](#). It needs to be installed alongside the other enscript state files, for example in `/usr/share/enscript/hl/` on SUSE linux.

groovy-mode for (X)Emacs

Jeremy Rayner created a groovy-mode for (X)Emacs, which has syntax highlighting, recognises curly brace indentation (just use the tab key), and doesn't panic about optional semicolons. He tested it in Emacs on Mac OSX 10.3, and others use it and it isn't painful.

Russel Winder has begun an alternative version of groovy-mode as a derived mode in CC Mode. Currently, this has some problems with indenting when semicolons are not used as statement terminators but this is being actively worked on -- CC Mode has support for languages like Awk and Groovy that do not require semicolons.

Stuart Clayman has created a "Groovy inferior mode" (nothing inferior about Stuart's code but this is the jargon for an interpreter execution mode) which allows groovysh to be run from within (X)Emacs.

Download

(NB Links go to the latest versions in Subversion)

Download Jeremy's [groovy-mode.el](#) file and place it somewhere like (on OSX)

`/usr/share/emacs/site-lisp/groovy-mode.el`

your mileage may vary...

Download Russel's [groovy-mode.el](#) and place it in your (X)Emacs' load path.

NB As both Jeremy's and Russel's are called groovy-mode you have to have one or the other, you can't have both.

Download Stuart's [inf-groovy.el](#) and place it in your (X)Emacs load path.

.emacs

add the following lines to your ~/.emacs file:

```
;;; turn on syntax highlighting
(global-font-lock-mode 1)

;;; use groovy-mode when file ends in .groovy or has #!/bin/groovy at start
(autoload 'groovy-mode "groovy-mode" "Groovy editing mode." t)
(add-to-list 'auto-mode-alist '("\\.groovy$" . groovy-mode))
(add-to-list 'interpreter-mode-alist '("groovy" . groovy-mode))
```

TODO

Comments regarding Jeremy's mode:

- check this works in xemacs, and put your results in this page (anyone can edit 😊)
 - The Groovy mode appears to work in XEmacs, but setting the global-font-lock-mode gets a message and was commented. Thanks!
 - I concur that groovy mode works in XEmacs and that the global-font-lock-mode needs to be commented. The indent level default was changed from 4 to 2.
- sort out the comment blocks, as it is currently based on ruby, where the symbol # currently denotes the start of a comment, maybe this can be cribbed from java-mode...
- at the moment you have to hit tab to do indents, I'm sure emacs can do this automatically on carriage return...

Comments regarding Russel's mode:

- Get optional semicolons working properly.
- Get the font-lock colouring a bit more consistent.

Disclaimers

- Jeremy's mode is based upon ruby-mode in ruby stable snapshot - Wed Nov 24 04:01:06 JST 2004. This is just a quick hack of a groovy-mode, so if it's broken for you, fix it and share with the world.
- Russel's mode has "issues" when used with CC Mode 5.31 where groovy-mode is not compiled and CC Mode is.

jez.

<http://javanicus.com/blog2>

Russel

<http://www.russel.org.uk>

UltraEdit Plugin

This page last changed on Jun 29, 2006 by [paulk_asert](#).

Well, the name 'Plugin' is a bit too much, but I wanted to stick to the naming convention...

Ultra Edit

UltraEdit is a nice little text editor when working on Windows. It is very much suited to handle all kinds of resource files and some little scripts, when starting your IDE just takes too long.

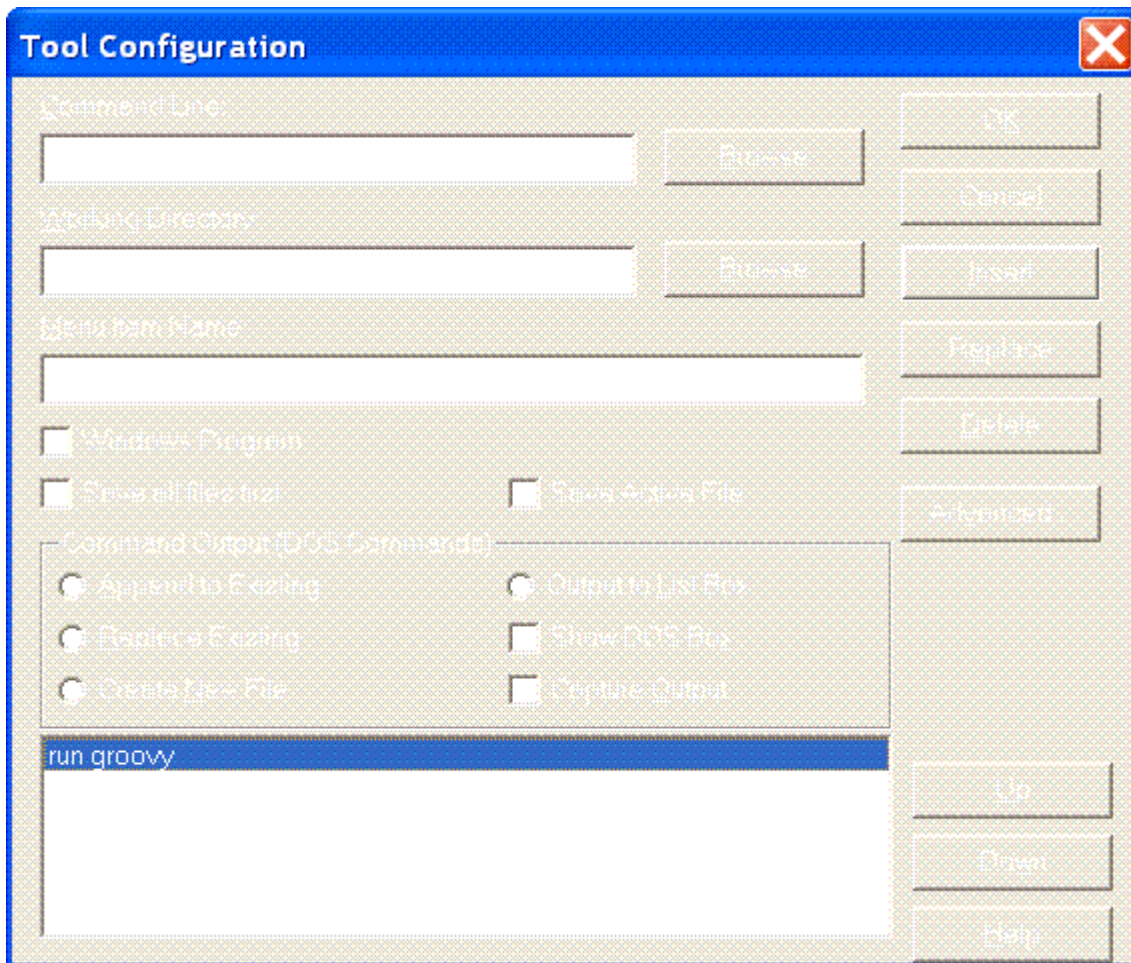
You can get it from <http://www.ultraedit.com/>

UltraEdit is not free but fairly inexpensive. One can work with the evaluation license forever, but warnings get more and more annoying then.

Running Groovy scripts

The first nice thing is to edit and run any groovy script from inside the editor. When doing so and getting a stacktrace, it is added to an output list that is click-aware. In the line you click, UltraEdit tries to find a filename and a line/column position and opens the editor at that position.

To make this happen, go to Advanced -> Tool Configuration and enter the following:

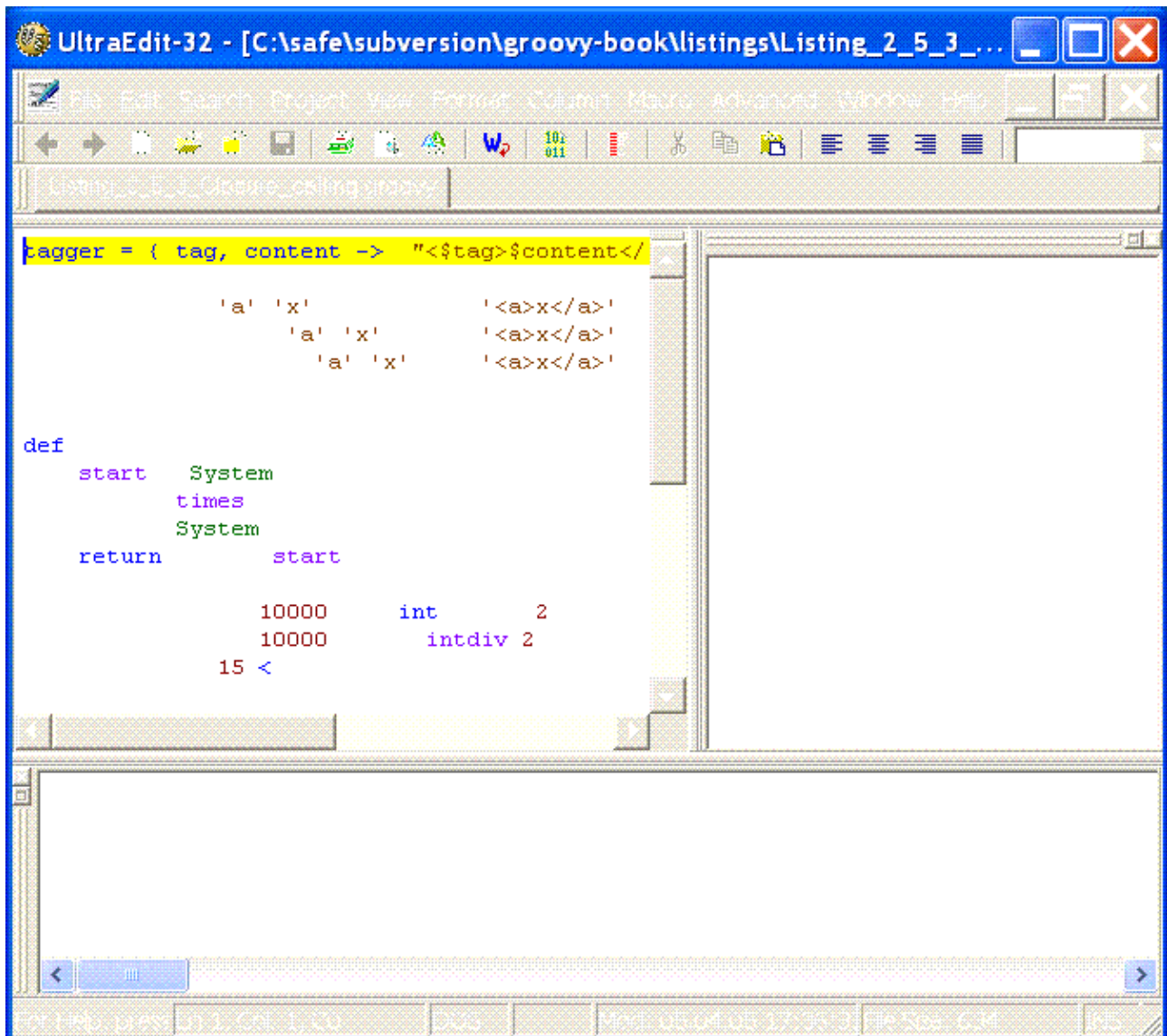


After that, you can run your active Groovy script with Ctrl-Shift-0.

Groovy awareness

UltraEdit is aware of those languages that are described in %INSTALL_DIR%\WORDFILE.txt. Add to that file what you find [here](#) . UltraEdit assigns numbers to its known languages (up to 20 may be defined). Groovy is numbered as 12 in the above file. If that would conflict with an existing entry, you can change that by editing the first line that reads /L12.

With that language support, Groovy code now looks like



Below the editor is the output window and right of it is a *function list*, that shows interesting lines of the file. The current implementation shows class and method definitions. They are clickable for easy navigation.

Other features

Hitting Ctrl-Space in UltraEdit will cause it to try some text-based code completion. It is surprising how helpful such a simple functionality can be.

UE will try to smart-indent your code while typing.

All the usual other stuff like

- moving selection with the mouse,
- indent/unindent with tab/shift-tab on selections,

- smart replacements with regular expressions in selection/current file/all open files/recursively through subdirs
- file type and encoding conversions
- hex view
- column mode
- smart selection on double click
- macros
- file compare
- and - above all - **starts amazingly quickly**

Have fun.

– Mittie

The Groovy TextMate Bundle

This page contains the TextMate bundle files that add Groovy & Grails support to the TextMate text editor for Mac OS X. They were originally written by Graeme Rocher (Grails project lead) and are made available as is.

DOWNLOAD

from [here](#)

However, the above link is not the latest code as the Groovy TextMate bundle is now hosted and maintained within the Macromates SVN repository. The details of which can be found here: <http://macromates.com/wiki/Main/SubversionCheckout>

INSTALLATION

Copy the Groovy and Grails bundle files to ~/Library/Application Support/TextMate/Bundles and start TextMate

USAGE

The bundles add Groovy and GSP support to files ending with .groovy and .gsp. There is syntax highlighting and code completion with snippets. All of the completions can be found in Bundles -> Groovy and Bundles -> Grails.

It is useful to look at these menus as a lot of the Groovy API is explore-able from there.

Some useful tips:

- type "to" and hit TAB for type conversion by method call
- type "as" and hit TAB for type conversion by coercion
- type "with" and hit TAB for i/o stuff
- typing ea, eawi, eal, eaf, eab, eam and hitting TAB do things like each, eachWithIndex, eachFile and so on
- type "static" and hit TAB for various options for statics
- type "cla" and hit TAB for class definition templates
- typing ":" and hitting TAB creates key/value hash pair
- Use ^ H to access JavaDoc help given you have them installed
- Use ^ ENTER to create new methods
- Use Apple + Run to execute the current file

- Select some text and use ALT + APPLE + Run to execute the snippet

Remember after you have hit TAB you can often TAG through the code the template generates to modify each changeable value.

Version History

0.2

- Fixed Multi-line Groovy string highlighting
- Added for snippet with key "for" + TAB
- Added Grails bundle

0.1

- Initial revision

Cookbook Examples

This page last changed on Mar 08, 2007 by [mittie](#).

Larger examples of using Groovy in the Wild with a focus on applications or tasks rather than just showing off the features, APIs or modules:

- [Accessing SQLServer using groovy](#)
- [Batch Image Manipulation](#)
- [Convert SQL Result To XML](#)
- [Embedded Derby DB examples](#)
- [Executing External Processes From Groovy](#)
- [Formatting simple tabular text data](#)
- [Integrating Groovy in an application - a success story](#)
- [Martin Fowler's closure examples in Groovy](#)
- [Other Examples](#)
- [Plotting graphs with JFreeChart](#)
- [Recipes For File](#)
- [Simple file download from URL](#)
- [Solving Sudoku](#)
- [SwingBuilder with custom widgets and observer pattern](#)
- [Unsign Jar Files \(Recursively\)](#)
- [Using MarkupBuilder for Agile XML creation](#)
- [Using the Delegating Meta Class](#)
- [Using the Proxy Meta Class](#)
- [Windows Look And Feel for groovyConsole](#)

Additional real-world example for the german readers:

<http://berndschiffer.blogspot.com/2007/03/groovy-im-fluss-ein-beispiel-aus-der.html>

Accessing SQLServer using groovy

This page last changed on Mar 23, 2007 by rangarajan@fastmail.fm.

*DISCLAIMER: *Use at your own risk. Author is not responsible for any damages resulting from direct or indirect use of the instructions here.

Accessing Microsoft SQLServer using Groovy

This is an example of how to access Microsoft SQL Server (2000) database using groovy to create reports on a unix box using a Microsoft JDBC driver. The instructions to install the JDBC driver itself are given in **Appendix A**. The script name is **queryMSSQL.groovy**. Assumptions are:

- The script takes as arguments one or more queryfiles and executes them against a Microsoft SQLServer 2000 database defined using options on the command line.
- host on which SQLServer resides is reachable from the unix host and that there are no firewall issues.
- All queries have one bind variable, which is satisfied by the argument to option **-v**
- USAGE: **groovy queryMSSQL.groovy -h -s sqlserverhost [-P port] -u userid -p password -v value -t textfile queryfile [queryfile]**
- Option / arguments info:

1. **-P port** - denotes the port where SQLServer is listening
2. **-u userid*** - * denotes userid (on SQLServer)
3. **-p password** - denotes password for the userid on SQLServer
4. **-v value** - value to satisfy bind variable (in a where clause eg. WHERE col = ...). If no **?** is seen in queryfile, then no bind variables are involved. In this case the value passed should be **none**.
5. **-t textfile*** - The name of text file where output would go
6. **queryfile** - A file containing query

```
import java.sql.Connection
import java.sql.DriverManager
import javax.sql.DataSource
import groovy.sql.Sql

def cli = new CliBuilder( usage: 'groovy queryMSSQL.groovy -h -s sqlserverhost [-P port] -u
userid -p password -v value -t textfile queryfile [queryfile]...' )
cli.h(longOpt:'help', 'usage information')
cli.s(argName:'servername', longOpt:'server', args:1, required:true, type:GString,
'sqlserverhost')
cli.P(argName:'port', longOpt:'port', args:1, required:false, type:GString, 'port')
cli.u(argName:'userid', longOpt:'userid', args:1, required:true, type:GString, 'userid')
cli.p(argName:'password', longOpt:'password', args:1, required:true, type:GString, 'password')
cli.v(argName:'value', longOpt:'value', args:1, required:true, type:GString, 'value')
cli.t(argName:'textfile', longOpt:'text', args:1, required:true, type:GString, 'text file')
def opt = cli.parse(args)
if (!opt) return
if (opt.h) cli.usage()
def port = 1433
if (opt.P) port = opt.P // If the port was defined
def servername = opt.s
def userid = opt.u
def password = opt.p
def valuetobind = opt.v
def textfile = opt.t
def outFile
def outFileWriter
try {
    outFile = new File(textfile)
    outFile.write(""); // truncate if output file already exists
} catch (Exception e) {
```

```

println "ERROR: Unable to open $textfile for writing";
return;
}
driver = Class.forName("com.microsoft.jdbc.sqlserver.SQLServerDriver").newInstance();
Connection conn = DriverManager.getConnection("jdbc:microsoft:sqlserver://$servername:$port",
userid, password);

try {
    if (args.length == 0) {
        usage_error = "Error: Invalid number of arguments"
        usage_error = "\n$usage_error\nUSAGE: groovy queryMSSQL.groovy queryfile\n"
        throw new IllegalArgumentException(usage_error)
    }
    Sql sql = new Sql(conn)
    // After options processing the remaining arguments are query files
    // Go through the query files one at a time for execution
    for (queryfilename in opt.arguments()) {
        queryfile = new File(queryfilename)
        query = "" // initialize the query string
        param_count = 0 // Number of placeholders needed for parameters to query
        pattern = /\?/ // pattern to look for to find number of parameters
        // read the query from the query file (line by line) and build it
        queryfile.eachLine { it ->
            query += " " + it
        }
        // number of bind variables to satisfy is obtained by number of ? seen in the query
        query.eachMatch(pattern) { param_count++ }
        println '-' * 40
        println "query is ${query}"

        println "Output is:"
        println '=' * 80
        def count = 0 // row count
        paramlist = []
        if (valuetobind != "none")
            1.upto(param_count) { paramlist << valuetobind }
        sql.eachRow(query, paramlist) { row ->
            count++; // increment number of rows seen so far
            //println "$count. ${row.name}" // print out the column name
            recstr = "" // initialize the string that represents row
            meta = row.getMetaData() // get metadata about the row

            for (col in 0..<meta.columnCount) {
                // record is stored in a string called recstr
                if (recstr == "") {
                    recstr = row[col]
                }
                else {
                    recstr += "," + row[col]
                }
            }

            outFile.append(recstr + "\n")
        }
        conn.close()
    } catch (Exception e) {
        print e.toString()
    }
} finally {
}

```

Appendix A - Installing the Microsoft JDBC driver on unix

These notes are based on instruction provided in <http://support.microsoft.com/kb/313100>.

- Download SQL Server 2000 Driver for JDBC Service Pack 3. This is done by getting the file mssqlserver.tar from Microsoft site:

<http://www.microsoft.com/downloads/details.aspx?FamilyID=07287B11-0502-461A-B138-2AA54BFDC03A&displaylan>

- Upload the tar file mssqlserver.tar to \$HOME/download (choose a suitable directory).
- Extract the files from mssqlserver.tar using **tar xvf mssqlserver.tar**
- Make a directory where the JDBC driver will be installed (say \$HOME/mssqljdbcsp3) using **mkdir \$HOME/mssqljdbcsp3**
- Change to \$HOME/download and run **./install.ksh**
- When prompted for the installation directory choose **\$HOME/mssqljdbcsp3**. This results in the message:
SQL Server 2000 driver for JDBC is installed in the following location: \$HOME/mssqljdbcsp3
- Set the CLASSPATH variable in the startup file (**.login** or **.profile**) to include the following jar files:
 1. \$HOME/lib/msbase.jar
 2. \$HOME/lib/mssqlserver.jar
 3. \$HOME/lib/msutil.jar

In Bourne/Korn shell CLASSPATH can be appended to using:

```
export
CLASSPATH="$CLASSPATH:$HOME/lib/msbase.jar:$HOME/lib/mssqlserver.jar:$HOME/lib/msutil.jar"
```

Batch Image Manipulation

This page last changed on Sep 26, 2006 by [paulk_asert](#).

An example image manipulation script, It's not that fresh anymore but it was laying around when at the sametime some people want to see more examples.

So here is my little contribution.

Note to the groovy gurus: find more groovier ways.

```
/**
 * A batch image manipulation utility
 *
 * A wrote this script just to get groovy, batch manipulate images in about
 * 240 lines of code (without this comment)!!!.
 *
 * commands:
 * values ending with '%' means size relative to image size.
 * values ending with 'px' means values in absolute pixels.
 * values without postfix use default notation.
 *
 * expressions:
 * scale(width,height)      * height is optional(use width) e.g: scale(50%) == scale(50%,50%)
 * fit(width,height)        * relative scale the image until it fits (default as scale)
 *                           * bounds of the given box, usefull for generating of thumbnails.
 * rotate(degrees,x,y)      * the rotation position x and y are optional (default is 50%)
 *
 * TODO: move(x,y)          * move the image within its own bounds (can be done with margin)
 *                           * y is optional(same height)
 * TODO: color(type)        * color transformation
 * TODO: shear(degrees,x,y) * x and y is optional
 * margin(x,y,x2,y2)        * add margins to image (resize image canvas), this operation can't
 *                           * be used on a headless environment.
 *
 * parameters:
 * -d                        * working directory (default current directory)
 * -e                        * execute expressions from command line.
 * -f                        * execute expressions from file.
 * -p                        * file mathing pattern default is \.png|\.jpg
 * -q                        * output file pattern can use {0} .. {9}
 *                           * backreferences from the input pattern. default: output/{0}
 * -h                        * help, nothing special (maybe this doc using heredoc)
 *
 * Example generate thumbnails(take *.png from images fit them in a 100X100 box,
 * add 10px margin, put them in the thumbnail dir.)
 *
 * $ groovy image.groovy -d images -e "fit(100px,100px) margin(5)" -p "(.*)\.png" -q
"thumbnail/{1}.png"
 *
 * @author Philip Van Bogaert alias tbone
 */

import java.io.*;
import javax.imageio.*;
import java.awt.*;
import java.awt.image.*;
import java.awt.geom.*;
import java.util.*;

class GroovyImage {
    property File srcDir = new File(".");

    operations = [];

    property pattern = ~".*(\\.png|\\.jpg)";
    property outputPattern = "output/{0}";

    void addOperation(command) {

        matcher = command =~ "([a-z]+)\\((.*)\\).*";
        matcher.find();
    }
}
```

```

method = matcher.group(1);
args = matcher.group(2).split(",").toList();

switch(method) {
    case "scale": // vertical, horizontal
        operations.add([parseAndScale, argsLength(args, 2)]);
        break;

    case "rotate": // degrees, x, y
        operations.add([parseAndRotate, argsLength(args, 3)]);
        break;

    case "margin": // left, top, right, bottom
        operations.add([parseAndMargin, argsLength(args, 4)]);
        break;

    case "fit": // width, height
        operations.add([parseAndFit, argsLength(args, 2)]);
        break;
}

}

BufferedImage parseAndRotate(image, degrees, x, y) {
    parsedRadians = 0;
    try {
        parsedRadians = Math.toRadians(Double.parseDouble(degrees));
    }
    catch(NumberFormatException except) {
    }

    parsedX = parseValue(x, image.width, true, "50%");
    parsedY = parseValue(y, image.height, true, parsedX);

    return rotate(image, parsedRadians, parsedX, parsedY);
}

BufferedImage rotate(image, radians, x, y) {
    transform = new AffineTransform();
    transform.rotate(radians, x, y);
    op = new AffineTransformOp(transform, AffineTransformOp.TYPE_BILINEAR);
    return op.filter(image, null);
}

BufferedImage parseAndScale(image, horizontal, vertical) {
    parsedHorizontal = parseValue(horizontal, image.width, false, "100%");
    parsedVertical = parseValue(vertical, image.height, false, parsedHorizontal);
    return scale(image, parsedHorizontal, parsedVertical);
}

BufferedImage scale(image, horizontal, vertical) {
    transform = new AffineTransform();
    transform.scale(horizontal, vertical);
    op = new AffineTransformOp(transform, AffineTransformOp.TYPE_BILINEAR);
    return op.filter(image, null);
}

BufferedImage parseAndMargin(image, left, top, right, bottom) {
    parsedLeft = parseValue(left, image.width, true, "0px");
    parsedTop = parseValue(top, image.height, true, parsedLeft);
    parsedRight = parseValue(right, image.width, true, parsedLeft);
    parsedBottom = parseValue(bottom, image.height, true, parsedTop);
    return margin(image, parsedLeft, parsedTop, parsedRight, parsedBottom);
}

BufferedImage margin(image, left, top, right, bottom) {
    width = left + image.width + right;
    height = top + image.height + bottom;
    newImage = new BufferedImage(width.intValue(),
height.intValue(), BufferedImage.TYPE_INT_ARGB);
    // createGraphics() needs a display, find workaround.
    graph = newImage.createGraphics();
    graph.drawImage(image, new AffineTransform(1.0d, 0.0d, 0.0d, 1.0d, left, top), null);
    return newImage;
}

BufferedImage parseAndFit(image, width, height) {
    parsedWidth = parseValue(width, image.width, true, "100%");

```

```

        parsedHeight = parseValue(height,image.height,true,parsedWidth);

        imageRatio = image.width / image.height;
        fitRatio = parsedWidth / parsedHeight;

        if(fitRatio < imageRatio) {
            parsedHeight = image.height * (parsedWidth/image.width);
        } else {
            parsedWidth = image.width * (parsedHeight/image.height);
        }

        return parseAndScale(image,parsedWidth+"px",parsedHeight+"px");
    }

    BufferedImage manipulate(image) {
        for(operation in operations) {
            image = operation[0].call([image] + operation[1]);
        }
        return image;
    }

    void batch() {
        images = getImages();
        for(imageMap in images) {
            imageMap.image = manipulate(imageMap.image);
            storeImage(imageMap);
        }
    }

    Object getImages() {
        imageMaps = [];

        for(i in srcDir.listFiles()) {
            if(!i.isDirectory()) {
                subpath = i.path;
                if(subpath.startsWith(srcDir.path)) {
                    subpath = subpath.substring(srcDir.path.length());
                }
                matcher = subpath =~ pattern;
                if(matcher.find()) {
                    imageMaps.add(["file":i,"matcher":matcher]);
                }
            }
        }
        imageMaps.each({it["image"] = ImageIO.read(it["file"]); });
        return imageMaps;
    }

    void storeImage(imageMap) {
        groupIndex = 0;
        name = outputPattern;
        matcher = imageMap.matcher;
        while(groupIndex <= matcher.groupCount()) {
            name = name.replaceAll("\\\\${groupIndex}\\\\",matcher.group(groupIndex++));
        }
        type = name.substring(name.lastIndexOf(".") + 1, name.length());
        file = new File(srcDir, name);
        file.mkdirs();
        ImageIO.write(imageMap.image, type, file);
    }

    static void main(args) {
        argList = args.toList();
        script = '';
        groovyImage = new GroovyImage();

        // command line parsing bit, NOTE: -h does System.exit(2)
        argAndClosure = ['-d':{groovyImage.srcDir = new File(it)},
            '-q':{groovyImage.outputPattern = it},
            '-p':{groovyImage.pattern = it},
            '-h':{groovyImage.help()});

        // parse non-conditional arguments
        parseMultipleCommandArgs(argList,argAndClosure);

        // expression,file,nothing
        if(!parseCommandArg(argList,'-e', {script = it})) {

```

```

        parseCommandArg(argList, '-f', {script = new File(it).text});
    }

    // execution bit
    commands = script =~ "([a-z]{1,}\\\[^\]*\\)";
    while(commands.find()) {
        groovyImage.addOperation(commands.group(1));
    }
    groovyImage.batch();
}

static boolean parseCommandArg(args, arg, closure) {
    index = args.indexOf(arg);

    if(index != -1 && index + 1 < args.size()) {
        closure.call(args[index + 1]);
        return true;
    } else {
        return false;
    }
}

static void parseMultipleCommandArgs(args, argAndClosureMap) {
    for(argAndClosure in argAndClosureMap) {
        parseCommandArg(args, argAndClosure.key, argAndClosure.value);
    }
}

void help() {
    println('usage: groovy image.groovy -i <inputDir> -o <outputDir> -e "<expressions>"');
    System.exit(2);
}

/**
 * absolute true -> returns pixels.
 * false -> returns relative decimal (e.g 1.0).
 */
Number parseValue(value, size, absolute, defaultValue="0") {
    pattern = "(-?[0-9]+\\.?[0-9]*)(.*)";
    matcher = value =~ pattern;
    if(!matcher.find()) {
        matcher = defaultValue =~ pattern;
        matcher.find();
    }

    decimalValue = Double.parseDouble(matcher.group(1));
    type = matcher.group(2);

    if(absolute) { // pixels
        switch(type) {
            case "%":
                return (int) size * (decimalValue / 100);
            case "px":
            default:
                return (int) decimalValue;
        }
    }
    else { // scale
        switch(type) {
            case "px":
                return decimalValue / size;
            case "%":
                return decimalValue / 100;
            default:
                return decimalValue;
        }
    }
}

Object argsLength(args, length) {
    if(args.size() < length) {
        while(args.size() < length) {
            args.add("");
        }
    } else {
        args = args.subList(0, length);
    }
}

```

```
    return args;  
}
```

Convert SQL Result To XML

This page last changed on Dec 07, 2006 by [marcdexet](#).

How to convert SQL Result to XML ?

```
import groovy.sql.Sql
import groovy.xml.MarkupBuilder
def schema = "PROD"
def sql = Sql.newInstance("jdbc:oracle:thin:@hostname:1526:${schema}", "scott", "tiger",
"oracle.jdbc.driver.OracleDriver")

/* Request */
def req = ""
SELECT id, name, givenname, unit FROM ${schema}.people
WHERE
in_unit=1
AND visible=0
""
def out = new File('out.xml')
def writer = new FileWriter( out )
def xml = new MarkupBuilder( writer )

xml.agents {
    sql.eachRow( req as String ) {
        /* For each row output detail */
        row ->
        xml.agent(id:row.id) {
            name( row.name )
            givenname( row.givenname )
            unit( row.unit )
        }
    }
}
```

Output is

```
<agents>
  <agent id='870872'>
    <name>ABTI</name>
    <givenname>Jean</givenname>
    <unit>Sales</unit>
  </agent>
  ...
</agents>

<!-- xml.agents {
  <!--   agent(id:row.id) {
  <!--     name( row.nom )
  <!--     givenname( row.prenom )
  <!--     unit( row.unite )
  <!--   }
-->
```

Embedded Derby DB examples

This page last changed on Jan 11, 2007 by raffaele.castagno@gmail.com.

Be sure that derby.jar is in the classpath before running this example.

This will create derby.log and derbyDB folder in the folder where the script is.

If something goes wrong, simply remove derbyDB folder, and everything will be clean for next run.

```
import groovy.sql.*
import java.sql.*

protocol = "jdbc:derby:";
def props = new Properties();
props.put("user", "user1");
props.put("password", "user1");

def sql = Sql.newInstance(protocol + "derbyDB;create=true", props);

/* Creating table, adding few lines, updating one */
sql.execute("create table people(id int, name varchar(40), second_name
varchar(40), phone varchar(30), email varchar(50))");

println("Created table 'people'");

sql.execute("insert into people values (1,'John', 'Doe', '123456','johndoe@company.com')");
sql.execute("insert into people values (2,'Bill', 'Brown', '324235','billbrown@company.com')");
sql.execute("insert into people values (3,'Jack', 'Daniels',
'443323','jackdaniels@company.com')");

println("Inserted people");

sql.execute("update people set phone='443322', second_name='Daniel's'where id=3");

println("Updated person");

/* Simple query */
def rows = sql.rows("SELECT * FROM people ORDER BY id");
rows.each {println it}

/* Dropping table 'people' */
sql.execute("drop table people")
println ("Table 'people' dropped")

try{
    DriverManager.getConnection("jdbc:derby::shutdown=true")
}
catch (SQLException se){
    gotSQLException = true
}

println("Finish!")
```


Executing External Processes From Groovy

This page last changed on Apr 13, 2007 by citizenkahn@gmail.com.

Executing External Processes From Groovy

Goal: execute a program via a command line from groovy code

Option 1: executing a string

```
A string can be executed in the standard java way:
def command = "\"executable arg1 arg2 arg3\"" // Create the String
def proc = command.execute()                // Call *execute* on the string
proc.waitFor()                              // Wait for the command to finish

// Obtain status and output
println "return code: ${proc.exitValue()}"
println "stderr: ${proc.err.text}"
println "stdout: ${proc.in.text}" // *out* from the external program is *in* for groovy
```

Limits:

If you wish to pass a quoted argument that contains white space it will be split into multiple arguments
"""executable "first with space" second"""

each is treated as a separate arg be the external executable:* arg1 = "first

- arg2 = with
- arg3 = space"
- arg4 = second

Option 2: using ant builder's exec task

Ant has an exec task and it be accessed from the AntBuilder object

```
def ant = new AntBuilder() // create an antbuilder
ant.exec(outputproperty:"cmdOut",
        errorproperty: "cmdErr",
        resultproperty:"cmdExit",
        failonerror: "true",
        executable: /opt/myExecutable') {
    arg(line:"""*first with space* second""")
}
println "return code:  ${ant.project.properties.cmdExit}"
println "stderr:       ${ant.project.properties.cmdErr}"
println "stdout:       ${ ant.project.properties.cmdOut}"
```

The good thing is that you now have all the ant features at your disposal and Ant will not break up quoted args containing whitespace.

Formatting simple tabular text data

This page last changed on Jan 03, 2007 by raffaele.castagno@gmail.com.

Formatting simple tabular text data

This class has been posted first time on the Groovy-User Mailing List by Raffaele Castagno in this format:

```
class TableTemplateFactory
{
    def columns = [];      // contains columns names and theyr length
    def header1 = '';      // contains columns names
    def header2 = '';      // contains underscores
    def body = '';         // the rows of the table
    def footer = '';       // actually unused: can contain footer notes, totals, etc.

    def addColumn(name, size)
    {
        columns << [name:name, size:size];
    }

    def getTemplate()
    {
        header1 = "\n";
        columns.each{ header1 += ' <%print "' + it.name + '".center('+it.size+')%> ' };
        header2 = "\n";
        columns.each{ header2 += ' <%print "_" * it.size + ' %> ' };
        body = '\n<% rows.each { %>';
        // If a value is longer than given column name, it will be trunked
        columns.each{ body += '
${it.' + it.name + '.toString().padRight('+it.size+').substring(0, '+it.size+')} ' };
        body += '\n<% } %>';
        return header1 + header2 + body + footer;
    }
}
```

and later "groovyfied" by Gavin Grover:

```
class TableTemplateFactory{
    def columns = []
    def addColumn(name, size) { columns << [name:name, size:size]; this }
    def getTemplate() { """
${columns.collect{ " <%print \"${it.name}\".center(${it.size})%> " }.join()}
${columns.collect{ " <%print \"_\" * ${it.size} %> " }.join()}
<% rows.each { %>${columns.collect{ "
\\${it.${it.name}.toString().padRight(${it.size}).substring(0, ${it.size})} " }.join()}
<% } %>"""
    }
}
```

First version is here only as an example of the "groovify process". Of course, the Gavin's version is better.

This class emulate the output of most RDBMS consoles (ie. Oracle SQL*, MySql).

Here's an usage example (again, grooved up by Gavin):

```
import groovy.text.Template; import groovy.text.SimpleTemplateEngine
def ttf = new TableTemplateFactory().addColumn("name", 15).addColumn("age", 4)
```

```
def names = [] << [name:"Raffaele", age:"23"] << [name:"Griorgio", age:"30"]  
def binding = ['rows': names]  
println new SimpleTemplateEngine().createTemplate(ttf.template).make(binding).toString()
```

This is the output:

name	age
Raffaele	23
Griorgio	30

Actually is really limited: column width must be declared, and strings are truncated to that given size.

Wish-list:

- Automatic column width based on maximum string length
- Multiline records
- Multiline fields
- More formatting options (alignment, case, etc)
- Management of footer fields (totals, formulae, etc)
- Automatic line-wrap based on screen size

Integrating Groovy in an application - a success story

Introduction

As I read in the Groovy user mailinglist that some people complained missing information about how to integrate Groovy into Java applications, I decided to give one example of how we integrated Groovy as extension language for our graphical developer tool.

First a bit of background regarding the application to be scripted:

It is a little SDE GUI for starting different build targets for different components in a workarea. As we noticed that, depending on some individual tasks or different roles a developer takes in a team, extension and customisation would be a nice feature, we integrated Groovy as scripting language used to plug in individual features at the user site.

The solution in overview

Extension points in the GUI:

We created two "extension points" in the GUI: An empty "user" menu ready to be filled with items and an empty panel at the bottom of the GUI being able to be filled with e.g. custom buttons.

There is also a specific script output window, where the script can place messages or other textual output. The opening of this window is part of the API (see point 2).

Integration point:

To keep the Groovy integration at one location, we created the class `ScriptConnector`, which is the adaptor between Groovy and the application.

It calls the Groovy engine, maintains the binding, provides some API methods to be called inside the Groovy script, leading to better separation which keeps the script clean from the application's intera.

BTW: One requirement was, that errors in the Groovy integration should not break the rest of the application, but should only affect the customised parts, so exceptions are caught and shown as 'warnings' in a dialog window.

One plugin script:

The plugin feature is provided by one dedicated plugin script which is customisable/extensible by the user. He can use all features the Groovy language provides, so external scripts and programs can be integrated via this script.

Coming to details

Let us have a look at the main class first, so you will see it all from startup on.
Please be aware that the shown source is a simplified form of our productive code.

The application main class

```
// The main application class
public class SDEGui {

    public static void main(String[] args) {
        SDEGui sdegui = new SDEGui();
        sdegui.startGui();
    }

    private void startGui() {
        ....
        final SDEGuiWindow window = SDEGuiWindow.getInstance(); // Create the whole "GUI"
        window.show();

        Workspace workarea = SettingManager.getCurrentWorkspace(); // Create the workarea,
        the object to be scripted
        ....

        // starting the Groovy interpreter
        try {
            startScript(workarea, window);
        }
        catch (Exception e) {
            JOptionPane.showMessageDialog(window, "Exception in groovy script connection: "
+ e.getMessage(),
                                           "Groovy-error", JOptionPane.WARNING_MESSAGE);
        }
    }

    // Starts the standard Groovy script to setup additional (customised) gui elements
    private void startScript(final Workspace workarea, final SDEGuiWindow window) {

        ScriptConnector connector = new ScriptConnector(workarea, window); // instantiate the
        connector ...
        connector.runGuiComponentScript("plugins.groovy"); // ... and run the
        plugin script

        window.show();
    }
}
```

The script connector

Now let's look at the ScriptConnector, as this is the important place of Groovy integration:

```

.....
import groovy.lang.Binding;
import groovy.util.GroovyScriptEngine;
import groovy.util.ResourceException;
import groovy.util.ScriptException;
.....

public class ScriptConnector {
    Binding    binding; // The 'binding' makes instances of the application objects
    available as 'variables' in the script
    SDEGuiWindow window; // The main application window, the GUI in general
    String[]    roots;    // A list of directories to search for Groovy scripts (think of it
    as a PATH).

    public ScriptConnector(Workspace workarea, SDEGuiWindow window) {
        roots    = new String[]{System.getProperty("user.home"), "." }; // The root list is
        filled with the locations to be searched for the script
        Binding    scriptenv = new Binding(); // A new Binding is created ...

        scriptenv.setVariable("workarea", workarea); // ... and filled with to 'variables':
        the workarea to work on
        scriptenv.setVariable("SDE", this); // and the current ScriptConnector
        instance as API provider.
        this.binding = scriptenv;
        this.window = window;
    }

    // Method to show Groovy related errors/warnings in a dialog window.
    public void showWarning(String message) {
        JOptionPane.showMessageDialog(window, message, "Groovy-error",
        JOptionPane.WARNING_MESSAGE);
    }

    // This is the main method called from the application code to start the Groovy integration
    public void runGuiComponentScript(String filename) {
        GroovyScriptEngine gse = null;
        try {
            gse = new GroovyScriptEngine(roots); // instanciating the script engine ...
        } catch (IOException ioe) {
            ioe.printStackTrace();
            showWarning("I/O-Exception in starting Groovy engine. Message is:\n"
                + ioe.getMessage()
                + "\n" + prepareStackTrace(ioe));
        }

        if (gse != null) {
            try {
                gse.run(filename, binding); // ... and running the specified script
            } catch (ResourceException re) {
                re.printStackTrace();
                showWarning("ResourceException in calling groovy script '" + filename +
                    "' Message is:\n" + re.getMessage()
                    + "\n" + prepareStackTrace(re));
            } catch (ScriptException se) {
                se.printStackTrace();
                showWarning("ScriptException in calling groovy script '" + filename +
                    "' Message is:\n" + se.getMessage()
                    + "\n" + prepareStackTrace(se));
            }
        }
    }

    // prepare a stacktrace to be shown in an output window
    private String prepareStackTrace(Exception e) {
        Throwable exc = e;
        StringBuffer output = new StringBuffer();
        collectTraces(exc, output);
        if (exc.getCause() != null) {
            exc = exc.getCause();
            output.append("caused by:\n");
            output.append(exc.getMessage());
            output.append("\n");
        }
    }
}

```

```

        collectTraces(exc, output);
    }
    return output.toString();
}

private void collectTraces(Throwable e, StringBuffer output) {
    StackTraceElement[] trace = e.getStackTrace();
    for (int i=0; i < trace.length; i++) {
        output.append(trace[i].toString());
        output.append("\n");
    }
}

// ----- API to be used inside scripts -----

// create a new dialog to display textual output from running scripts
public ScriptOutputDialog newOutputDialog(String title, String tabTitle) {
    return window.newOutputDialog(title, tabTitle);
}

// get the panel instance prepared to contain customised GUI elements, e.g. buttons
public DynamicPanel getDynpanel() {
    return window.getDynamicPanel();
}

// get the user menu instance to add custom items and submenus to.
public JMenu getUsermenu() {
    return window.getSDEUserMenu();
}

// create a process to run a shell command in a given directory
public Process exec(String command, File inDir) {
    Process proc = null;
    try {
        proc = Runtime.getRuntime().exec(command, null, inDir);
    } catch (Exception e) {
        displayExecError(e.toString());
    }
    return proc;
}

// create a process to run a shell command
public Process exec(String command) {
    Process proc = null;
    try {
        proc = Runtime.getRuntime().exec(command);
    } catch (Exception e) {
        displayExecError(e.toString());
    }
    return proc;
}

private void displayExecError(String message) {
    ScriptOutputDialog win = window.newOutputDialog("Groovy Error", "Error during exec");
    win.addTabPane("error");
    win.println("error", message);
}
}

```

Customisation: The script plugin.groovy

This is only an (senseless) example of how to create custom buttons and menu items, but in combination with the connector class it will give you an idea of how an application can be customised/scripted with Groovy as scripting language.

```

import groovy.swing.SwingBuilder

// -- declare standard elements --
allButtons = []

```

```

allItems    = []
builder     = new SwingBuilder()

// USER CODE ----->

// custom methods doing the different tasks

def runDoSomething() {
    def outp = SDE.newOutputDialog("Plugin-Window")
    outp.show()
    dir = workarea.workdir
    Thread.start() {
        outp.println ("=== ${dir}" )
        def proc = SDE.exec("doSomething.bat", new File("${dir}") )
        outp.useInputStream(proc.in)
        proc.waitFor()
    }
    outp.println("end")
}

def showLogfile() {
    def outp = SDE.newOutputDialog("Plugin-Window")
    outp.show()
    def logfile = new File("logfile.txt")
    logfile.eachLine{ line ->
        outp.println(line)
    }
}

// user gui elements

allButtons << builder.button( text: 'Do Something', actionPerformed: { runDoSomething() } )
allButtons << builder.button( text: 'showLogfile',   actionPerformed: { showLogfile()   } )

allItems << builder.menuItem( text: 'TestItemOne', actionPerformed: { /* more code, you know
... */ } )
allItems << builder.menuItem( text: 'TestItemTwo', actionPerformed: { /* ... here too ... */ }
)

// < -----    USER CODE

// ----- add custom gui elements to the dynamic panel and user menu -----
allButtons.each { SDE.dynpanel.add(it) }
allItems.each { SDE.usermenu.add(it) }

```

I hope this spontaneous little article could give you a help in Groovy application integration and give a slight idea of what Groovy could do for you.

Martin Fowler's closure examples in Groovy

This page last changed on Aug 23, 2006 by [paulk_asert](#).

[Martin Fowler](#) wrote an [article in his Bliki](#) on [Closures](#). He uses Ruby as demonstration language for closures. On this page the same example is nearly written in Groovy:

```
def managers(emps) {  
    return emps.findAll { e -> e.isManager() }  
}
```

```
def highPaid(emps) {  
    threshold = 150  
    return emps.findAll { e -> e.salary > threshold }  
}
```

```
def paidMore(amount) {  
    return { e -> e.salary > amount }  
}
```

```
def highPaid = paidMore(150)  
println highPaid(emps[0])
```

```
new File(filename).withReader{ reader -> doSomethingWith(reader) }
```

The whole example with class *Employee* (with an dispensible, but convenient, because boosting readability, *toString()* method), an example list with four employees and some explaining assertions (Dierk would call this *Inline Unittests*):

```
class Employee {  
    def name, salary  
    boolean manager  
    String toString() { return name }  
}  
  
def emps = [new Employee(name:'Guillaume', manager:true, salary:200),  
            new Employee(name:'Graime', manager:true, salary:200),  
            new Employee(name:'Dierk', manager:false, salary:151),  
            new Employee(name:'Bernd', manager:false, salary:50)]  
  
def managers(emps) {  
    return emps.findAll { e -> e.isManager() }  
}  
  
assert emps[0..1] == managers(emps) // [Guillaume, Graime]  
  
def highPaid(emps) {  
    threshold = 150  
    return emps.findAll { e -> e.salary > threshold }  
}  
  
assert emps[0..2] == highPaid(emps) // [Guillaume, Graime, Dierk]  
  
def paidMore(amount) {  
    return { e -> e.salary > amount }  
}  
def highPaid = paidMore(150)  
  
assert highPaid(emps[0]) // true
```

```
assert emps[0..2] == emps.findAll(highPaid)

def filename = 'test.txt'
new File(filename).withReader{ reader -> doSomethingWith(reader) }

def readersText
def doSomethingWith(reader) { readersText = reader.text }

assert new File(filename).text == readersText
```

Other Examples

This page last changed on Sep 26, 2006 by [paulk_asert](#).

Some examples and snippets:

- [Scripts](#)
- [Unit tests](#)
- [GroovyAnt](#)
- [GroovySwing](#)
- [Make a builder](#)

Plotting graphs with JFreeChart

This page last changed on Dec 12, 2006 by [paulk_asert](#).

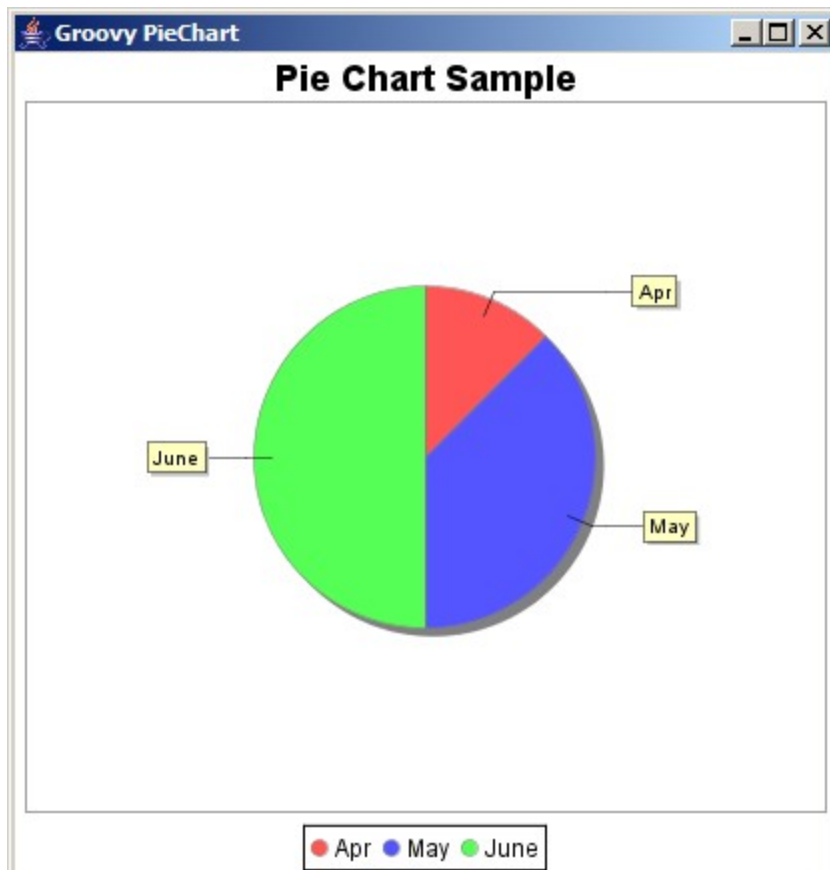
Inspired by the excellent [BeanShell example](#), here is the same thing in Groovy (but displaying in a Swing window rather than writing to a file):

```
//require(groupId:'jfree', artifactId:'jfreechart', version:'1.0.3')
//require(groupId:'jfree', artifactId:'jcommon', version:'1.0.6')
import org.jfree.chart.ChartFactory
import org.jfree.data.general.DefaultPieDataset
import groovy.swing.SwingBuilder
import java.awt.*
import javax.swing.WindowConstants as WC

def piedataset = new DefaultPieDataset();
piedataset.setValue "Apr", 10
piedataset.setValue "May", 30
piedataset.setValue "June", 40

def options = [true, true, true]
def chart = ChartFactory.createPieChart("Pie Chart Sample",
    piedataset, *options)
chart.setBackgroundPaint = Color.white
def swing = new SwingBuilder()
def frame = swing.frame(title:'Groovy PieChart',
    defaultCloseOperation:WC.EXIT_ON_CLOSE) {
    panel(id:'canvas') { rigidArea(width:400, height:400) }
}
frame.pack()
frame.show()
chart.draw(swing.canvas.graphics, swing.canvas.bounds)
```

Here is the result:



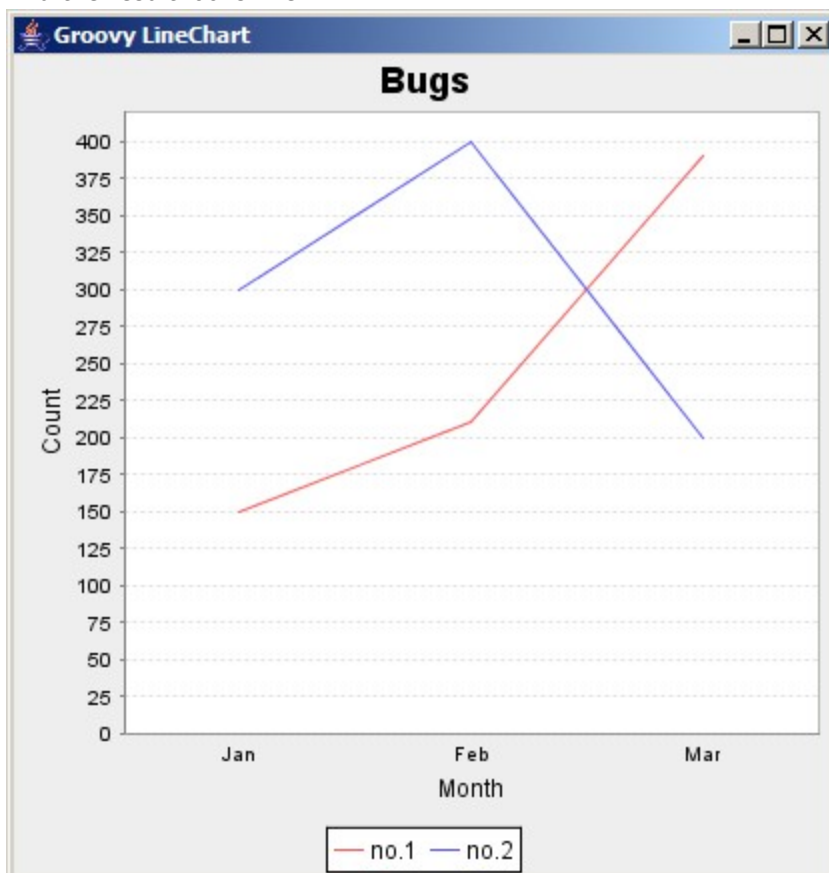
Or if you prefer [Line Charts](#):

```
//require(groupId:'jfree', artifactId:'jfreechart', version:'1.0.3')
//require(groupId:'jfree', artifactId:'jcommon', version:'1.0.6')
import org.jfree.chart.ChartFactory
import org.jfree.data.category.DefaultCategoryDataset
import org.jfree.chart.plot.PlotOrientation as Orientation
import groovy.swing.SwingBuilder
import javax.swing.WindowConstants as WC

def dataset = new DefaultCategoryDataset()
dataset.addValue 150, "no.1", "Jan"
dataset.addValue 210, "no.1", "Feb"
dataset.addValue 390, "no.1", "Mar"
dataset.addValue 300, "no.2", "Jan"
dataset.addValue 400, "no.2", "Feb"
dataset.addValue 200, "no.2", "Mar"

def labels = ["Bugs", "Month", "Count"]
def options = [true, true, true]
def chart = ChartFactory.createLineChart(*labels, dataset,
    Orientation.VERTICAL, *options)
def swing = new SwingBuilder()
def frame = swing.frame(title:'Groovy LineChart',
    defaultCloseOperation:WC.EXIT_ON_CLOSE) {
    panel(id:'canvas') { rigidArea(width:400, height:400) }
}
frame.pack()
frame.show()
chart.draw(swing.canvas.graphics, swing.canvas.bounds)
```

And the result looks like:



Recipes For File

This page last changed on Dec 21, 2006 by [marcdexet](#).

Groovy recipes for every day!

Today is the **File** Day !

List my imported packages

Today: I get a list of imported package into my old groovy scripts !

```
//Pattern for groovy script
def p = ~/.*groovy/
new File( 'd:\\scripts' ).eachFileMatch(p) {
    f ->
        // imports list
        def imports = []
        f.eachLine {
            // condition to detect an import instruction
            ln -> if ( ln =~ '^import .*' ) {
                imports << "${ln - 'import '}"
            }
        }
        // print thmen
        if ( ! imports.empty ) {
            println f
            imports.each{ println "    $it" }
        }
    }
}
```

Output

```
D:\groovy getImports.groovy
d:\scripts\testCom.groovy
    org.codehaus.groovy.scriptom.ActiveXProxy
d:\scripts\testDurableSubscriber.groovy
    javax.jms.*;
    org.apache.activemq.ActiveMQConnectionFactory;
    org.apache.activemq.command.ActiveMQTopic;
d:\scripts\testJmsBroker.groovy
    javax.jms.*;
    org.apache.activemq.ActiveMQConnectionFactory;
    org.apache.activemq.command.ActiveMQTopic;
```

Clean old files

today: Oh jeez! I get on my SysAdmin's nerves, file System /data is full! .. I have to clean all these useless daily reports !

```
def yesterday = ( new Date() ).time - 1000*60*60*24

def cleanThem = { prefix ->
    new File('/data/waporwaresystem/reports').eachFileMatch( ~".*${prefix}.*xml" ) { f ->
        if ( f.lastModified() <= yesterday ) {
```

```

        f.delete()
    }
}

['sales-carambar_', 'stock-scoubidou_', 'stock_frehtagad_', 'coffee.vs.tea_stats_'].each(
    cleanThem )

```

Saved! My SysAdmin loves me, it's sure 😊

Recursively deleting files and directories.

Today is a recursive day ! We have a bunch of files and directories to delete, let's go!

the Ant way

Don't forget this old java swiss knife...

```
new AntBuilder().delete(dir: "D:/tmp/test")
```

the Groovy Way

```

// Create a ref for closure
def delClos

// Define closure
delClos = { println "Dir ${it.canonicalPath}";
            it.eachDir( delClos );
            it.eachFile {
                println "File ${it.canonicalPath}";
                it.delete()
            }
        }

// Apply closure
delClos( new File("D:/tmp/test") )

```

Simple file download from URL

This page last changed on Jan 20, 2007 by [paulk_asert](#).

This method takes a string containing the URL of the file to be downloaded. It will create a file in the current folder whose name is the same as the remote file.

```
def download(address)
{
    def file = new FileOutputStream(address.tokenize("/")[1])
    def out = new BufferedOutputStream(file)
    out << new URL(address).openStream()
    out.close()
}
```

If proxy configuration is needed, call this:

```
System.properties.putAll( ["http.proxyHost":"proxy-host",
"http.proxyPort":"proxy-port","http.proxyUserName":"user-name",
"http.proxyPassword":"proxy-passwd"] )
```

before the call.

Here is another approach using categories. The default left shift operators acts on text streams only. This category overrides the left shift operator making it a binary copy and uses the URL type as the source for the data.

```
package tests.io;

class FileBinaryCategoryTest extends GroovyTestCase
{
    void testDownloadBinaryFile()
    {
        def file = new File("logo.gif")

        use (FileBinaryCategory)
        {
            file << "http://www.google.com/images/logo.gif".toURL()
        }

        assert file.length() > 0

        file.delete()
    }
}

class FileBinaryCategory
{
    def static leftShift(File a_file, URL a_url)
    {
        def input
        def output

        try
        {
            input = a_url.openStream()
            output = new BufferedOutputStream(new FileOutputStream(a_file))

            output << input
        }
        finally
        {
            input?.close()
            output?.close()
        }
    }
}
```



```
}  
}
```

Solving Sudoku

This page last changed on Oct 30, 2006 by [paulk_asert](#).

This page describes a Groovy solution for [ShortestSudokuSolver](#). Check the link for all the details, but basically the puzzle state is fed in as a String. Each line of the script must be no more than 80 characters in length.

The solution (184 characters plus 2 newlines):

```
def r(a){def i=a.indexOf(48);if(i<0)print a else(('1'..'9')-(0..80).collect{j->
g={(int)it(i)==(int)it(j)};g{it/9}|g{it%9}|g{it/27}&g{it%9/3}?a[j]:'0'}).each{
r(a[0..<i]+it+a[i+1..-1])}}
```

Notes:

- The script could be 25 characters shorter if Groovy supported integer division.
- The script executes more efficiently if you use logical operators '&&' and '||' instead of '&' and '|' because short-circuiting kicks in at the expense of 3 characters.
- The script would be 1 character longer if for clarity you wanted to use '0' instead of the first 48.
- The script would be 2 characters longer if you want to use `println` rather than `print` if you are fussy about the formatting
- To make the function stop as soon as it finds the first solution (proper puzzles will only have one solution), the part before the `else` becomes `{print a;System.exit(1)}`

Add the following line to the script to solve a partially complete puzzle (should take just a few seconds):

```
r '200375169639218457571964382152496873348752916796831245900100500800007600400089001'
```

Alternatively, add the following line to the script to solve a puzzle from scratch (may take 30-60 minutes or more):

```
r '200370009009200007001004002050000800008000900006000040900100500800007600400089001'
```

The expected output is:

```
284375169639218457571964382152496873348752916796831245967143528813527694425689731
```

Here is the more usual representation of the puzzle:

2			3	7				9
		9	2					7
		1			4			2
	5					8		
		8				9		
		6					4	
9			1			5		
8					7	6		
4				8	9			1

You can run it from the command-line by adding `;r args[0]` to the end of the script (saved in a file called `sudoku.groovy`) and then invoking:

```
> groovy sudoku.groovy
200370009009200007001004002050000800008000900006000040900100500800007600400089001
```

If you use `'.groovy'` as your script file extension, you can even leave off the extension as follows:

```
> groovy sudoku
200370009009200007001004002050000800008000900006000040900100500800007600400089001
```

A slightly longer version using a matcher and no inner closure (209 characters plus 2 newlines):

```
def r(a){def m=a =~ '0';if(m.find()){int i=m.start();(('1'..'9')-(0..80).collect{
j->int q=j/9,r=i/9,u=q/3,v=r/3,w=j%9/3,x=i%9/3;q==r||j%9==i%9||u==v&&w==x?
a[j]:'0'})}.each{r(a[0..<i]+it+a[i+1..-1])}}else print a}
```

Or without the matcher (193 characters plus two newlines):

```
def r(a){int i=a.indexOf(48);if(i<0)print a else(('1'..'9')-(0..80).collect{j->
int q=j/9,r=i/9,u=q/3,v=r/3,w=j%9/3,x=i%9/3;q==r||i%9==j%9||u==v&&w==x?a[j]:'0'
}).each{r(a[0..<i]+it+a[i+1..-1])}}
```

Also see [another version](#) for a more understandable (though much longer) algorithm - but it also does a lot more.

SwingBuilder with custom widgets and observer pattern

This page last changed on Apr 28, 2007 by wiktor.gworek@gmail.com.

In this tutorial you will learn how to:

- use custom widgets with SwingBuilder,
- implement observer pattern (also known as subject-observer pattern) in Swing & Groovy,
- use action listeners with SwingBuilder,
- build simple currency converter 😊.

Swing introduced modified **MVC** pattern (for more details see <http://java.sun.com/products/jfc/tsc/articles/architecture/>). To update model I'll use **observer pattern** (if you're not familiar with it, see http://en.wikipedia.org/wiki/Observer_pattern) which is directly supported in Java by `Observable` class and `Observer` interface in `java.util` package.

For the example let's choose currency converter application from **Java Generics and Collections** book by *Maurice Naftalin* and *Philip Wadler* (<http://www.oreilly.com/catalog/javagenerics/>) from chapter 9.5. It will show explicitly the benefits from using dynamic language like Groovy over static typed Java with generic observer pattern introduced in the book. If you would like to see implementation of generic observer pattern you can download examples from the book website and have a look.

OK. Let's start with the model:

```
class Model extends Observable {
    static CURRENCY = ["USD", "EURO", "YEN"]

    private Map rates = new HashMap()
    private long value

    void initialize(initialRates) {
        (0..CURRENCY.size() - 1).each {
            setRate(CURRENCY[it], initialRates[it])
        }
    }

    // setting rate for currency
    void setRate(currency, f) {
        rates.put(currency, f);
        setChanged();
        notifyObservers(currency);
    }

    // setting new value for currency
    void setValue(currency, double newValue) {
        value = Math.round(newValue / rates[currency]);
        setChanged();
        notifyObservers(null);
    }

    // getter for value for particular currency
    def getValue(currency) {
        value * rates[currency]
    }
}
```

The converter model allows conversions over three different currencies. As you can see it extends `Observable` class to provide Model class observable behaviour (for more details see java.util.Observable).

Now let's create two custom widgets for displaying rate and value.

```
class RateView extends JTextField implements Observer {
    private Model model;
    private currency;

    public void setModel(Model model) {
        this.model?.removeObserver(this)
        this.model = model
        model.addObserver(this)
    }

    public void update(Observable o, Object currency) {
        if (this.currency == currency)
            text = String.format("%15.2f", model.rates[currency])
    }
}

class ValueView extends JTextField implements Observer {
    private Model model
    private currency

    public void setModel(Model model) {
        this.model?.removeObserver(this)
        this.model = model
        model.addObserver(this)
    }

    public void update(Observable o, Object currency) {
        if (currency == null || this.currency == currency)
            text = String.format("%15.2f", model.getValue(this.currency));
    }
}
```

These classes extends `JTextField` to hold model and currency which is representing. They also implement `Observer` interface to be noticed when the model is changed. As you can see in update method there are not class casts required although it receives `Object`, because as dynamic nature of Groovy. Also in `setModel` method safe dereferencing is shown to protect from throwing `NullPointerException` when initially model is `null`.

Now let's put it all together.

```
swing = new SwingBuilder()
model = new Model()

frame = swing.frame(title: "Groovy SwingBuilder MVC Demo", layout: new GridLayout(4, 3), size:
[300, 150],
    defaultCloseOperation: WindowConstants.EXIT_ON_CLOSE) {

    label("currency")
    label("rate")
    label("value")

    for (c in Model.CURRENCY) {
        label(c)
        widget(new RateView(), model: model, currency: c,
            action: swing.action(closure: { event ->
                event.source.model.setRate(event.source.currency,
event.source.text.toDouble());
            })))
        widget(new ValueView(), model: model, currency: c, action: swing.action(closure:
{event ->
                event.source.model.setValue(event.source.currency,
event.source.text.toDouble());
            })))
    }
}
```

```
frame.show()
model.initialize([1.0, 0.83, 0.56]);
```

Frame is constructed by using `swing.frame()`. To frame there are provided `title`, `layout`, `defaultCloseOperation`, `size` properties. You can think of it like creating a new instance of `JFrame` and invoking methods `setTitle()`, `setLayout()`, `setDefaultCloseOperation()`, `setSize()`. Then 12 components are added to frame:

- JLabel components using `label("label's text")`,
- RateView components using `widget()` builder method and setting model, currency attributes,
- ValueView components in the same way like RateView.

When new rate or value is entered all action listeners of that component are noticed with `actionPerformed()` method ([java.awt.ActionListener](#)). To construct classes which implements `ActionListener` interface `SwingBuilder` provides **`action()`** builder method. One of this method's attributes is closure when we are able to provide our closure with application logic. The closure argument has `ActionEvent` type.

Download the source code of the example: [SwingBuilderObserver.groovy](#)

Unsign Jar Files (Recursively)

This page last changed on Feb 14, 2007 by [moatas](#).

```
ant = new AntBuilder();
tmpDir = "tmpDir"
```

```
new File(args[0]).eachFileRecurse({file->
  if(file.name.endsWith(".jar")) {
    ant.sequential {
      mkdir(dir:tmpDir)
      echo "Unsigning file: $file"
      unjar(src:file, dest:tmpDir)
      delete {
        fileset(dir:tmpDir, includes:"META-INF/*.DSA,META-INF/*.SF,META-INF/*.RSA")
      }
      jar(destFile:file,baseDir:tmpDir)
      delete(dir:tmpDir)
    }
  }
})
```

Using MarkupBuilder for Agile XML creation

This page last changed on Oct 06, 2006 by [paulk_asert](#).

Two principles of Agile development are *DRY* (don't repeat yourself) and *merciless refactoring*. Thanks to excellent IDE support it isn't too hard to apply these principles to coding Java and Groovy but it's a bit harder with XML.

The good news is that Groovy's Builder notation can help. Whether you are trying to refactor your Ant build file(s) or manage a family of related XML files (e.g. XML request and response files for testing Web Services) you will find that you can make great advances in managing your XML files using builder patterns.

<p>Scenario: Consider we have a program to track the sales of copies of GINA 😊. Books leave a warehouse in trucks. Trucks contain big boxes which are sent off to various countries. The big boxes contain smaller boxes which travel to different states and cities around the world. These boxes may also contain smaller boxes as required. Eventually some of the boxes contain just books. Either GINA or some potential upcoming Groovy titles. Suppose the delivery system produces XML files containing the items in each truck. We are responsible for writing the system which does some fancy reporting.</p>
--

If we are a vigilant tester, we will have a family of test files which allow us to test the many possible kinds of XML files we need to deal with. Instead of having to manage a directory full of files which would be hard to maintain if the delivery system changed, we decide to use Groovy to generate the XML files we need. Here is our first attempt:

```
import groovy.xml.MarkupBuilder

def writer = new StringWriter()
def xml = new MarkupBuilder(writer)
xml.truck(id:'ABC123') {
    box(country:'Australia') {
        box(country:'Australia', state:'QLD') {
            book(title:'Groovy in Action', author:'Dierk König et al')
            book(title:'Groovy in Action', author:'Dierk König et al')
            book(title:'Groovy for VBA Macro writers')
        }
        box(country:'Australia', state:'NSW') {
            box(country:'Australia', state:'NSW', city:'Sydney') {
                book(title:'Groovy in Action', author:'Dierk König et al')
                book(title:'Groovy for COBOL Programmers')
            }
        }
    }
}
```



```

        }
        box(country:'Australia', state:'NSW', suburb:'Albury') {
            book(title:'Groovy in Action', author:'Dierk König et al')
            book(title:'Groovy for Fortran Programmers')
        }
    }
    box(country:'USA') {
        box(country:'USA', state:'CA') {
            book(title:'Groovy in Action', author:'Dierk König et al')
            book(title:'Groovy for Ruby programmers')
        }
    }
    box(country:'Germany') {
        box(country:'Germany', city:'Berlin') {
            book(title:'Groovy in Action', author:'Dierk König et al')
            book(title:'Groovy for PHP Programmers')
        }
    }
    box(country:'UK') {
        box(country:'UK', city:'London') {
            book(title:'Groovy in Action', author:'Dierk König et al')
            book(title:'Groovy for Haskel Programmers')
        }
    }
}

println writer.toString()

```

There is quite a lot of replication in this file. Lets refactor out two helper methods `bk1` and `bk2` to remove some of the duplication. We now have something like this:

```

import groovy.xml.MarkupBuilder

// standard book
def standardBook1(builder) { builder.book(title:'Groovy in Action', author:'Dierk König et al')
}
// other standard books
def standardBook2(builder, audience) { builder.book(title:"Groovy for ${audience}") }
def writer = new StringWriter()
def xml = new MarkupBuilder(writer)
xml.truck(id:'ABC123') {
    box(country:'Australia') {
        box(country:'Australia', state:'QLD') {
            standardBook1(this)
            standardBook1(this)
            standardBook2(this, 'VBA Macro writers')
        }
        box(country:'Australia', state:'NSW') {
            box(country:'Australia', state:'NSW', city:'Sydney') {
                standardBook1(this)
                standardBook2(this, 'COBOL Programmers')
            }
            box(country:'Australia', state:'NSW', suburb:'Albury') {
                standardBook1(this)
                standardBook2(this, 'Fortran Programmers')
            }
        }
    }
}
box(country:'USA') {
    box(country:'USA', state:'CA') {
        standardBook1(this)
        standardBook2(this, 'Ruby Programmers')
    }
}
box(country:'Germany') {
    box(country:'Germany', city:'Berlin') {
        standardBook1(this)
        standardBook2(this, 'PHP Programmers')
    }
}
box(country:'UK') {
    box(country:'UK', city:'London') {

```

```

        standardBook1(this)
        standardBook2(this, 'Haskel Programmers')
    }
}

println writer.toString()

```

Next, let's refactor out a few more methods to end up with the following:

```

import groovy.xml.MarkupBuilder

// define standard book and version allowing multiple copies
def standardBook1(builder) { builder.book(title:'Groovy in Action', author:'Dierk König et al') }
def standardBook1(builder, copies) { (0..copies).each { standardBook1(builder) } }
// another standard book
def standardBook2(builder, audience) { builder.book(title:"Groovy for ${audience}") }
// define standard box
def standardBox1(builder, args) {
    def other = args.findAll { it.key != 'audience' }
    builder.box(other) { standardBook1(builder); standardBook2(builder, args['audience']) }
}
// define standard country box
def standardBox2(builder, args) {
    builder.box(country:args['country']) {
        if (args.containsKey('language')) {
            args.put('audience', args['language'] + ' programmers')
            args.remove('language')
        }
        standardBox1(builder, args)
    }
}

def writer = new StringWriter()
def xml = new MarkupBuilder(writer)
xml.truck(id:'ABC123') {
    box(country:'Australia') {
        box(country:'Australia', state:'QLD') {
            standardBook1(this, 2)
            standardBook2(this, 'VBA Macro writers')
        }
        box(country:'Australia', state:'NSW') {
            [Sydney:'COBOL', Albury:'Fortran'].each { city, language ->
                standardBox1(this, [country:'Australia', state:'NSW',
                    city:"${city}", audience:"${language} Programmers"])
            }
        }
        standardBox2(this, [country:'USA', state:'CA', language:'Ruby'])
        standardBox2(this, [country:'Germany', city:'Berlin', language:'PHP'])
        standardBox2(this, [country:'UK', city:'London', language:'Haskel'])
    }
}

println writer.toString()

```

This is better. If the format of our XML changes, we will minimise the changes required in our builder code. Similarly, if we need to produce multiple XML files, we can add some for loops, closures or if statements to generate all the files from one or a small number of source files.

We could extract out some of our code into a helper method and the code would become:

```

import groovy.xml.MarkupBuilder

def writer = new StringWriter()
def xml = new MarkupBuilder(writer)
def standard = new StandardBookDefinitions(xml)
xml.truck(id:'ABC123') {
    box(country:'Australia') {
        box(country:'Australia', state:'QLD') {

```

```

        standard.book1(2)
        standard.book2('VBA Macro writers')
    }
    box(country:'Australia', state:'NSW') {
        [Sydney:'COBOL', Albury:'Fortran'].each{ city, language ->
            standard.box1(country:'Australia', state:'NSW',
                city:"${city}", audience:"${language} Programmers")
        } }
    standard.box2(country:'USA', state:'CA', language:'Ruby')
    standard.box2(country:'Germany', city:'Berlin', language:'PHP')
    standard.box2(country:'UK', city:'London', language:'Haskel')
}

println writer.toString()

```

So far we have just produced the one XML file. It would make sense to use similar techniques to produce all the XML files we need. We can take this in several directions at this point including using GStrings, using database contents to help generate the content or making use of templates.

We won't look at any of these, instead we will just augment the previous example just a little more. First we will slightly expand our helper class. Here is the result:

```

import groovy.xml.MarkupBuilder

class StandardBookDefinitions {
    private def builder
    StandardBookDefinitions(builder) {
        this.builder = builder
    }
    def removeKey(args, key) { return args.findAll{it.key != key} }
    // define standard book and version allowing multiple copies
    def book1() { builder.book(title:'Groovy in Action', author:'Dierk König et al') }
    def book1(copies) { (0..<copies).each{ book1() } }
    // another standard book
    def book2(audience) { builder.book(title:"Groovy for ${audience}") }
    // define standard box
    def box1(args) {
        def other = removeKey(args, 'audience')
        builder.box(other) { book1(); book2(args['audience']) }
    }
    // define standard country box
    def box2(args) {
        builder.box(country:args['country']) {
            if (args.containsKey('language')) {
                args.put('audience', args['language'] + ' programmers')
                args.remove('language')
            }
            box1(args)
        }
    }
    // define deep box
    def box3(args) {
        def depth = args['depth']
        def other = removeKey(args, 'depth')
        if (depth > 1) {
            builder.box(other) {
                other.put('depth', depth - 1)
                box3(other)
            }
        } else {
            box2(other)
        }
    }
    // define deep box
    def box4(args) {
        builder.box(country:'South Africa'){
            (0..<args['number']).each{ book1() }
        }
    }
}

```

And now we will use this helper class to generate a family of related XML files. For illustrative purposes,

we will just print out the generated files rather than actually store the files.

```
import groovy.xml.MarkupBuilder

def writer = new StringWriter()
xml = new MarkupBuilder(writer)
standard = new StandardBookDefinitions(xml)
def shortCountry = 'UK'
def longCountry = 'The United Kingdom of Great Britain and Northern Ireland'
def shortState = 'CA'
def longState = 'The State of Rhode Island and Providence Plantations'
def countryForState = 'USA'

def generateWorldOrEuropeXml(world) {
    xml.truck(id:'ABC123') {
        if (world) {
            box(country:'Australia') {
                box(country:'Australia', state:'QLD') {
                    standard.book1(2)
                    standard.book2('VBA Macro writers')
                }
                box(country:'Australia', state:'NSW') {
                    [Sydney:'COBOL', Albury:'Fortran'].each { city, language ->
                        standard.box1(country:'Australia', state:'NSW',
                            city:"${city}", audience:"${language} Programmers")
                    }
                }
                standard.box2(country:'USA', state:'CA', language:'Ruby')
            }
            standard.box2(country:'Germany', city:'Berlin', language:'PHP')
            standard.box2(country:'UK', city:'London', language:'Haskel')
        }
    }
}

def generateSpecialSizeXml(depth, number) {
    xml.truck(id:'DEF123') {
        standard.box3(country:'UK', city:'London', language:'Haskel', depth:depth)
        standard.box4(country:'UK', city:'London', language:'Haskel', number:number)
        box(country:'UK') {} // empty box
    }
}

def generateSpecialNamesXml(country, state) {
    xml.truck(id:'GHI123') {
        if (state) {
            box(country:country, state:state){ standard.book1() }
        } else {
            box(country:country){ standard.book1() }
        }
    }
}

generateWorldOrEuropeXml(true)
generateWorldOrEuropeXml(false)
generateSpecialSizeXml(10, 10)
generateSpecialNamesXml(shortCountry, '')
generateSpecialNamesXml(longCountry, '')
generateSpecialNamesXml(countryForState, shortState)
generateSpecialNamesXml(countryForState, longState)
println writer.toString()
```

This will be much more maintainable over time than a directory full of hand-crafted XML files.

Here is what will be produced:

```
<truck id='ABC123'>
  <box country='Australia'>
    <box state='QLD' country='Australia'>
      <book title='Groovy in Action' author='Dierk König et al' />
      <book title='Groovy in Action' author='Dierk König et al' />
      <book title='Groovy for VBA Macro writers' />
    </box>
  </box>
</truck>
```

[illegible]

```

    <book title='Groovy in Action' author='Dierk König et al' />
    <book title='Groovy in Action' author='Dierk König et al' />
    <book title='Groovy in Action' author='Dierk König et al' />
  </box>
  <box country='UK' />
</truck>
<truck id='GHI123'>
  <box country='UK'>
    <book title='Groovy in Action' author='Dierk König et al' />
  </box>
</truck>
<truck id='GHI123'>
  <box country='The United Kingdom of Great Britain and Northern Ireland'>
    <book title='Groovy in Action' author='Dierk König et al' />
  </box>
</truck>
<truck id='GHI123'>
  <box state='CA' country='USA'>
    <book title='Groovy in Action' author='Dierk König et al' />
  </box>
</truck>
<truck id='GHI123'>
  <box state='The State of Rhode Island and Providence Plantations' country='USA'>
    <book title='Groovy in Action' author='Dierk König et al' />
  </box>
</truck>

```

Using the Delegating Meta Class

This page last changed on Jan 28, 2007 by [esumerfd](#).

This is an example of how to replace a MetaClass to adjust the default behavior. Each groovy object has a metaClass that is used to manage the dynamic nature of the language. This class intercepts calls to groovy objects to ensure that the appropriate grooviness can be added. One feature of the invokeConstructor allows us to create groovy objects using a map argument to set the properties of the object (new X([prop1: value1, prop2: value2])).

These solutions perform complete replacements, where as a more scoped solution can be found at [Using the Proxy Meta Class](#).

InvokeHelper Solution

This technique installs the meta class at runtime using the InvokerHelper to gain access to the registry which allows us to change the meta class instance that is in use. Note that this is "at runtime" so instances created or used before the change are also impacted. You will have to answer for yourself whether this is a good idea for your particular problem.

This sample code overrides the invokeMethod method to augment the behavior but there are other options that you can choose from like set and getAttribute, invokeStaticMethod and invokeConstructor. The complete list can be found in the Groovy's source release in "src/main/groovy/lang/DelegatingMetaClass.java".

```
import org.codehaus.groovy.runtime.InvokerHelper

class DelegatingMetaClassInvokeHelperTest extends GroovyTestCase
{
    void testReplaceMetaClass()
    {
        /*
         * Constructing first instance before meta class replacment
         * is made.
         */
        def firstInstance = "first"
        assertEquals "first", firstInstance.toString()

        def myMetaClass = new MyDelegatingMetaClass(String.class)
        def invoker = InvokerHelper.instance
        invoker.metaRegistry.setMetaClass(String.class, myMetaClass)

        /*
         * Constructing second instance after meta class replacment
         * is made.
         */
        def secondInstance = "second"

        /*
         * Since we are replacing a meta class at the class level
         * we are changing the behavior of the first and second
         * instance of the string.
         */
        assertEquals "changed first", firstInstance.toString()
        assertEquals "changed second", secondInstance.toString()
    }
}

class MyDelegatingMetaClass extends groovy.lang.DelegatingMetaClass
{
    MyDelegatingMetaClass(final Class a_class)
    {
```

```

        super(a_class);
        initialize()
    }

    public Object invokeMethod(Object a_object, String a_methodName, Object[] a_arguments)
    {
        return "changed ${super.invokeMethod(a_object, a_methodName, a_arguments)}"
    }
}

```

Package Name Convention Solution

This second solution offers a more consistent augmentation of existing classes. There are no risks of unpredictable results from methods. The idea is that any package.class can have a custom meta class loaded at startup time by placing it into a well known package with a well known name.

```
groovy.runtime.metaclass.[YOURPACKAGE].[YOURCLASS]MetaClass
```

So your class Foo in package "bar" could have a custom meta class FooMetaClass in package "groovy.runtime.metaclass.bar".

The following example shows how we can change the behavior of the String class. Firstly the custom meta class, similar to the implementation above except that it needs a MetaClassRegistry argument in its constructor.

```

package groovy.runtime.metaclass.java.lang

class StringMetaClass extends groovy.lang.DelegatingMetaClass
{
    StringMetaClass(MetaClassRegistry a_registry, final Class a_class)
    {
        super(a_class);
    }

    public Object invokeMethod(Object a_object, String a_methodName, Object[] a_arguments)
    {
        return "changed ${super.invokeMethod(a_object, a_methodName, a_arguments)}"
    }
}

```

The actual class that uses the enhanced features is now very simple. Notice that there are no extra imports or any work with the meta class. The mere package and name of the class tells the groovy runtime to use the custom meta class.

```

class DelegatingMetaClassPackageImpliedTest extends GroovyTestCase
{
    void testReplaceMetaClass()
    {
        assertEquals "changed hello world", "hello world".toString()
    }
}

```

Precedence

So what would happen if you used both techniques. Assume that the package convention class exists in your class path and you create and set another meta class. The answer is that the last setMetaClass that you did applies to the usages of all instance of the effected type.

Using the Proxy Meta Class

This page last changed on Mar 17, 2007 by [gavingrover](#).

The [Using the Delegating Meta Class](#) page talks about techniques to change the behavior of existing classes by replacing the meta class in use. However, the Delegating Meta Class effects all loaded classes.

The Proxy Meta Class allows us to replace the meta class in use by a class but in a well defined scope. This technique would be more appropriate for temporary behavior replacements such as

This example shows how we can create a proxy meta class for the String class and intercept its method invocations.

```
import org.codehaus.groovy.runtime.InvokerHelper

class ProxyMetaClassTest extends GroovyTestCase
{
    void testProxyMetaClass()
    {
        def proxy = ProxyMetaClass.getInstance(String.class);
        proxy.interceptor = new MyInterceptor()

        def text = "hello world"

        assertEquals "hello world", text.toString()

        proxy.use {
            assertEquals "changed hello world", text.toString()
        }

        assertEquals "hello world", text.toString()
    }
}

class MyInterceptor implements groovy.lang.Interceptor
{
    Object beforeInvoke(Object a_object, String a_methodName, Object[] a_arguments)
    {
    }

    boolean doInvoke()
    {
        return true
    }

    Object afterInvoke(Object a_object, String a_methodName, Object[] a_arguments, Object
a_result)
    {
        return "changed ${a_result}"
    }
}
```

For more detail on using the ProxyMetaClass, see <http://groovy.codehaus.org/Using+the+Proxy+Meta+Class+in+depth>.

Windows Look And Feel for groovyConsole

This page last changed on Apr 28, 2007 by [paulk_asert](#).

Add the following lines:

```
set JAVA_OPTS=%JAVA_OPTS% -Dswing.aatext=true
set JAVA_OPTS=%JAVA_OPTS% -Dswing.defaultlaf=com.sun.java.swing.plaf.windows.WindowsLookAndFeel
```

just after the line

```
if "%JAVA_OPTS%" == "" set JAVA_OPTS="-Xmx128m"
```

in `groovyConsole.bat`. The first line turns on text antialiasing and the second turns on the Windows Look And Feel. You can do the same in all the other `.bat` files as well. You may find the antialiasing doesn't improve the appearance of the fonts very much, in which case remove it.

FAQ

This page last changed on Mar 12, 2007 by [furashgf](#).

- [Class Loading](#)
- [Developers](#)
- [FAQ - Classes and Object Orientation](#)
- [FAQ - Closures](#)
- [FAQ - Collections, Lists, etc.](#)
- [FAQ - RegExp](#)
- [General](#)
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 - [Why does == differ from Java](#)
- [Learning about Groovy FAQ](#)

- [Old FAQ](#) (Some links may be broken)
- [Class Loading](#)

Class Loading

This page last changed on Mar 15, 2007 by [furashgf](#).

I'm getting an "unable to resolve class My Class" error when I try to use a class contained in external .groovy file.

If the problem goes away when you apply groovyc to the .groovy file (compiling it), and you're running on windows, the problem is probably spaces in the current directory structure. Move your files to a path without spaces (e.g., c:\source rather than c:\documents and settings\Administrator\My Documents\source).

How do I load jars and classes dynamically at runtime?

Use the groovy script's classLoader to add the jar file at runtime.

```
this.class.classLoader.rootLoader.addURL(new URL("file:///path to file"))
```

Then, use Class.forName to load the class.

```
def cls = Class.forName("com.mysql.jdbc.Driver").newInstance();
```

Developers

This page last changed on Apr 26, 2004 by [jstrachan](#).

FAQ - Classes and Object Orientation

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Classes and Object Orientation

How do you include groovy classes within other classes?

Groovy classes work exactly like java classes. For example, to include the class "TestClass" in your program, ensure that it is in a file called "TestClass.groovy," and in a path seen by your CLASSPATH environment variable (or command line). Remember that JAR files need to be included explicitly by name.

FAQ - Closures

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Closures

What problem do closures solve? Why have closures?

At one level they just allow internal iterators instead of external ones. This alone is really nice because looping is a lot cleaner. With Iterators for example you do all the work, because if you want to execute the loop of the body, you have to take responsibility for `hasNext()` and `next()`.

So its basically providing the body of a loop or a callback etc which will execute within the original scope.

Anonymous classes can seem like they are in fact closures, but they have limitations that cause annoying things like having to declare all your variables as `final`. The compiler just creates a synthetic constructor that takes any variables you are going to reference.

For me the main benefit of closures is that they allow you to write code for collections with a lot less boilerplate.

```
accounts.findAll { it.overdrawn && !it.customer.vip }.each { account ->
    account.customer.sendEmail("Pay us now!!")
}
```

FAQ - Collections, Lists, etc.

This page last changed on Apr 10, 2007 by [tomstrummer](#).

Collections, Lists, etc.

Why don't return statements work when iterating through an object?

The {...} in an each statement is not a normal Java block of code, but a *closure*. Closures are like classes/methods, so returning from one simply exits out of the closure, not the enclosing method.

How do I declare and initialize a list at the same time?

Syntax:

```
def x = [ "a", "b" ]
```

How do I declare and initialize a traditional array at the same time?

Syntax:

```
String[] x = [ "a", "qrs" ]
```

or

```
String[] x = [ "a", "qrs" ] as String[]
```

or

```
def x = [ "a", "qrs" ] as String[]
```

Why does myMap.size or myMap.class return null?

In Groovy, maps override the dot operator to behave the same as the index[] operator:

```
myMap["size"]="ONE MILLION!!!";
println myMap.size           // outputs 'ONE MILLION!!!'

//use the following:
println myMap.@size          // '1'
println myMap.size()         // '1'
println myMap.getClass()     // 'class java.util.HashMap'
```


Why is my map returning null values?

Chances are, you tried to use a variable as a key in a map literal definition. Remember, keys are interpreted as literal strings:

```
myMap = [myVar:"one"]  
assert myMap[myVar] == "one"
```

Try this (note the parentheses around the key):

```
myMap = [ (myVar) : "one" ]
```

FAQ - RegExp

This page last changed on Dec 20, 2006 by [marcdexet](#).

RegExp

matcher.matches() returns false

Why this code fails ?

```
def matcher = "/home/me/script/test.groovy" =~ /\.groovy/  
assert matcher.matches()
```

Because of you think you do something like *"Oh dear it contains the word!"*, but you're confusing *matches* with *find*

From Javadoc: [http://java.sun.com/j2se/1.5.0/docs/api/java/util/regex/Matcher.html#matches\(\)](http://java.sun.com/j2se/1.5.0/docs/api/java/util/regex/Matcher.html#matches())

```
public boolean matches()  
Attempts to match the entire region against the pattern.  
...
```

So `/\.groovy/` is just a subsequence.
You must use

```
def matcher = "/home/me/script/test.groovy" =~ /\.*\.groovy/
```

What is the difference between `=~` and `==~` ?

- `~` is the [Pattern](#) symbol.
- `=~` means [matcher.find\(\)](#)
- `==~` means [matcher.matches\(\)](#)

Pattern, Matcher ?

A pattern is not very usefull alone. He's just waiting input to process through a *matcher*.

```
def pattern = ~/groovy/  
def matcher = pattern.matcher('my groovy buddy')
```

Matcher can say a lot of thing to you:

- if the *entire* input sequence matches the pattern, with [matcher.matches\(\)](#) ;

- if just a *subsequence* of the input sequence matches the pattern, with `matcher.find()`.

A matcher with `/groovy/` pattern **finds** a matching subsequence in the 'my groovy buddy' sequence. On the contrary the whole sequence doesn't **match** the pattern.

```
def m = c.matcher('my groovy buddy')
assert m.find()
assert m.matches() == false
```

Application: to filter a list of names.

```
def list = ['/a/b/c.groovy', 'myscript.groovy', 'groovy.rc', 'potatoes']
// find all items whom a subsequence matches /groovy/
println list.findAll{ it =~ /groovy/ } // => ["groovy", "/a/b/c.groovy", "myscript.groovy",
"groovy.rc", "groovy."]

// find all items who match exactly /groovy/
println list.findAll{ it ==~ /groovy/ } // => ["groovy"]

// find all items who match fully /groovy\..*/ ('groovy' with a dot and zero or more char
trailing)
println list.findAll{ it ==~ /groovy\..*/ } // => ["groovy.rc", "groovy."]
```

A little tilde headache ? Remember like this

~	the pattern
=~	roughly as the pattern (easy to write)
==~	more than roughly, exactly as the pattern (think hard...)

General

This page last changed on Apr 26, 2004 by [jstrachan](#).

- [How can I edit the documentation](#)

How can I edit the documentation

This page last changed on Apr 26, 2004 by [jstrachan](#).

The entire Groovy website is stored in this [wiki](#)

The home page is called [Home](#) then the navigation links on the left are on a magic page called [Navigation](#) and the top right navigation links are on a magic page called [QuickLinks](#).

Hopefully now anyone can contribute to the documentation.

If you ever edit a page and wonder why its not yet been updated on the <http://groovy.codehaus.org/> site well it could be cached. To view a latest greatest page just add the 'refresh=1' to your URL. e.g.

<http://groovy.codehaus.org/?refresh=1>

Language questions

This page last changed on Sep 24, 2006 by [paulk_asert](#).

- [How can I dynamically add a library to the classpath](#)
- [Why does == differ from Java](#)

[How can I dynamically add a library to the classpath](#)

How can I dynamically add a library to the classpath

This page last changed on Sep 24, 2006 by [paulk_asert](#).

Use `getRootLoader().addUrl([Some URI])`

See [RootLoader javadoc](#)

Sample: Dynamic JDBC Driver Loading

```
import Groovy.sql.Sql
this.class.classLoader.rootLoader.addURL( new URL("file:///d:/drivers/ojdbc14.jar") )
def driver="oracle.jdbc.driver.OracleDriver";
def sql = Sql.newInstance("jdbc:oracle:thin:@hostname:port:schema", "scott", "tiger", driver);
```

Why does == differ from Java

This page last changed on Oct 07, 2006 by [jbaumann](#).

This is described [here](#).

Basically in Java == with primitive types means use equality. For object types == means test identity.

We found when working with Groovy that if we kept those semantics and folks used dynamic typing as follows

```
def x = 2 * 2
if (x == 4) {
  ...
}
```

They would get surprising results, as they often mean equality based on value, such as in the above, rather than identity. Indeed folks rarely ever use identity comparisons.

So to avoid many common gotchas and confusions, we've made == mean equals, the meaning most developers use, and we use this for both primitive types and for object types and across both static and dynamic typing to simplify things.

Currently if you really want to compare identities of the objects, use the method `is()`, which is provided by every object.

```
if (x.is(4)) {
  ... // never true
}
```

The above condition is never true, since the Integer object in `x` (which is the result of the computation above) is not identical to the Integer object with value 4 that has been created for the comparison.

Learning about Groovy FAQ

This page last changed on Dec 15, 2004 by [jez](#).

This FAQ hopes to answer common questions for users of Groovy

What is Groovy?

- [Groovy](#) is trying to provide a high level language (like Ruby, Python or Dylan) that maps cleanly to Java bytecode.
- It needs to work with Java objects, and the root of all the object trees is [java.lang.Object](#).
- The syntax will be Java friendly, but doesn't have to be backwards compatible.
- Groovy will sit on top of [J2SE](#).

Where can I get more information on Groovy?

The current user documentation for Groovy is available from <http://groovy.codehaus.org>

What if the documentation is wrong?

Anybody can change these pages, just click on the little **Edit** link on the right of each page (you then have to signup/login if you haven't already).

How can I get a binary version of Groovy?

Download latest distribution as a [zip](#) or [tgz](#) file and then follow the [installation instructions](#)

How do I embed Groovy in my own programs?

Download latest [groovy-all.jar](#) and place it in your classpath.

How can I grab the sources?

You can either [browse](#) the CVS repository, or if you are happy with using [cvs](#)

```
cvs -d :pserver:anonymous@cvs.groovy.codehaus.org:/home/projects/groovy/scm login
cvs -z3 -d :pserver:anonymous@cvs.groovy.codehaus.org:/home/projects/groovy/scm co groovy
```

Home

This page last changed on Apr 27, 2007 by [glaforge](#).

Groovy ...

- is an agile dynamic language for the Java Platform with many features that are inspired by languages like Python, Ruby and Smalltalk, making **modern programming features** available to Java developers with **almost-zero learning curve**
- makes writing shell scripts and build **scripts easier than ever** by supporting powerful processing primitives, a touch of OO programming and an Ant domain specific language
- increases developer productivity by **reducing scaffolding code** when developing web, GUI, database or console applications
- makes **writing concise meaningful maintainable code easier** than ever by supporting domain specific languages, closure expressions and many compact syntax abbreviations
- greatly **simplifies testing** because all the support you need including unit testing and mocking is built right in
- cleanly **integrates with all existing Java objects and libraries** and compiles straight to Java bytecode in either *application development* or *scripting* mode.

Groovy, a creative and innovative project



[JAX](#) is the most important Java conference in Germany. Every year, the organizers are running a [contest](#) to select the **most innovative and creative projects**. From over [40 proposals](#), the jury selected only [ten nominees](#). Although great projects were selected, like the Matisse GUI builder in NetBeans, or the Nuxeo Enterprise Content Management solution, [Groovy won the first prize!](#) It is a great honor and a huge pleasure for us to receive such a prize, especially knowing the cool projects we were competing with, or the past winners like the Spring framework.

[Dierk König](#), author of the best-selling "[Groovy in Action](#)" book, received the [prize](#) in the name of the Groovy community, after having presented several sessions on Groovy at this conference. **This award proves and reaffirms how innovative, creative and influential the Groovy project is for the Java community.**

<p>"Groovy is like a super version of Java. It can leverage Java's enterprise capabilities but also has cool productivity features like closures, builders and dynamic typing. If you are a developer, tester or script guru, you have to love Groovy."</p>	<h3>Samples</h3>
	<p>A simple hello world script:</p>
	<pre>def name='World'; println "Hello \$name!"</pre> <p>A more sophisticated version using Object Orientation:</p>



```
class Greet {  
    def name  
    Greet(who) { name = who[0].toUpperCase()  
+ who[1..-1] }  
    def salute() { println "Hello $name!" }  
}  
  
g = new Greet('world') // create object  
g.salute()              // Output "Hello  
World!"
```

Leveraging existing Java libraries:

```
import org.apache.commons.lang.WordUtils  
  
class Greeter extends Greet {  
    Greeter(who) { name =  
WordUtils.capitalize(who) }  
}  
  
new Greeter('world').salute()
```

On the command line:

```
groovy -e "println 'Hello ' + args[0]"  
World
```

Catch **Groovy and Grails** on the
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The following modules are currently available:

- [COM Scripting](#) — allows you to script any ActiveX or COM Windows component from within your Groovy scripts
- [Gant](#) — a build tool for scripting Ant tasks using Groovy instead of XML to specify the build logic

- [Gant_Script](#)
- [Gant_Tasks](#)
- [Gants_Build_Script](#)
- [Google Data Support](#) — makes using the Google Data APIs easier from within Groovy
- [Gram](#) — a simple xdoclet-like tool for processing doclet tags or Java 5 annotations
- [Groovy Jabber-RPC](#) — allows you to make XML-RPC calls using the Jabber protocol
- [Groovy Monkey](#) — is a dynamic scripting tool for the Eclipse Platform
- [Groovy SOAP](#) — allows you to create a SOAP server and/or make calls to remote SOAP servers using Groovy
- [GroovySWT](#) — a wrapper around SWT, the eclipse Standard Widget Toolkit
- [GSP](#) — means GroovyServer Pages, which is similar to JSP (JavaServer Pages)
- [GSQL](#) — supports easier access to databases using Groovy
- [Native Launcher](#) — a native program for launching groovy scripts
- [Process](#) — provides a shell-like capability for handling external processes
- [XMLRPC](#) — allows you to create a local XML-RPC server and/or to make calls on remote XML-RPC servers
- [Grails](#) — a Groovy-based web framework inspired by Ruby on Rails
- [GORM](#) — the Grails Object-Relational Mapping persistence framework
- [GroovyPlugin](#) — A Groovy plugin for JSPWiki

Enjoy making your code groovier !!!!

Latest news

If you wish to stay up-to-date with our vibrant community, you can learn more about:

- the [latest posts from our mailing-lists](#)
- the [latest commits to our SVN trunk](#)
- the [buzz around Groovy in the blogosphere](#)

And below, you will find the latest announcements:

 [Thursday, April 26, 2007](#)

[Groovy wins first prize at JAX 2007 innovation award](#)

Last changed: Apr 26, 2007 15:24 by [Guillaume Laforge](#)

[JAX](#)[🔗] is the **most important Java conference in Germany**. Every year, the organizers are running a [contest](#)[🔗] to select the **most innovative and creative projects**. From [over 40 proposals](#)[🔗], the jury selected only [ten nominees](#)[🔗]. Although great projects were selected, like the Matisse GUI builder in NetBeans, or the [Nuxeo](#)[🔗] Enterprise Content Management solution, **Groovy won the first prize!** It is a great honor and a huge pleasure for us to receive such a prize, especially knowing the cool projects we were competing with, or the [past winners](#)[🔗] like the Spring framework.

[Dierk König](#)[🔗], author of the best-selling "[Groovy in Action](#)[🔗]" book, received the prize in the name of the Groovy community, after having presented several sessions on Groovy at this conference. Dierk took a [picture of the prize](#)[🔗] if you want to see what it looks like.

This award proves how innovative, creative and influential the Groovy project is for the Java community. After a **1.0 release** this year, and a **book**, with IDE makers working on **IDE plugin support** for the language, with many **companies betting on Groovy** for writing business rules or for

scripting their products, with dedicated [news sites](#) and [feed aggregators](#), with [dedicated conferences](#) and tracks, and with over [10 sessions](#) about **Groovy** and **Grails** at the upcoming [JavaOne](#), Groovy stands out of the crowd and proves it's a very **successful and mature project**.

I would like to seize this opportunity to thank all the Groovy committers and contributors who helped develop this project, as well as the whole Groovy community without which Groovy wouldn't be as great and as cool as it is today. This award is really to all of you, and you're all part of this incredible success.

Update: JAX now lists the winners and has got [some pictures](#) of Dierk receiving the award

Posted at 26 Apr @ 1:56 AM by  [Guillaume Laforge](#) |  [3 comments](#)

 [Sunday, March 25, 2007](#)

[Groovy Series about Regular Expressions available!](#)

Last changed: Mar 25, 2007 14:08 by [Sven Haiges](#)

The next part of the [Groovy Series](#) is available, this time Dierk König and Sven Haiges talk about Regular Expressions. As always, this episode is complemented with a few code snippets at [snipplr.com](#). If you don't want to miss an episode, subscribe via the [Grails Podcast](#) RSS Feed:

<http://hansamann.podspot.de/rss>;

Posted at 25 Mar @ 2:08 PM by  [Sven Haiges](#) |  [0 comments](#)

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Korean Collections

This page last changed on Jun 14, 2006 by paulk_asert.

Groovy# List, Map, ##(arrays)# ## ##### ## ## ##### ##### ##.

List

List# ### ## ## # ##### [] # # List# #####:

```
def list = [5, 6, 7, 8]
assert list.get(2) == 7
assert list[2] == 7
assert list instanceof java.util.List

def emptyList = []
assert emptyList.size() == 0
emptyList.add(5)
assert emptyList.size() == 1
```

List ##### [java.util.List](#) # ##### ## ## ##.

Range

Range# ### ## ## #####, List# ##### ## # ##.

[Range](#) # [java.util.List](#) # ##### ##.

.. ##### ## Range# ### # ## # ## ## ##### ## ## ..< ##### ## Range# ### # ##
#####.

```
// ### Range
def range = 5..8
assert range.size() == 4
assert range.get(2) == 7
assert range[2] == 7
assert range instanceof java.util.List
assert range.contains(5)
assert range.contains(8)

// ##(exclusive) Range
range = 5..<8
assert range.size() == 3
assert range.get(2) == 7
assert range[2] == 7
assert range instanceof java.util.List
assert range.contains(5)
assert ! range.contains(8)
```

Range# from# to# ##### # # ## ## ## ## ## ##.

Range# ### # [java.lang.Comparable](#) # ##### ##, ## ## ## ## ## ## next(), previous() ###
##. ## ##, ##### ## ## ##.

```
// an inclusive range
def range = 'a'..'d'
assert range.size() == 4
assert range.get(2) == 'c'
assert range[2] == 'c'
assert range instanceof java.util.List
assert range.contains('a')
assert range.contains('d')
assert ! range.contains('e')
```

Range# ## for #### ## # ####:

```
for (i in 1..10) {  
  println "Hello ${i}"  
}
```

Map

```
Map# ## ### ## ## # #####. [:] ### # Map# #####.
```

```
def map = [name:"Gromit", likes:"cheese", id:1234]
assert map.get("name") == "Gromit"
assert map.get("id") == 1234
assert map["name"] == "Gromit"
assert map['id'] == 1234
assert map instanceof java.util.Map

def emptyMap = [:]
assert emptyMap.size() == 0
emptyMap.put("foo", 5)
assert emptyMap.size() == 1
assert emptyMap.get("foo") == 5
```

```
Map# Bean ## # ## #####. ### Map# ##### Key# ### Groovy ##### ## ##### ## ##
##(property)# ##### ## ## # # #####.
```

```
def map = [name:"Gromit", likes:"cheese", id:1234]
assert map.name == "Gromit"
assert map.id == 1234

def emptyMap = [:]
assert emptyMap.size() == 0
emptyMap.foo = 5
assert emptyMap.size() == 1
assert emptyMap.foo == 5
```

```
##: ###, map.foo# ### map# ##### foo## Key# #####. # # Map# ## foo.class # getClass()#
##### ## null# ### #####.
```

##

String, List, ##, Map, ### ### ## ### ##### ## ## ### ### # #####:

```
def text = "nice cheese gromit!"
def x = text[2]

assert x == "c"
assert x.class == String

def sub = text[5..10]
assert sub == 'cheese'

def map = [name:"Gromit", likes:"cheese", id:1234]

assert map["name"] == "Gromit"
assert map.name == "Gromit"

def list = [10, 11, 12]
def answer = list[2]
assert answer == 12
```

List/##/String/#### ##### ## Range# ### ## #####. Python ## ##### ##### ##
#####(slicing)## #####:

```
def list = 100..200
def sub = list[1, 3, 20..25, 33]
assert sub == [101, 103, 120, 121, 122, 123, 124, 125, 133]
```

#####:

```
def list = ["a", "b", "c"]
list[2] = "d"
list[0] = list[1]
list[3] = 5
assert list == ["b", "b", "d", 5]
```

#####:

```
def text = "nice cheese gromit!"
def x = text[-1]
assert x == "!"

def name = text[-7..-2]
assert name == "gromit"
```

Range# ##### # ## ## #####:

```
def text = "nice cheese gromit!"
def name = text[3..1]
assert name == "eci"
```

(Expando)

Expando# ### ##### #####. ### Map ## Javascript### Object# #####. [Expando](#) # #####
[###](#) # ## ##### ##### ## #####:

```
def player = new Expando()
```

```
player.name = "Dierk"
player.greeting = { "Hello, my name is $name" }

println player.greeting()
player.name = "Jochen"
println player.greeting()
```

player.greeting # ### [###](#) # [Expando](#) # ## greeting() # ### # #####. ### ##### [GString](#) #
"\$variableOrProperty" ##### ## ### ### ### # ### # ### #####.

More Information

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- [Groovy Series](#)
- [PLEAC Examples](#)
- [AboutGroovy](#): The community portal news site about everything Groovy and Grails, with frequent news items, podcast interviews, pointers to important resources.
- [GroovyBlogs](#): A JavaBlog-like news aggregator for the Groovy and Grails mailing-lists feeds, and many feeds from famous bloggers spreading the Groovy and Grails love.

Groovy Series

This page last changed on Apr 28, 2007 by [paulk_asert](#).

The Groovy Series is an audio lecture on Groovy and is part of the Grails Podcast. The episodes are produced by Dierk König (Lead author of the book [Groovy in Action](#)) and [Sven Haiges](#). You will find complementary information about the topics below in Dierk's Book and we mention the page numbers at the beginning of each series to help you find the right chapters.

Code Examples at [snipplr.com](#)

The code examples that we discuss in the podcasts are posted to [snipplr.com](#), you can [find all code snippets here](#). Please note that we cannot change the code snippets once they are published (we would run into problems with mentioned line numbers in the podcast), but you are invited to post comments. Simply log in to snipplr and leave us some feedback.

Current Groovy Series Planning

This is a rough plan and we might switch topics, add or delete at any time. The Groovy Series Episodes will be part of the [Grails Podcast](#) and published between regular episodes. You can subscribe to the [podcast feed](#) via: <http://hansamann.podspot.de/rss>. Once the podcast episodes are released, you can click the title links to download the mp3 files manually, too.

1. Strings & GStrings ([direct mp3](#))
 - a. Snippet 1/2: <http://snipplr.com/view/2047/groovy-series-string--gstring-12/>
 - b. Snippet 2/2: <http://snipplr.com/view/2089/groovy-series-string--gstring-22/>
2. Regular Expressions ([direct mp3](#))
 - a. Snippet 1/3: <http://snipplr.com/view/2090/groovy-series-regular-expressions-13/>
 - b. Snippet 2/3: <http://snipplr.com/view/2091/groovy-series-regular-expressions-23/>
 - c. Snippet 3/3: <http://snipplr.com/view/2092/groovy-series-regular-expressions-33/>
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 - a. Snippet 1/1: <http://snipplr.com/view/2093/groovy-series-numbers/>
4. Ranges ([direct mp3](#))
 - a. Snippet 1/1: <http://snipplr.com/view/2197/groovy-series-ranges/>
5. Lists
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7. Background on Groovy Typing
8. Groovy Control Structures
9. Closures
10. Classes / Objects / Scripts
11. GroovyBeans (incl. Expando)
12. GPath & Co
13. MOP
14. Builders
15. GDK - Working with Objects
16. GDK - Files & I/O
17. GDP - Threads and Processes
18. Java Integration
19. DB Programming with Groovy

- 20. XML Part 1 / XML Standalone
- 21. XML Distributed (RSS, ATOM, REST)

PLEAC Examples

This page last changed on Apr 28, 2007 by [paulk_asert](#).

[PLEAC](#) presents a suite of common programming problems from the [Perl Cookbook](#) in various programming languages. Groovy contains a complete set of examples. Here are links to the these examples:

- Manipulating [Strings](#), [Numbers](#), [Dates](#), [Arrays](#), and [Maps](#)
- [Pattern matching and text substitutions](#)
- [File Access](#)
- [File Contents](#)
- [Directories](#)
- [Subroutines](#)
- [References and Records](#)
- [Packages, Libraries, and Modules](#)
- [Classes and Objects](#)
- [Database Access](#)
- [User Interfaces](#) including screen addressing, menus, and graphical applications
- [Process Management and Communication](#)
- [Sockets](#)
- [Internet Services](#) including mail, news, ftp, and telnet
- [CGI Programming](#)
- [Web Automation](#)

Roadmap, Discussions and Proposals

This page last changed on Apr 28, 2007 by [paulk_asert](#).

Groovy has an active community from which many ideas and discussions arise. Initial discussions or clarifications occur within the [Mailing Lists](#). Very specific suggestions can often be included in the Groovy [Issue Tracker](#). Ideas which require wider or on-going discussion or greater formalism are documented here.

- *Discussions* are ideas or potential changes in their early formation.
 - *Proposals* are ideas that have reached a greater level of maturity but still require discussion or wider communication.
 - The *Roadmap* outlines things we have committed to do or hope to do soon.
-
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 - [First impressions](#)
 - [J2ME and Groovy](#)
 - [New Groovy Console Wish List](#)
 - [Running Groovy on .NET 2.0 using IKVM](#)
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Roadmap

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Milestones

Considering our limited human resources and time constraints, it is hard to give definitive and accurate estimates of the milestones we are going to release.












For 1.1, we've decided to follow the same beta / RC numbering scheme. It means we will be releasing a few betas, and a couple of RCs before release 1.1-final:

- 1.1-beta-1
- 1.1-beta-2
- 1.1-beta-3
- 1.1-rc-1
- 1.1-rc-2
- 1.1-final

We plan to release 1.1 before the end of the year, and ideally, in Q3 of 2007.

Roadmap

Here are the various features we would like to implement in the forthcoming releases of Groovy:

jira.codehaus.org (24 issues)		
T	Key	Summary
	GROOVY-158	Multiple assignment
	GROOVY-164	Date/Calendar operations
	GROOVY-217	support java style old for loop notation
	GROOVY-776	Create a GroovyDoc/JavaDoc tool
	GROOVY-1646	Inherited method establishing logic needs to be MetaClass aware
	GROOVY-1698	No way to escape the / character in Groovy regex
	GROOVY-1709	GEP: Groovy Enhancement Proposal
	GROOVY-1710	Update all file headers to the ASL 2
	GROOVY-1713	Automated GLS documentation out of TCK test cases
	GROOVY-1714	Java 5 features
	GROOVY-1716	Annotation definition



[GROOVY-1717](#)

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[GROOVY-1808](#)

[GROOVY-1809](#)

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[Named-parameters without parentheses](#)

[MetaClass enhancements](#)

[Discovery mechanism for customizing metaclasses with a script using ExpandoMetaClass](#)
[Extract interfaces from the Meta* classes](#)

[Provide unit tests for date/time support](#)

[Extend Map coercion to classes](#)

[Grammar cleanup](#)

[Groovy shell and Groovy swing console improvements](#)

[Compiler performance](#)

[MarkupBuilder doesn't allow entities \(like nbsp\)](#)

[make GPath work correctly on arrays](#)

[non-static fields should not be treated as static properties](#)

NotYetDocumented

This page last changed on Apr 28, 2007 by [paulk_asert](#).

The following items need documentation.

When documenting, please create a page for each and link to it.

- 'special' variables like 'owner' in Closures, 'out' in Groovlets etc.
- handling of "return, break, and continue"
- open blocks vs closed blocks
- general typing approach (explicit static typing vs duck typing)
- 'use' keyword
- 'as' keyword with its different meanings
- method dispatch algorithm
- annotations
- Name scoping rules.
- scoping rules for Closures
- Method calls and property references, in all their complexity.
- Conversion rules, in all their complexity.
- conversion vs coercion vs autoboxing
- Reduction of most statement and expression semantics to method calls (a la Scheme).
- Miscellaneous expression and statement semantics.
- Standard injected methods (e.g., List.collect).
- Class member naming conventions, and other JVM interfaces.
- Some part of the metaobject protocol. (The rest predicted and planned for 2.0.)
- JMX support
- Annotation support
- Swing builder
- more builder documentation

Articles

This page last changed on Apr 28, 2007 by [paulk_asert](#).

Here are a bunch of articles and blog posts on all things groovy

Beginners Tutorials

- The K&R Series by Simon P. Chappell
 1. [Groovin' with Kernighan and Ritchie](#)
 2. [Groovin' with K&R 2](#)
 3. [Groovin' and Regroovin'](#)
 4. [Groovin' with K&R 4](#)
- Getting Groovy series by James Williams
[Originally a series of three articles. It has been merged into one document.]
[Getting Groovy Without the Bad Clothes](#)

James Strachan talks about Groovy

- A [collection](#) of references to articles and emails by James Strachan on the topic of Groovy.

Guillaume Laforge interviews on Groovy and Grails

- [Vanward / Stelligent interview](#)
- [IndicThreads interview](#)

General

- [Using Groovy to Send Emails](#) by Paul King.
- Russel Winder gave a talk "[Builders: How MOPs Make Life Easy](#)" at ACCU 2007 which focused on the way Groovy does things.
- [Implementing Domain-Specific Languages with Groovy](#) - tutorial given by [Guillaume Laforge](#) and John Wilson at QCon 2007
- BEA Dev2Dev features an [introduction to Groovy and Grails](#)
- Scott Hickey gave a [presentation](#) about Groovy at the Omaha Java User Group, July 2006
- Russel Winder had an article introducing Groovy published in *{CVU}* **18**(3):3-7. *{CVU}* is the journal of the [ACCU](#). For more details on the article click [here](#).
- Scott Davis gave a recent [presentation](#) about Groovy even mentioning a few words about [Grails](#).
- [Groovying With the JVM](#) was a presentation given by [Russel Winder](#) at the [ACCU](#) 2006 conference.
- [It's a Groovy Day!](#) by Eric Armstrong (inspired by Rod Cope's presentation at JavaOne 2005)
- [JavaPolis 2004 presentation](#) or [video](#) from James and Dion along with a [snap of James rambling](#) 😊
- JSR 241 - Nov 2004 London Conference presentations
 - [Keynote\(mp3 - 34Mb\)](#) by James Strachan
 - [History of Groovy](#) by Jeremy Rayner
 - [User Feedback \(mp3 - 15Mb\)](#) by Guillaume LaForge

- Ian Darwin wrote [this article](#) for O'Reilly
- John Wilson gave [this presentation](#) on XML processing in Groovy at XMLOpen 2004 in Cambridge
- Ian Darwin gave [this presentation at the Toronto JUG in November]
<http://www.darwinsys.com/groovy/jugslides-20041102.pdf>]
- James Strachan and Rod Cope gave [this presentation at JavaOne 2004](#) or [as PDF](#)
- Alexander Schmid gave [this presentation](#) at the JA00 in Cannes
- Rod Cope gave [this presentation](#) at the Denver JUG
- Laurent Weichberger gave [this presentation](#) at JSRING in the Netherlands
- Mike Spille wrote a great [review of Groovy](#)

- Ted Leung did a great [presentation at SeaJUG](#)

- Gerald Bauer did a presentation at the [Austria JUG](#)

- Mark Volkmann has written the excellent [Groovy - Scripting in Java](#)
- An old presentation James Strachan gave at CodehausOne August 2003 is available as a [PPT](#)
- Marc Hedlund has written several very good introductory articles about getting stuff done with Groovy (especially with the SwingBuilder). The index of all his articles can be found at [O'Reilly's website](#).
- Articles from the [Practically Groovy](#) series by Andrew Glover
 - [Smooth operators](#)

(25 Oct 2005)

- ◦ [Of MOPs and mini-languages](#)

(20 Sep 2005)

- ◦ [Functional programming with curried closures](#)

(23 Aug 2005)

- ◦ [Groovy's growth spurt](#)

(19 Jul 2005)

- ◦ [Stir some Groovy into your Java apps](#)

(24 May 2005) syntax prior to the JSR syntax

- ◦ [Mark it up with Groovy Builders](#)

(12 Apr 2005)

- ◦ [Go server side up, with Groovy](#)

(15 Mar 2005)

- ◦ [MVC programming with Groovy templates](#)

(15 Feb 2005)

- ◦ [JDBC programming with Groovy](#)

(11 Jan 2005)

- ◦ [Ant scripting with Groovy](#)

(14 Dec 2004)

- ◦ [Unit test your Java code faster with Groovy](#)

(09 Nov 2004)

- Craig Castelaz guides you through [Groovy closures](#) on java.net (syntax prior to the JSR syntax|<http://today.java.net/pub/a/today/2005/05/19/fences.html>)on java.net (syntax prior to the JSR syntax|<http://today.java.net/pub/a/today/2005/05/19/fences.html>)on java.net (syntax prior to the JSR syntax|<http://today.java.net/pub/a/today/2005/05/19/fences.html>)on java.net (syntax prior to the JSR syntax]
- If you're [getting to know Groovy](#) John Zukowski will bring you up to speed with Groovy (syntax prior to the JSR syntax)
- Matthias Luebken wrote about [Implementing OSGi-Services in Groovy](#).

References

- Jeremy Rayner has created a [Groovy reference card](#) with [latex source](#)

French articles

- [Guillaume Laforge](#) gave an [introductory presentation](#) of Groovy at the Parisian [OSS-Get Together](#) event
- Guillaume speaks about the advantage of using dynamic languages to increase the semantic density to
- [Introduction au langage de script Groovy](#) on the JDN site
- [Introduction au langage de script Groovy](#) on developpez.com
- [Intégrer JXTA dans une application Web avec JSF et Groovy](#) par Bertrand Goetzmann

German articles

- Dierk's Groovy series in JavaMagazin.
 - 8.2006 **Groovy für Java-Entwickler: Dynamische Programmierung auf der Java-Plattform** [Dynamischer Nachwuchs](#)
 - 9.2006 **Groovy für Java-Entwickler: Ausdruckskraft durch starke Syntax** [Klassen- und Objektnotation, Referenzierungsmöglichkeiten, Operatoren, Kontrollstrukturen und Meta-Objekt-Protokoll](#)
 - 10.2006 **Groovy-Datentypen** [First class citizens: Zahlen, Strings, Reguläre Ausdrücke, Listen, Maps, Ranges und Closures](#)
 - 11.2006 **Ausgewählte Groovy-Beispiele** [Groovy everywhere](#)
 - 12.2006 **Grails** [Groovy für Java-Entwickler](#)
 - 27.12.2006 [Interview: Groovy - das Beste aus der Java- und der Scripting-Welt vereinen](#)
- Joachim Baumann gave a [presentation](#) about Groovy in German at the "Symposium: Trends in der Informations- und Kommunikationstechnik" in Stuttgart, September 2006.
- An [article](#) by Alexander Schmid
- [Sigs Datacom article](#)
- Dierk's Groovy presentation at [JAX 2006](#) is attached as [Groovy at JAX pub.zip](#).
- Dierk's Groovy usage patterns article in [iX Magazin 7/06](#)

Korean articles

- [Groovy Language Study](#)
- [Groovy I, Dynamic Agile Scripting Language](#) (Korean Language) by Pilho Kim
- [Groovy II, Groovlet and GSP \](#) (Korean Language|<http://www.zdnet.co.kr/builder/dev/java/0,39031622,39133077,00.htm>){Korean Language] by Pilho Kim
- [Groovy III, Compare Groovy to Other Languages \](#) (Korean Language|<http://www.zdnet.co.kr/builder/dev/java/0,39031622,39134013,00.htm>){Korean Language] by Pilho Kim

Japanese articles

- coverage of our JavaOne talk [June 2004](#)

Books

This page last changed on Apr 28, 2007 by [paulk_asert](#).

Groovy in Action

The [Manning book page](#) leads to all the online resources about the book like

- the table of contents
- free chapters
- reader's forum
- errata

The [Amazon page](#) allows for quickly buying the book.



Read the news feed about Groovy in Action

[Dierk König's Amazon Blog \(rss_2.0\)](#)
(Dierk König's Amazon Blog)

[Meet the author and hear voices about Groovy in Action](#) (Apr 19, 2007 07:23)

Whoever would like to meet me (Dierk König that is), you will find me at the following upcoming events:

- the German [JAX conference \(Wiesbaden 23.-27. April\)](#), where I will present [various talks on Groovy and Canoo WebTest](#), lead the Groovy discussion table at the ballroom event, and represent the Groovy project as it was nominated for the JAX Innovation Award.
- the [JavaOne](#) (San Francisco, 7.-13 May) technical session TS-1742: "Cool Things You Can Do with the Groovy Dynamic Language" May 8th, 10:50 am
- the digitalGuru booksigning hour at JavaOne, May 8th, 12:30 am. You may also find me occasionally at the **Canoo booth #715**
- the [Java Forum Stuttgart](#) (July 5th) with "Advanced Groovy"
- the [Expert Forum Stuttgart](#) (July 6th) with a Grails workshop

I would very much appreciate talking to you!

Concerning the reception of the Groovy in Action book, the following voices were raised lately in the blogosphere:

[Burkhardt Hufnagel](#)

It's all I'd hoped for and more.

If you're interested in learning Groovy, this is an excellent book. Just make sure you're near a machine with Groovy installed when you read it. You'll want to try out many of the code samples, just for the fun of it.

[Gregory Pierce](#)

This book should actually be called Groovy: The Definitive Guide as it will work both as an educational text and as a reference book for those developers who adopt Groovy as either a scripting language or as a primary development language for their project. The entirety of the language is covered and sections on frequently debated language features such as closures are detailed enough to allow the reader to understand the material even outside of the context of the language.

[Andres Almiray](#)

.. it's incredible how easy to grasp Groovy concepts while reading GINA, I find it hard to stop reading it .. GINA is more than an introduction to the language, it is more like a map of the current Groovy environment and its correlation to the Java ecosystem. Even the fact that the book was ultimately integrated and "tested" with Groovy to get to the final version is a testimony on Groovy's power and that the authors really know the topic =) (this may be a trend, at least I know that the Ruby book has done the same approach), congratulations to the authors and everyone involved in this fine piece of work.

[kousenit](#)

[Groovy in Action] .. has jumped to the top of my favorite technical books list.

keep groovin'

Dierk

[Groovy tutorial series and Groovy in Action reception in the blogosphere and at JavaLobby](#) (Mar 26, 2007 04:01)

The **Groovy tutorial series** by Sven Haiges and [Groovy in Action](#) author Dierk König has released another issue. This time it is about [regular expression support in Groovy](#).

Subscribe to the [podcast](#) and improve your Groovy kung-fu while listening. The related code examples are available at [snipplr](#) tagged *groovyseries*.

What [David Black](#) says about Groovy in Action (2007/03/15) :

"I'm about half way through Groovy in Action and I'm really enjoying it, and despite having used early versions of Groovy for a couple of years now, I'm learning [loads of new tricks](#). This is a well written technical introduction to the language, and as with all great technical books its easy to read and doesn't get bogged down. [..]"

And here is [Victor Charlie](#) (2007/03/15):

"From cover to cover I commend the writing style of this book. It teaches theory and teaches it well. GinA shows the most complete, up-to-date usage of Groovy. The price of the book is worth it in just learning how cool XML can be. The Manning Books that are on my shelf are the ones I have kept and [the books I](#)

NEVER loan out.[..]

I just spent 2 weeks trying to embed Groovy into an ongoing java app. Funny, the lines of Groovy code kept getting shorter and shorter. [..]"

From the [David Sills Groovy in Action review](#) at [JavaLobby](#) (rated the maximum of five smileys in all categories):

"A unique aspect of the book permeates the examples: [..] This sort of guarantee of accuracy is worth its weight in gold. [..] just clean, well-tested code.

And what examples! The authors have not flinched from tackling some decidedly non-trivial issues in their pursuit of examples that would really reveal the features and utility of the language. It is astonishing to see how wide a range of applications Groovy can tackle and how successfully it can simplify and clarify code that in Java could easily become prohibitively complex.

The prose style is engaging and highly readable; the author's voice is never excessively prominent. This isn't a collection of opinions, but it does fairly shout excitement about the possibilities it describes. One feels it a work of proselytization in the best sense, a work that radiates an infectious enthusiasm about a new and useful discovery, and that ignites a corresponding enthusiasm in the reader.[..]

This book is therefore squarely in the line of other books in Manning's distinguished "In Action" series. It will grace my bookshelf for many a year."

[InfoQ chief architect reviews Groovy in Action](#) (Mar 11, 2007 06:49)

2007/03/08

Read what **Alexandru "mindstorm" Popescu**, [InfoQ](#) chief architect and co-founder of the [TestNG](#) testing framework has to say about [Groovy in Action](#) in [his blog](#):

- ".. the Bible of that programming language .."
- ".. attractive and fun and entertaining .."
- ".. I must confess that I read GINA in less than 3 days, even if it has more than 600 pages (oke, I confess I haven't read it all, but for sure more than 80% of it). And not only that I got that feeling that it is so fun that [I cannot stop myself](#), but I think it fulfills all the characteristics of great and absolutely enjoyable PL book."

He closes with:

"Finally, without any fear, I would say that Groovy in Action is not just a language guide, but represents the clear, readable and enjoyable specification of Groovy (and you should definitely read it and start playing with Groovy [blink/])."

Big thanks to Alexandru for this great review and making Groovy annotations-aware such that it can be used with EJB3, Hibernate 3, TestNG, and all other frameworks that rely on annotation support.

Dierk König

[Groovy in Action 9 stars on slashdot review](#) (Mar 05, 2007 13:11)



[Groovy in Action](#) was [reviewed on slashdot](#) by Simon P. Chappell.

He ranks it 9 on a scale from 1 to 10.

He calls it the "*definitive guide*", gives an overview of the contents, and finally closes with "*There is much to like about Groovy. Mr. König and his co-authors writing is clear and engaging and Manning's layout and typography are up to their usual excellent standards. On it's own, these are good reasons to consider this book if Groovy interests you, but when you mix in the fact that Mr. König is a committer on the Groovy project and has taken an active role in the creation of the language itself, then you have a very compelling reason to choose it.*

Groovy in Action is an excellent book, written by one of the designers of the Groovy language. If you

have any interest in modern scripting languages at all, I would recommend that you check out this book.
"

Review on german [JavaMagazin](#)

Edition 4.2007 of that print magazine with [Grails as cover story](#) features a [review of Groovy in Action](#) by Grails expert [Sven Haiges](#).

His comments include:

- "ohne Wenn und Aber das Standardwerk zur dynamischen Sprache Groovy"
- "locker geschrieben"
- "krönender Abschluss"
- "Wenn Sie sich mit Groovy beschäftigen, werden Sie um dieses Buch nicht herum kommen!"

Readers of that magazin may also enjoy the recently published [interview with Dierk König \(german\)](#) in the previous edition.

[Groovy tutorial series on Grails podcast](#) (Feb 28, 2007 04:51)

The [Grails podcast](#) by [Sven Haiges](#) starts a brand new [Groovy tutorial](#). In the podcast, Sven Haiges and Dierk König (lead author of [Groovy in Action](#)) discuss Groovy language features and their usage. The series starts with basic datatypes and advances to the dynamic behavior and common usages of Groovy.

Subscribe to this tutorial series and become a Groovy expert!

The code under consideration is embedded in the rss feed and thus visible for iPod users. Others can see it in snippetr. See the [wiki page](#) for details.

enjoy!

Dierk

[More recent voices on Groovy in Action](#) (Feb 16, 2007 06:13)

[Groovy And Others Continue To Expand The JVM Horizon](#)

Jeff Brown: Jeffs Mostly Java Web Log, January 20, 2007

"Manning has recently published [Groovy In Action](#), known as GINA. GINA is being referred to as **"Groovy's Pick Axe Book"** (a reference to Dave Thomas' definitive guide to Ruby, Programming Ruby). That is not because GINA was the first major book published on Groovy. This has more to do with GINA's clear, direct and thorough coverage of the language."

[Gettin' Groovy With It](#)

Mark, 2007-02-10

"I picked up Groovy in Action. I highly recommend it. It's very accessible, has lots and lots of code examples, and is highly readable."

[Code for fun](#)

2007-01-10

"I got my copy of Groovy in Action a couple of days ago and ever since I've been reading and trying to apply everything I've learned. [...] I read over the Groovy XML chapter and got really excited. I was like, *#Wow! I bet I could write a five or ten liner groovy script to split up this big ol# XSL doc!#* Big ol# fat chance!"

[Book reception: voices on Groovy in Action](#) (Feb 09, 2007 08:58)

Andrew Binstock in SD Times, [Feeling Groovy at Last](#)

"The definitive book on the language is Manning Press# excellent #Groovy in Action,# which was written by several project leads."

[Weiqi Gao, I Picked It Up, I Can't Put It Down!](#)

"All-in-all, I think Groovy in Action is among the top five Manning books. For me personally, it's also a perception changing and influential book. [...]"

I highly recommend Groovy in Action for Java developers who want to learn Groovy in a systematic way and who are starting Groovy projects."

[Listen to the Groovy in Action authors at JavaPosse](#) (Jan 29, 2007 03:37)

The [JavaPosse](#) podcasters interviewed the Groovy in Action authors Jon Skeet and Dr. Paul King. Check out the podcast and the show notes under [the Groovy in Action JavaPosse interview](#) !

enjoy

Dierk

[Win a free copy of Groovy in Action at the release party contest!](#) (Jan 26, 2007 16:50)

This year started with two important events: the availability of the Groovy in Action book and the final release of Groovy 1.0. Both events will be celebrated with a global release party on January 29th. The idea is to have numerous parties with Groovy enthusiasts all over the planet: Paris, London, Berlin, Munich, Jamaica, Uruguay, and so on. Make sure to find [the party near you](#).

Pictures of this event will be uploaded to [flickr with groovyparty tag](#).

Now the best part. Manning promotes this event with running the following contest:

Send Manning your Groovy photos from Global Groovy 1.0 day and win!

Download a cover image of Groovy in Action at www.manning.com, print it out and take it to your party on January 29th.

Photo must show our poster, clearly indicate the location of the party, and have at least 2 people in the photo.

Any person who sends in a photo that fulfills the easy requirements will receive a **40% off coupon** good for any Manning title (good for up to \$100 purchase).



The **top 5 photos** (based on some Groovy theme) will get a **free Groovy in Action** print

edition.

Photos must be sent as .jpg files to [mkt \[at\] manning \[dot\] com](mailto:mkt@manning.com). One entry per contestant, one prize per entry. Names and emails must be included with photo submission. Entries must be received by February 5, 2007.

Questions: Visit [Manning](#) and look for the Global Groovy 1.0 banner in the right hand column.

So, everybody: don't hesitate to invite your friends organize your party!

Dierk

[Meet the author](#) (Jan 18, 2007 16:02)

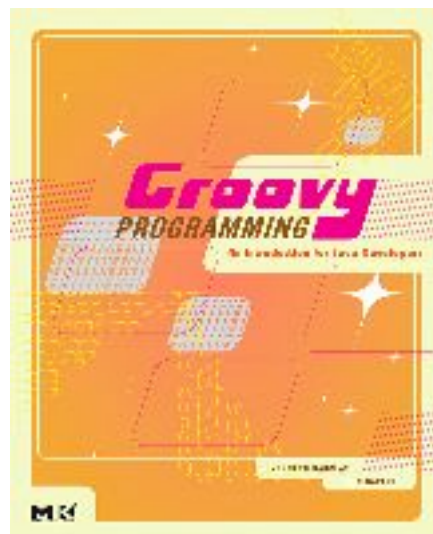
Next Thursday, January 25th, I will talk about [Groovy at OOP 07](#) in Munich, Germany.

I would be glad to meet you there

Dierk König

Programming Groovy

- [Authors' book page](#)
- [Amazon](#)




Continuous Integration


This page last changed on Mar 10, 2007 by [paulk_asert](#).

The Groovy project is extremely lucky to have several [continuous integration](#) environments available to us to give us immediate feedback whenever changes are made to Groovy. As Groovy evolves, this helps us ensure that it remains working on various platforms (including various operating systems, Java versions and to some degree different build systems, e.g. different [Ant](#)/[Maven](#) versions running on [CruiseControl](#), [Bamboo](#) and [TeamCity](#)).

At the moment the main CI server is hosted by [Canoo](#) but other versions are also hosted by [The Codehaus](#) and [JetBrains](#). Details are covered below.

Server Information

URL	http://build.canoo.com/groovy/	
Build Server	CruiseControl 2.2.0	
Operating System	Linux	
Java Version	1.4.2 with Ant 1.7.0	
SVN modification check	every 5 minutes	
SVN quiet period	2 minutes of CVS inactivity before build starts	
build results	http://build.canoo.com/groovy/	
artifacts	http://build.canoo.com/groovy/artifacts	
mail data feed	subscribe to SCM Mailing lists	
RSS 2.0 data feed	http://build.canoo.com/groovy/buildstatus.rss	

URL	http://bamboo.ci.codehaus.org/ CORE (ignore build errors at the moment - awaiting configuration change from administrators)	
Build Server	Bamboo	
Operating System	Fedora	
Java Version	1.4, 1.5, 1.6 available	

URL	http://teamcity.jetbrains.com
Build Server	TeamCity
Operating System	Linux, Windows, MacOS available
Java Version	1.4, 1.5, 1.6 available



The screenshot shows the TeamCity web interface. At the top, there are tabs for 'Builds', 'Configuration', 'Tools', and 'Users'. Below the tabs, there's a 'Property' section with a search bar. The main content area displays a list of build configurations, each with a name, a status icon (green for success, red for failure), and a 'Build' button. The configurations are organized into sections like 'Builds' and 'Tools'.