Groovy with Eclipse - Tutorial

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Groovy. This article gives a short overview of the Groovy language including collections, loops, gstrings, MOP, closures, operator overloading, XML handing and using Groovy together with Java class. It also describes how to use the Eclipse IDE for developing Groovy. This article assumes that you have already Eclipse installed and that you have used Eclipse for Java development. This article was written using Groovy 2.4, Eclipse 4.4 (Luna) and Java 1.8.

1. Groovy

1.1. What is Groovy?

Groovy (http://www.groovy-lang.org/) is an optionally typed, dynamic language that runs on the JVM. It is tightly integrated with the Java programming language. Groovy describes itself as feature-rich and Java-friendly language.

Groovy source code is compiled into Java byte-code by the Groovy compiler. To run Groovy code in a Java virtual machine, only the Groovy `JAR` file must be present in the classpath at runtime.

Groovy supports standard Java constructs including annotations, generics, static imports, enums, varargs and lambda expression. It provides lots of simplifications compared to the Java programming language and advanced language features as properties, closures, dynamic methods, the Meta Object Protocol (MOP), native support for lists, maps, regular expressions, duck typing and the elvis operator.

1.2. Groovy classes and scripts

A Groovy source files ends with the `.groovy` extension. This file can contain a Groovy script or a Groovy class. A Groovy script is a code listing which does not include a class definition. Groovy scripts are converted at compile time to a class which extends the `groovy.lang.Script` class.

The classical "Hello world" program can be written as a short Groovy script.

```
println 'Hello World'
```
JAVA

1.3. Compatibility with Java

Groovy runs inside the JVM and can use Java libraries. Every Groovy type is a subclass of `java.lang.Object`.

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create instances of the Groovy class. This instance can be used to call methods or to pass as parameter to a fitting Java method. Groovy classes can extend Java classes and Java classes can also extend Groovy classes.

Groovy is almost compatible with the Java 7 sytax, e.g., almost every valid Java 7 construct is valid Groovy code. This makes the migration to Groovy for a Java programmer relatively smooth.

Groovy does currently not support Java 8 lambda expressions.

1.4. Reasons to use Groovy

Groovy focus on simplicity and ease of use as its leading principle. This makes using Groovy very productive.

The enhancements of Groovy compared to Java can be classified as:

- Groovy language features
- Groovy specific libraries
- Additional methods to existing Java classes by the Groovy Developer Kit, this is commonly known as the Groovy JDK.

The following list contains some of the example how Groovy archives this.

- Simplification - Groovy does not require semicolons at the end of statements. The `return` keyword can be left out, by default Groovy returns the last expression of the method, top level parentheses can be left out, the `public` keyword can be left out, it is the default in Groovy. It also allows optional typing.
- Flexibility - Groovy allows to change classes and methods at runtime, e.g., if a method is called which does not exist on a class, the class can intercept this call and react to it. This allows for example that Groovy provides a very flexible builder pattern.
- Ease of use - Groovy has list, maps and regular expressions directly build into the language.
- Simplification in I/O - parsing and creating XML, JSON and files is very simple with Groovy.

1.5. Imports in Groovy

Groovy automatically imports the following packages and classes which can be used in Groovy without specifying the package name.

- groovy.lang.*
- groovy.util.*
- java.lang.*
- java.util.*
- java.net.*
- java.io.*

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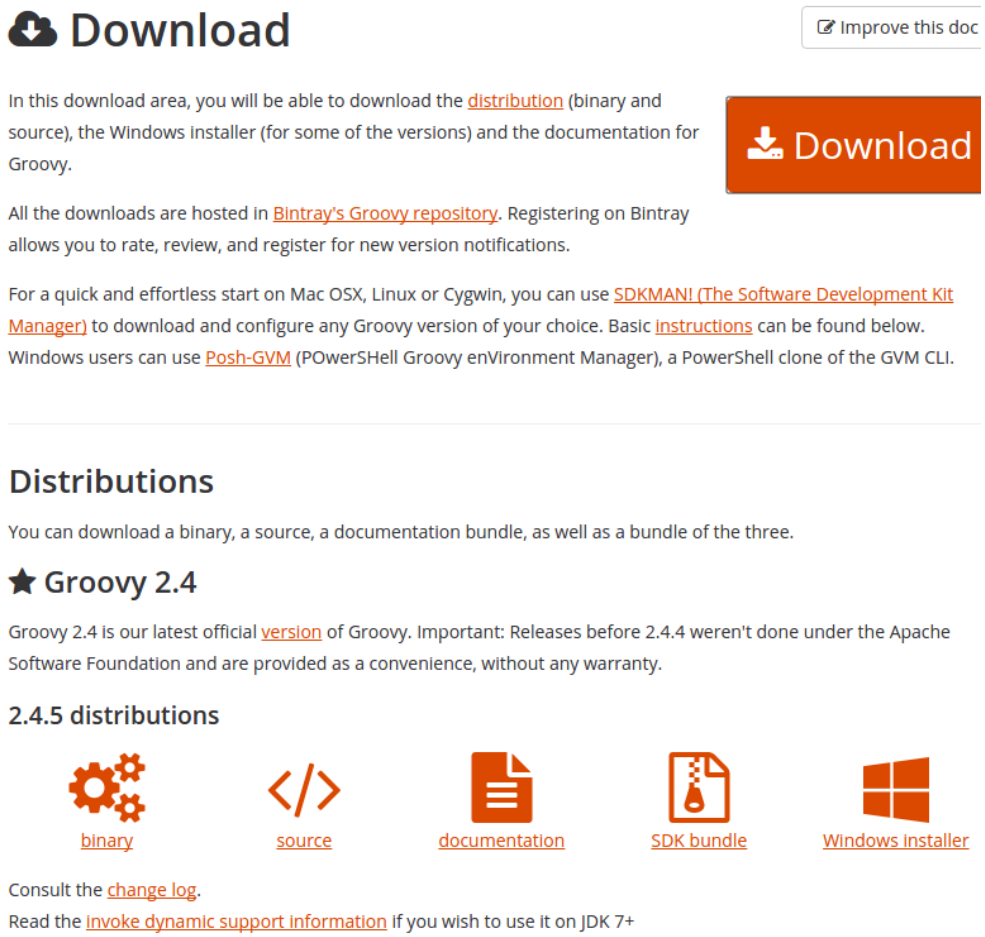
Groovy allows that an import is shortened for later access e.g. `import javax.swing.WindowConstants as WC`.

2. Install Groovy for the command line

To be able to run Groovy code from the command line download the latest version from Groovy from the Groovy download website (http://www.groovy-lang.org/download.html).

Download at least the binary zip file and extract it to a directory on your hard disk. Afterwards set the GROOVY_HOME environment variable and %GROOVY_HOME%/bin to your path.

If you are using MS Windows you can use the Windows installer. This installer configured the environment variables automatically for you.



3. Installation of the Groovy tools for the Eclipse IDE

You can download a pre-configured version of the Eclipse IDE with Groovy and Gradle support from the following website: Spring tools download side (http://spring.io/tools).

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menu entry to install the Groovy Eclipse plug-in. Enter the following URL in this dialog:

```
http://dist.springsource.org/snapshot/GRECLIPSE/e4.8
```

The update site is Eclipse version dependent, see Groovy/Grails Tool Suite™ Downloads (https://github.com/groovy/groovy-eclipse/wiki) if you use a different release than Eclipse 4.8.

4. Installation of the Groovy tools for the IntelliJ IDE

You can also download the IntelliJ IDEA Community edition (https://www.jetbrains.com/idea/download/) for free which includes support for Groovy.

5. Using Groovy without IDE support

5.1. Options for using Groovy with IDE support

You can execute a Groovy class or script from your IDE but Groovy provides other options. You can run Groovy code via:

- the Groovy shell: groovysh
- the Groovy interpreter: groovy
- the Groovy Console : groovyConsole
- complile Groovy code to classfiles and run it via the Java virtual machine

5.2. The Groovy Console

Start the interactive Groovy Shell with the command groovyConsole. This console allows you to test Groovy code.

5.3. The Groovy shell

The Groovy shell is the simplest way to run Groovy program. The groovy shell allow you to type in groovy commands and let them evaluate.

Open a command shell (Start→ Run → cmd under Windows) and start the groovy shell via "groovysh". Type in the following code:

```
println("Hello Groovy")
```

Press enter→ the system will execute your code.

5.4. Using the Groovy compiler to create class files

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To create Java bytecode, run the `groovyc Hello.groovy` command.

6. Exercise: Create a Groovy program with the Eclipse IDE

6.1. Target of this exercise

In this exercise you learn how to create Groovy program with the Eclipse IDE.

6.2. Create a new Groovy project

The following example assumes you have Groovy and the Eclipse IDE installed and configured.

Create a new Groovy project called *com.vogella.groovy.first* the File > New > Other > Groovy > Groovy Project.

After entering the project name, press the `Finish` button. This creates a new Groovy project similar to a new Java project but with the required Groovy libraries.

Right click on the source folder and New > Package from the context menu. Create a new package called `first`.

Create a new Groovy class called `FirstGroovy` via File > New > Other > Groovy > Groovy Class.

Create the following code.

```
package first

class FirstGroovy {

    static void main(def args){
        def mylist= [1,2,"Lars","4"]
        mylist.each{ println it }
    }
}
```

6.3. Run the Groovy class

Right-click the Groovy class, and select Run As > Groovy Script from the context menu.

6.4. Validate the Groovy class

The above menu entry triggers the execution of the main method in your Groovy class and prints output to *Console* view of the Eclipse IDE.

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7. Groovy classes, objects and methods

7.1. A Groovy class and default access modifier

A Groovy class is defined with the `class` keyword, similar to Java. All Groovy classes and methods are by default public.

The following is an example Groovy class called `Task.groovy`.

```
package com.vogella.groovy.first

class Task {
    String summary
    String description
    Date dueDate
}
```

7.2. Groovy objects (Plain Old Groovy Objects) and fields

In Groovy all fields of a class have by default the `private` access modifier. Groovy creates automatically getter and setter methods for the fields. If you annotate the class or a property with the `@Bindable`annotation, Groovy also adds `PropertyChangeSupport` to the class or property. Such a Groovy classes fits to the *Java beans* specification.

Groovy objects are frequently referred to as *Plain Old Groovy Objects (POGO)*.

You can use the getter and setter directly or use the name of the field for access. Groovy also supports the array subscript acessor (object[property]). Groovy uses the getter or setter method, even if you directly use the name of the field. If a field should not be changeable define it as `final`, in this case Groovy will not provide a setter.

7.3. Constructors

Groovy provides *constructors with named parameters* in which you can specify the element you would like to set during construction. This constructor is also called *map based constructor*, as it uses the `property:value` map syntax.

If such a constructor is used, Groovy calls the default constructor and then calls the setter methods for the attributes. This "constructor with named parameters" works also if you call a Java class from Groovy code as Groovy uses again the default constructor of the Java class and then the methods to set the properties.

The usage of the constructors with named parameters is demonstrated by the following example.

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```
    String firstName
    String lastName
    int age
    def address
    static void main(def args) {
        Person p = new Person()
        // use the generated access methods
        p.setFirstName("Lars")
        // this will still use the generated access method, it is not a
direct access!
        p.lastName = "Vogel"
        p.address = ("Homestreet 3");
        println(p.firstName + " " + p.lastName);
        // use the generated constructor
        p = new Person(firstName: "Peter", lastName: "Mueller");
        println(p.firstName + " " + p.lastName);
    }

}
```

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7.4. Equals, == and the method is()

One difference between Java and Groovy is that the == operator will check for equality and not for identity. Java checks if both variables points to the same object while Groovy checks if both variables are equals. To check for identify you can use in Groovy the is() method.

In Groovy null == null returns true. If two references point to the same object it is also true. If an object implements the `compareTo` method, Comparable this method is used, otherwise the `equals` method.

7.5. Optional parameters in methods

Groovy allows to have optional parameter values. Optional parameter values are indicated by =0.

```
class Hello {

static main(args){
    println sum(1,5)
    println sum(1,2,5)
    }

static sum(a,b,c=0){
    a+b+c;
    }
}
```

7.6. Default parameters in methods

In Groovy you assign default values to parameters in a method. If a default value for a parameter is defined, Groovy offers two method signatures: one with all parameters and one where the parameter with a default value is omitted. If you use multiple parameters with default values then the right most parameter with a default value is first eliminated then the next, etc.

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8. GPath

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.

For example the `a.b.c` statement is equivalent to `a.getB().getC()`.

GPath navigation works also in complex structures like XML or JSON.

9. Groovy data types

9.1. Optional typed variables

Variables and fields can be typed as in Java or you can use the `def` keyword to define a variable. As a rule of thumb, use the type if it adds clarity to your code otherwise use `def`.

```
// valid variable definitions

// typed
String name
int x
Integer y

// untyped
def list
def map
def todo
```

At runtime variables and fields are always typed, Groovy infers the type based on your source code. This means that at runtime you receive an error if you try to assign a non fitting type to a variable.

Variables which are not declared can be used in Groovy scripts to indicate that they can be set from outside. Such declarations are only valid in scripts and become part of the scripts binding.

9.2. Groovy and generics

Groovy supports the syntax of generics but does not enforce it. For example, you can put any type into a `List<Integer>` collection. To enforce type checking in Groovy you can use AST transformations. See Compile-time meta programming and AST transformations to learn more about AST transformations.

9.3. All types are objects

All variables in Groovy are objects (reference variables), Groovy does not use primitive variables. Groovy still allows to use the primitives types as a short form for the variable declaration but the compiler translates this into the object.

9.4. Numbers

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automatically the down- and upcasting for you.

As numbers are object they have also methods for example the `times` method which executes a block of code the number of times defined by the number.

Create the following class called `TypesTest` to play with numbers.

```
package example

int i = 1 // Short form for Integer i = new Integer(1)
int j = i +3
int k = i.plus(3) // Same as above
// Make sure this worked
assert(k==4)
println i.class
println j.class
println k.class

// Automatic type assignement
def value = 1.0F
println value.class
def value2 = 1
println value2.class
// this would be zero in Java
value2 = value2 / 2
println value2
// value was upcasted
println value2.class

10.times {println "Test"}
```

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The operators, like + or - are also mapped to methods by Groovy.

Table 1. Operators and Methods

Operator	Name	Method
a+b	plus	a.plus(b)
a-b	minus	a.minus(b)
a*b	star	a.multiply(b)
a/b	divide	a.div(b)
a%b	modulo	a.mod(b)
a--, --a	decrement	a.previous()
a, a	increment	a.next()
a**b	power	a.power(b)
a-b	minus	a.minus(b)
a-b	minus	a.minus(b)

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9.5. Ranges

Groovy supports the `Range` data type is a `Collection`. Ranges consists of two values separated by two dots. Ranges can for example be used to define a loop statement.

```
package de.vogella.groovy.datatypes

for (i in 0..9) {
    println ("Hello $i" )
}
assert 'B'..'E' == ['B', 'C', 'D', 'E']
```

You can use Strings for the definition of ranges, these ranges follow the alphabet.

Every object can be used as `Range` long as it implements the `previous()` and `next()` methods and the `java.util.Comparable` interface. The methods map to the ++ and — operators.

10. Operator overloading

Groovy supports that you can use the standard operations in your own classes. For example if you want to use the operation a+b where a and b are from class Z then you have to implement the method `plus(Zname)` in class Z.

11. Strings in Groovy

11.1. Strings and GStrings

Groovy allows to use two different types of String, the `java.lang.String` and the `groovy.lang.GString` class. You can also define a single line or a multi-line string in Groovy.

Strings which are quoted in by "" are of type `GString` (short for Groovy Strings). In GStrings you can directly use variables or call Groovy code. The Groovy runtime evaluates the variables and method calls. An instance of `GString` is automatically converted to a `java.lang.String` whenever needed.

GROOVY

```
package com.vogella.groovy.strings

def name = "John"
def s1 = "Hello $name" // $name will be replaced
def s2 = 'Hello $name' // $name will not be replaced
println s1
println s2
println s1.class
println s2.class

// demonstrates object references and method calls
def date = new Date()
println "We met at $date"
println "We met at ${date.format('MM/dd/yy')}"
```

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Table 2. Define Strings in Groovy

String example	Description
'This is a String'	Standard Java String
"This is a GString"	Groovy GString, allows variable substitution and method calls
''' Multiline string (with line breaks)'''	A multi line string
""" Multiline string (with line breaks)"""	A multi line GString
/regularexpression/	Forward Slash – Escape backslashes ignored, makes Regular Expressions more readable

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The `tokenize()` method tokenize the String into a list of String with a whitespace as the delimiter.

The Groovy JDK adds the `toURL()` method to String, which allows to convert a String to a URL.

The `trim` method removes is applied to remove leading and trailing whitespace.

11.2. Operator overloading in Strings

String support operator overloading. You can use + to concatenate strings, - to substract strings and the *left-shift operator* to add to a String.

11.3. Regular expressions

Groovy is based on Java regular expression support and add the addition support operators to make the usage of regular expressions easier.

Groovy adds the Slashy string as String declaration. Slashy strings are Strings between two "/" signs. They don't need escape backslashes in regular expressions.

Table 3. Constructs

Construct	Description
str =~ pattern	Creates a Matcher from a regex and a string. Same as Pattern.compile(pattern).matcher(str). If you call the find method it returns true if the pattern is contained in the str variable.
==~	Returns a boolean if pattern matches str. Same as Pattern.matches(pattern, str).

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~String	Creates a Pattern object from a string. Equivalent to Pattern.compile(str) in Java.

If you use the ~ operator such a string turns into a regular expression which can be used for pattern matching. You can use special sign (escape characters) in strings if you put them between slashes.

```
package de.vogella.groovy.datatypes

public class RegularExpressionTest{
    public static void main(String[] args) {
        // Defines a string with special signs
        def text = "John Jimbo jingeled happily ever after"

        // Every word must be followed by a nonword character
        // Match
        if (text==~/(\w*\W+)*/){
            println "Match was successful"
        } else {
            println "Match was not successful"
        }
        // Every word must be followed by a nonword character
        // Find
        if (text=~/(\w*\W+)*/){
            println "Find was successful"
        } else {
            println "Find was not successful"
        }

        if (text==~/^J.*/ ){
            println "There was a match"
        } else {
            println "No match found"
        }
        def newText = text.replaceAll(/\w+/, "hubba")
        println newText
    }


}
```

Groovy also provides the `replaceAll` method, which allows to define a closure for the replacement.

12. Lists

12.1. Defining and accessing lists

Groovy treads lists as first class constructs in the language. You define a list via `List list = new List[]`. You can also use generics. To access element i in a list you can either use list.get(i) or list[i].

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```
    String firstName;
    String lastName;
    Person(String firstName, String lastName){
        this.firstName = firstName
        this.lastName= lastName
    }
}
```

```
package de.vogella.groovy.datatypes

public class ListMapTest{

    public static void main(args){
        List<Integer> list = [1,2,3,4]
        println list[0]
        println list[1]
        println list[2]
        List<Person> persons = list[]
        Person p = new Person("Jim", "Knopf")
        persons[0] = p
        println persons.size()
        println persons[0].firstName
        println persons.get(0).firstName
    }
}
```

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Groovy allows direct property access for a list of items. This is demonstrated by the following snippet.

```groovy
package de.vogella.groovy.datatypes

public class ListMapTest{

    public static void main(args){
        List<Person> persons = list[]
        persons[0] = new Person("Jim", "Knopf")
        persons[1] = new Person("Test", "Test")
        println persons.firstName
    }
}
```

12.2. Convert a list to an array and vice versa

Groovy converts automatically an Array to a List and vice versa. This is demonstrated by the following snippet.

```groovy
package list

// demo of auto conversion
def String[] strings = "This is a long sentence".split();
// convert Array to list
def List listStrings = strings
// convert List back to Array
def String[] arrayStrings = listStrings

println strings.class.name
println listStrings.class.name
println arrayStrings.class.name
```

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12.3. List methods

The following lists the most useful methods on List.

- reverse()
- sort()
- remove(index)
- findAll{closure} - returns all list elements for which the closure validates to true
- first()
- last()
- max()
- min()
- join("string") - combines all list elements, calling the toString method and using the string for concatenation.
- << e - appends element e to the list

The `grep` method can be used to filter elements in a collection.

12.4. Operator overloading in Lists

List support operator overloading. You can use + to concatenate strings, - to substract lists and the *left-shift operator* to add elements to a list.

12.5. Spreaddot operator

The spread dot operator (spread-dot operator) `*.` is used to invoke a method on all members of a Collection. The result of this operation is another Collection object.

```
JAVA
def list = ["Hello", "Test", "Lars"]

// calculate the length of every String in the list
def sizeList = list*.size()
assert sizeList = [5, 4, 4]
```

12.6. Searching in a list with find, findall and grep

You can search in a list.

- findAll{closure} - returns all list elements for which the closure validates to true
- find{closure} - returns the list element for which the closure validates to true
- grep(Object filter) - Iterates over the collection of items and returns each item that matches the given filter - calling the Object#isCase. This method can be used with different kinds of filters like regular expressions, classes, ranges etc.

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```
// check with grep that one element is a Boolean
assert [true] == [1, 2, 3].grep(Boolean)

// grep for all elements which start with a pattern
assert ['Groovy'] == ['test', 'Groovy', 'Java'].grep(~/^G.*/)

// grep for if the list contains b and c
assert ['b', 'c'] == ['a', 'b', 'c', 'd'].grep(['b', 'c'])

// grep for elements which are contained in the range
assert [14, 16] == [5, 14, 16, 75, 12].grep(13..17)

// grep for elements which are equal to 42.031
assert [42.031] == [15, 'Peter', 42.031, 42.032].grep(42.031)

// grep for elements which are larger than 40 based on the closure
assert [50, 100, 300] == [10, 12, 30, 50, 100, 300].grep({ it > 40 })
```

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13. Maps in Groovy

13.1. Map declaration and access

Groovy treads maps as first class constructs in the language.

The items of maps are key–value pairs that are delimited by colons. An empty map can be created via `[:]`. By default a map is of the `java.util.HashMap` type. If the keys are of type String, you can avoid the single or double quotes in the map declaration.

JAVA

```
package com.vogella.groovy.maps

class Main {

    static main(args) {
        // create map
        def map = ["Jim":"Knopf", "Thomas":"Edison"]
        // the dot operator is overloaded to access the value
        map.AnotherKey="Testing"
        // create map without quotes for the keys
        def anotherMap = [Jim:"Knopf", Thomas:"Edison"]
        // size is used to determine the number of elements
        assert create.size() == 2

        // if key should be evaluated put it into brackets
        def x ="a"
        // not true, as x is interpreted as "x"
        println ([a:1]==[x:1])
        // force Groovy to see x as expression
        println ([a:1]==[(x):1])

        // create empty map
        def emptyMap = [:]



    }

}
```

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the second case, if the key is not found and the default is returned, the (key,default) pair is added to the map.

The `keySet()` method returns a set of keys, a collection without duplicate entries and no guaranteed ordering.

13.2. Each, any and the every method

You can call closures on the elements, via the `each()`, `any()` and `every()` method. The `any()` and `every()` methods return a boolean depending whether any or every entry in the map satisfies a condition defined by a closure.

```
package com.vogella.groovy.maps

class CallMethods {

    static main(args) {
        def mymap = [1:"Jim Knopf", 2:"Thomas Edison", 3:"Lars Vogel"]
        mymap.each {entry -> println (entry.key > 1)}
        mymap.each {entry -> println (entry.value.contains("o"))}
        println "Lars contained:" + mymap.any {entry ->
entry.value.contains("Lars")}
        println "Every key small than 4:" + mymap.every {entry -> entry.key
< 4}

        def result =''
        for (key in mymap.keySet()) {
            result += key
        }
        println result

        mymap.each { key, value ->
            print key + " "
            println value
        }

        mymap.each { entry ->
            print entry.key + " "
            println entry.value
        }
    }
}
```

GROOVY

As you can see in the above example you can iterate in different ways through a map. The parameter for each can by one parameter and than it is the map entry or two in which case it is the key, value combination.

13.3. Searching in a map

You can also use the following methods:

- findAll(closure) - Finds all entries satisfying the condition defined by the closure
- find(closure) - Find the first entry satisfying the condition defined by the closure
- collect(closure) - Returns a list based on the map with the values returned by the closure
- submap('key1', 'key2',) - returns a map based on the entries of the listed keys

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13.4. Getting and adding defaults values via the get method

The `get(key, default_value)` allows to add the "default_value" to the map and return it to the caller, if the element identified by "key" is not found in the map. The `get(key)` method, does not add automatically to the map.

13.5. Named arguments for method invocation

It is possible to use named arguments in method invocation.

```
JAVA
package namedarguments

def address = new Address(street: 'Reeperbahn', city: 'Hamburg')
def p = new Person(name: 'Lars', address: address, phoneNumber:
'123456789')

// Groovy translates the following call to:
// p.move([street: 'Saselbeck', city: 'Hamburg'], '23456789')
p.moveToNewPlace(street: 'Saselbeck', '23456789', city: 'Hamburg')


assert 'Lars' == p.name
assert 'Hamburg' == p.address.city
assert 'Saselbeck' == p.address.street
assert '23456789' == p.phoneNumber
```

All named arguments are used are converted by Groovy them a map and passed into the method as first parameter. All other parameters are passed in afterwards. The method can now extract the parameter from the map and perform its setup.

```
JAVA
package namedarguments

class Address {
    String street, city
}

class Person {
    String name
    Address address
    String phoneNumber

    def moveToNewPlace(inputAsMap, newPhoneNumber) {
        address.street = inputAsMap.street
        address.city   = inputAsMap.city
        phoneNumber = newPhoneNumber

    }
}
```

13.6. Convert a list to a map

To convert a list to a map you can use the `collectEntries` method.

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```
// simple conversion
def result = words.collectEntries {
    [(it):0]
}

assert result.size() == 4
assert result.Ubuntu == 0

// now calculate value with a closure, true if word contains "n"
def map = words.collectEntries {
    [(it): it.contains('n')]
}

println map
assert map.Ubuntu && map.Windows && map.Android && !map.'Mac OS X'
```

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14. Control structures

14.1. Groovy evaluation of conditions - The Groovy truth

Groovy evaluates a condition defined in a control statement differently from Java. A pure boolean expression is evaluated the same as in Java. In difference to Java every object in Groovy has a boolean value. This means that all objects evaluate either to true or false in a boolean context. The number "0" evaluates to `false`, all other numbers evaluate to `true`. Empty collections or `null` evaluate to `false`. Every other non-`null` object evaluates to `true`.

JAVA

```
package example

map = [:]
assert !map

list = ["Ubuntu", "Android"]
assert list
assert !0
assert 1
assert -1
assert !""
assert "Hello"
def test = null
assert !test
```

This evaluation is commonly known in the Groovy worlds as *the Groovy truth*. In other languages with this concept values that evaluate to `true` are sometimes called `truthy` and those that evaluate to `false` are called `falsy`.

14.2. if statements

The `if` and `switch` are supported, the if statement supports the Groovy truth, e.g., you can use for example a list as parameter in `if` and Groovy will evaluate this Groovy truth value.

14.3. switch statement and the isCase method

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`isCase()` method to `Class` (using isInstance), `Object` (using (equals), `Collections` (using contains) and regular expressions (using matches). You can also specify a closure, which is evaluated to a boolean value.

```
def testingSwitch(input) {
    def result
    switch (input) {
        case 51:
            result = 'Object equals'
            break
        case ~/^Regular.*matching/:
            result = 'Pattern match'
            break
        case 10..50:
            result = 'Range contains'
            break
        case ["Ubuntu", 'Android', 5, 9.12]:
            result = 'List contains'
            break
        case { it instanceof Integer && it < 50 }:
            result = 'Closure boolean'
            break
        case String:
            result = 'Class isInstance'
            break
        default:
            result = 'Default'
            break
    }
    result
}

assert 'Object equals' == testingSwitch(51)
assert 'Pattern match' == testingSwitch("Regular pattern matching")
assert 'Range contains' == testingSwitch(13)
assert 'List contains' == testingSwitch('Ubuntu')
assert 'Closure boolean' == testingSwitch(9)
assert 'Class isInstance' == testingSwitch('This is an instance of String')
assert 'Default' == testingSwitch(200)
```

JAVA

If several conditions fit, the first `case` statement is selected.

To use your custom class in a switch statement implement the `isCase` method.

14.4. Safe navigation operator

You can use safe navigation operator to check safety for null via the `?.` operator. This will avoid a `NullPointerException` if you access properties of an object which is null.

```
// firstName is null, if user is null. No NPE
def firstName = user?.firstName
```

TEXT

14.5. Elvis operator

The `?:` (called the Elvis operator) is a short form for the Java ternary operator. You can use this to set a default if an expression resolves to false or null.

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```
String test = null
String result2 = test ? test : new String()

// Java version
String user = null;
String result1 = user!=null ? user : new String();
```

15. Loops

15.1. For and while loops

Groovy supports the standard Java `for`, the `for-each` and the `while` loop. Groovy does not support the `do while` loop.

15.2. Using the each method

While for and while loops are supported the Groovy way of iterating thrOw a list is using the `each()` method. Groovy provides this method on several objects include lists, maps and ranges.

This method takes as argument a closure, a block of code which can directly get executed. You can either directly define the name of the variable which the value of each iteration should get assigned to or using the implicit available variable "it".

JAVA

```
package de.vogella.groovy.loops

public class PrintLoop{
    public static void main(def args){
        def list = ["Lars", "Ben", "Jack"]
        // using a variable assignment
        list.each{firstName->
          println firstName
        }
        // using the it variable
        list.each{println it}
    }
}
```

Groovy provides also the `eachWithIndex` method which provides two parameters, the first is the element and the second it the index.

15.3. Iterative with numbers

In additional your have the methods `upto()`, `downto()`, `times()` on number variables. Also you can use ranges (this is an additional datatype) to execute certain things from a number to another number. This is demonstrated by the following example.

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```
    public static void main(args){
        5.times {println "Times + $it "}
        1.upto(3) {println "Up + $it "}
        4.downto(1) {print "Down + $it "}
        def sum = 0
        1.upto(100) {sum += it}
        print sum
        (1..6).each {print "Range $it"}
    }
}
```

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16. Using lambdas and closures in Groovy

16.1. Defining closures

Closures are *code fragments* or *code blocks* which can be used without being a method or a class.

A closure in Groovy is defined via the following construct: `{list of parameters→ closure body}`. The values before the `→` sign define the parameters of the closure.

For the case that only one parameter is used you can use the implicit defined `it` variable. The last statement of a closure is implicitly used to define the return value, if no return statement is defined. The usage of `it` variable on the automatic return statement is demonstrates in the following example.

```
// return the input, using the implicit variable it
def returnInput = {it}

assert 'Test' = returnInput('Test')

// return the input without implicit variable
def returnInput2 = {s-> s}

assert 'Test' = returnInput2('Test')
```

16.2. Defining default values in a closure

If you define a closure you can also define default values for its parameters.

```
package closures

def multiply = {int a, int  b = 10 -> a * b}

assert multiply(2) == 20
assert multiply(2,5) == 10
```

16.3. Example: Using closures in the each method

The Groovy collections have several methods which accept a closure as parameter, for example the each method.

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```
// calculate the sum of the number up to 10

def total = 0
(1..10).each {total+=it}
```

16.4. Example: Sort a list by lenght of the string

The Groovy collections have several methods which accept a closure as parameter, for example the each method.

```
package list

def List strings = "this is a long sentence".split();
strings.sort({s1, s2 -> s1.size() <=> s2.size()});
println strings
```

16.5. Using the with method

Every Groovy object has a `with` method which allows to group method and property calls to an object. The `with` method gets a closure as parameter and every method call or property access in this closure is applied to the object.

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```
    String property1
    String property2
    List<String> list = []
    def addElement(value) {
        list << value
    }
    def returnProperties () {
        "Property 1: $property1, Property 2: $property2 "
    }
}

def sample = new WithTestClass()
def result= sample.with {
    property1 = 'Input 1'
    property2 = 'This is cool'
    addElement 'Ubuntu'
    addElement 'Android'
    addElement 'Linux'
    returnProperties()
}
println result
assert 3 == sample.list.size()
assert 'Input 1' == sample.property1
assert 'This is cool' == sample.property2
assert 'Linux' == sample.list[2]


def sb = new StringBuilder()
sb.with {
    append 'Just another way to add '
    append 'strings to the StringBuilder '
    append 'object.'
}
```

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17. File and network I/O with Groovy

17.1. Groovy and processing files

Groovy adds several convenient methods the `File` class from Java. The following example demonstrates how to print out every line to the console and and also how to change the output of a line by adding a prefix.

```
// write the content of the file to the console
File file = new File("./input/test.txt")
file.eachLine{ line -> println line }

// adds a line number in front of each line to the console
def lineNumber = 0
file = new File("./input/test.txt")
file.eachLine{ line ->
    lineNumber++
    println "$lineNumber: $line"
}

// read the file into a String
String s = new File("./input/test.txt").text
println s
```

The `File` object provides methods like `eachFile`, `eachDir` and `earchFileRecursively` which takes an closure as argument.

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17.2. Writing to files

Groovy also provides API to write to a file and append to it.

```
// write the content of the file to the console
File file = new File("output.txt")
file.write "Hello\n"
file.append "Testing\n"
file << "More appending...\n"
File result = new File("output.txt")
println (result.text)
// clean-up
file.delete()
```

TEXT

17.3. Groovy and processing HTTP get requests

Reading an HTTP page is similar to reading a text file.

```
def data = new URL(http://www.vogella.com).text

// alternatively use Groovy JDK methods
'http://www.vogella.com'.toURL().text
```

TEXT

18. Using template engines in Groovy

A template is some text with predefined places for modificatoins. This template can contain variable reference and Groovy code. The templates engines from Groovy provide `createTemplate` methods for Strings, Files, Readers or URL and create a `Template` object based on their input.

Template objects are used to create the final text. A map of key values is passed to the `make` method of the template which return a `Writable`.

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```
 String templateText = '''Project report:

We have currently ${tasks.size} number of items with a total duration of
$duration.
<% tasks.each { %>- $it.summary
<% } %>

'''

def list = [
    new Task(summary:"Learn Groovy", duration:4),
    new Task(summary:"Learn Grails", duration:12)]
def totalDuration = 0
list.each {totalDuration += it.duration}
def engine = new SimpleTemplateEngine()
def template = engine.createTemplate(templateText)
def binding = [
duration: "$totalDuration",
tasks: list]

println template.make(binding).toString()
```

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19. Groovy builders

Groovy supports the builder pattern to create tree-like data structures. The base class for the builder support is `BuilderSupport` and its subclasses are `NodeBuilder`, `MarkupBuilder`, `AntBuilder` and `SwingBuilder`.

20. Groovy and Markup like XML or HTML

20.1. Parsing XML with XmlSlurper

Groovy allows to process XML very easily. Groovy provide the `XmlSlurper` class for this purpose. There are other options but the `XmlSlurper` is usually considered to be the more efficient in terms of speed and flexibility. XmlSlurper can also be used to transform the XML white parsing it.

`XmlSlurper` allows to parse an XML document and returns an `GPathResult` object. You can use `GPath` expressions to access nodes in the XML tree.

XMLParser allows to parse an XML document and returns an `groovy.util.Node` object. You can use `GPath` expressions to access nodes in the XML tree. Dots traverse from parent elements to children, and @ signs represent attribute values.

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```
    static void main(args){
        def xmldocument = '''
        <persons>
            <person age="3">
                <name>
                    <firstname>Jim</firstname>
                    <lastname>Knopf </lastname></name>
            </person>
            <person age="4">
                <name>
                    <firstname>Ernie</firstname>
                    <lastname>Bernd</lastname></name>
            </person>
        </persons>
        '''

        // in case you want to read a file
        // def persons = new XmlSlurper().parse(new File('data/plan.xml'))
        def persons = new XmlSlurper().parseText(xmldocument)
        def allRecords = persons.person.size()

        // create some output
        println("Number of persons in the XML documents is: $allRecords")
        def person = persons.person[0]
        println("Name of the person tag is: ${person.name}")

        // Lets print out all important information
        for (p in persons.person){
            println "${p.name.firstname.text()}  ${p.name.lastname.text()}
is ${p.@age} old"
        }
    }

}
```

20.2. Using the MarkupTemplateEngine to generated Markup

Introduce in Groovy 2.3 the `MarkupTemplateEngine` which supports generating XML-like markup (XML, XHTML, HTML5, etc), but it can be used to generate any text based content.

It is compiled statically to be very fast and supports internationalization. It also supports templates as input.

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```
import groovy.text.markup.TemplateConfiguration
String xml_template = '''xmlDeclaration()
tasks {
    tasks.each {
        task (summary: it.summary, duration: it.duration)
    }
}'''
String html_template ='''
yieldUnescaped '<!DOCTYPE html>'
html(lang:'en') {
    head {
        meta('http-equiv':'"Content-Type" content="text/html; charset=utf-
8"')
        title('My page')
    }
    body {
        p('This is an example of HTML contents')
    }
}'''

values = [tasks:[
    new Task(summary:"Doit1", duration:4),
    new Task(summary:"Doit2", duration:12)
    ]]
TemplateConfiguration config = new TemplateConfiguration()
def engine = new MarkupTemplateEngine(config)
def template1 = engine.createTemplate(xml_template)
def template2 = engine.createTemplate(html_template)
println template1.make(values)
println template2.make(values)
```

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Templates support includes.

20.3. Creating Markup (XML) files with the MarkupBuilder

The usage of the `MarkupBuilder` as "old" builder is demonstrated by the following snippet.

JAVA

```
package com.vogella.groovy.builder.markup

import groovy.xml.MarkupBuilder

class TestMarkupWriter {
    static main (args) {
        def date = new Date()
        StringWriter writer = new StringWriter()
        MarkupBuilder builder = new MarkupBuilder(writer)
        builder.tasks {
            for (i in 1..10) {
                task {
                    summary (value: "Test $i")
                    description (value: "Description $i")
                    dueDate(value: "${date.format('MM/dd/yy')}")
                }
            }
        }
        print writer.toString()
    }
}
```

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constructed at runtime.

It is possible to use maps MarkupBuilderin the builder

```
package com.vogella.groovy.builder.markup

import groovy.xml.MarkupBuilder



class TestMarkupWriterMap {
    static main (args) {
        Map map = [Jim:"Knopf", Thomas:"Edison"]
        def date = new Date()
        StringWriter writer = new StringWriter()
        MarkupBuilder builder = new MarkupBuilder(writer)
        builder.tasks {
            map.each { key, myvalue ->
                person {
                firstname (value : "$key")
                lastname(value : "$myvalue")
                }
            }
        }
        print writer.toString()
    }
}
```

JAVA

You can also use the builder to create valid HTML.

```
package com.vogella.groovy.builder.markup

import groovy.xml.MarkupBuilder



class TestMarkupHtml {
    static main (args) {
        Map map = [Jim:"Knopf", Thomas:"Edison"]
        def date = new Date()
        StringWriter writer = new StringWriter()
        MarkupBuilder builder = new MarkupBuilder(writer)
        builder.html {
            head { title "vogella.com" }
            body {
                dev (class:"strike") {
                    p "This is a line"
                }
            }
            print writer.toString()
        }
    }
}
```

JAVA

21. Groovy and JSON

Similar to the `XmlSlurper` class for parsing XML, Groovy provides the `JsonSlurper` for parsing JSON.

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```
def a = new JsonSlurper().parse(new File("./input/tasks.json"))
println(JsonOutput.prettyPrint(a.toString()))
```

You can use the `setType(LAX)` method to parse partially invalid JSON files. With this mode the JSON file can contain // comments, Strings can use ' for quotes can be forgotten.

22. Compile-time meta programming and AST transformations

22.1. What are AST transformations?

An *Abstract Syntax Tree* (AST) is a in memory representation of code as data. An AST transformation allows to modify this representation during compile time. This is sometimes called compile-time metaprogramming.

Groovy provides several AST transformations which allows you to reduce the amount of code you have to write.

22.2. @TupleConstructor

If a class is annotated with `@TupleConstructor` Groovy generates a constructor using all fields.

22.3. @EqualsAndHashCode

The `@EqualsAndHashCode` annotation can be applied to a class, creates the `equals` and `hashCode` method. Includes fields can be customized.

```
package asttransformations

import groovy.transform.EqualsAndHashCode


@EqualsAndHashCode (excludes=["summary","description"])
public class Task {
    private final long id;
    private String summary;
    private String description;
}
```

22.4. @ToString for beans

The `@ToString` annotation can be applied to a class, generates a toString method, support boolean flags, like includePackage, includeNames, allows to exclude a list of fields.

This annotation typically only considers properties (non-private fields) but you can include them via `@ToString(includeFields=true)`. Via `@ToString(excludes=list)` we can exclude a list of fields and properties.

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```groovy
@ToString(includeFields=true)
public class Task {
    private final long id;
    private String summary;
    private String description;
}
```

22.5. @Canonical

Combines @ToString, @EqualsAndHashCode and @TupleConstructor.

22.6. @Immutable for immutable Java beans

This annotation marks all fields in a class as final and ensures that there are no setters generate for the fields. It also creates a constructor for all fields, marks the class as final.

22.7. @Delegate

@Delegate can be used on a field. All methods on the delegate are also available on the class with defines the delegate. If several delegates define the same method, it is recommended to override the method. If you do not override Groovy will use the first method it finds.

22.8. @Sortable for beans

You can automatically created a `Comparator` for a Groovy bean by annotating it with `@Sortable`. Fields are used in the order of declaration.

You can also include/exclude fields.

```groovy
package asttransformations

import groovy.transform.Sortable

@Sortable(excludes = ['duration'])
class Task {
    String summary
    String description
    int duration
}
```

22.9. @Memoize for methods

If the `@Memoize` annotation is to a method the Groovy runtime caches the result for invocations with the same parameters. If the annotated method is called the first time with a certain set of parameter, it is executed and the result is cached. If the method is called again with the same parameters, the result is returned from the cache.

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```
class MemoizedExample {
    @Memoized
    int complexCalculation (int input){
        println "called"
        // image something really time consuming here
        return input + 1;
    }
}
```

JAVA

```
package asttransformations

def m = new MemoizedExample()

// prints "called"
m.complexCalculation(1)

// no output as value is returned from cache
m.complexCalculation(1)
```

22.10. @AnnotationCollector for combining AST Transformations annotations

The `AnnotationCollector` allows to combine other AST Transformations annotations.

JAVA

```
package asttransformations;

import groovy.transform.AnnotationCollector
import groovy.transform.EqualsAndHashCode
import groovy.transform.ToString

@ToString(includeNames=true)
@EqualsAndHashCode
@AnnotationCollector
public @interface Pojo {}
```

You can use this annotation, it is also possible to override parameters in them.

JAVA

```
package asttransformations


@Pojo
class Person {
    String firstName
    String lastName
}

@Pojo(includeNames=false)
class Person2 {
    String firstName
    String lastName
}
```

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```
def p = new Person(firstName:"Lars" ,lastName:"Vogel")
println p
// output: asttransformations.Person(firstName:Lars, lastName:Vogel)

p = new Person2(firstName:"Lars" ,lastName:"Vogel")
println p
// output: asttransformations.Person2(Lars, Vogel)
```

22.11. @Bindable observable Properties

The Java beans specification requires that Java beans support `PropertyChangeSupport` for all fields.

The `@groovy.beans.Bindable` annotation can be applied to a whole class or a method. If the property is applied to a class, all methods will be treated as having the `@Bindable` annotation. This will trigger Groovy to generated a `java.beans.PropertyChangeSupport` property in the class and generate methods so that listeners can register and deregister. Also all setter methods will notfiy the property change listener.

The following listing shows the Java version of a Java Bean with one property.

22.12. @Builder

The `@Builder` can be applied to a class and generates transparently a builder for this class.

```
package asttransformations

import groovy.transform.ToString
import groovy.transform.builder.Builder

@Builder
@ToString(includeNames=true)
class TaskWithBuilder {
    String summary
    String description
    int duration
}
```

```
package asttransformations

TaskWithBuilder test = TaskWithBuilder.builder().
                       summary("Help").
                       description("testing").
                       duration(5).
                       build();

print test;
```

22.13. @Grab for dependency management

Groovy allows to add Maven dependencies to your Groovy script or Groovy class using the `@Grab` annotation. Before a Groovy program is executed it reads the `@Grab` annotation, resolves the Maven dependencies, downloads them and adds

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```
@Grab(group='org.eclipse.jetty.aggregate', module='jetty-all',
version='7.6.15.v20140411')
```

Using the @GrabResolver annotation you can specify the Maven repository you want to use. For example `@GrabResolver(name='myrepo', root='http://myrepo.my-company.com/')`.

22.14. Other AST Transformations

The following table lists other commonly used annotations in Groovy code:

Table 4. AST transformation annotations

Annotation	Description
@Singleton	Makes annotated class a Singleton, access via ClassName.instance.
@PackageScope	Defines fields, methods or class as package scope, which is the default access modifier in Java.

22.15. Writing custom transformations

You can also define you custom local or global transformations. For a local transformation you would write your own annotation and write a processors for that and use the annotation on an element in your Groovy class. The Groovy compiler calls your processors to transform the input into something else.

Global transformations are applied to every single source unit in the compilation without the need for additional customization.

23. Meta Object Protocol

23.1. What is the Meta Object Protocol_

The *Meta-Object Protocol (MOP)* is the underlying layer in Groovy which allows you to add methods and properties to an object at runtime. Using MOP you can methods and properties at runtime to existing objects.

23.2. Calling methods or accessing properties on a Groovy object

If a method is called or a property is accessed in a class and this class does not define this method / property then pre-defined methods are called which can be used to handle this call.

- def methodMissing (String name, args) - Called for missing method
- void setProperty (String property, Object o) - called for non existing setter of a property
- Object getProperty (String property) - called for non existing getter of a property

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methods at runtime if a method or property cannot be found. This approach is for example used by the Groovy builder pattern, it pretends to have certain method.

23.3. Adding methods and properties

Using the `.metaclass` access you can add properties and methods to an existing class.

```
Class Todo {}

Todo.metaClass.summary = 'Learn MOP'
Todo.metaClass.done = false
Todo.metaClass.markAsFinish = {-> done=true}

Todo t = new Todo()
t.markAsFinish()
```

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24. Exercise: Meta Object Protocol

24.1. Target of this exercise

In this exercise you learn how to extend a Groovy class using the Meta Object Protocol.

24.2. Making a Groovy object responding to all methods and property calls

Create the following Groovy class. This class returns a fixed value for every property asked and it fakes method calls.

```
package mop


public class AnyMethodExecutor{
    // Should get ignored
    String value ="Lars"

    // always return 5 no matter which property is called
    Object getProperty (String property){
        return 5;
    }

    void setProperty (String property, Object o ){
        // ignore setting
    }

    def methodMissing (String name, args){
        def s = name.toLowerCase();
        if (!s.contains("hello")) {
            return "This method is just fake"
        } else {
            return "Still a fake method but 'hello' back to you."

        }
    }

}
```

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```
package mop
def test = new AnyMethodExecutor ();

// you can call any method you like
// on this class
assert "This method is just fake" == test.hall();
assert "This method is just fake" == test.Hallo();
assert "Still a fake method but 'hello' back to you." ==
test.helloMethod();

// setting is basically ignored
test.test= 5;
test.superDuperCool= 100

// all properties return 5
assert test.superDuperCool == 5
assert test.value == 5;
```

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24.3. Exercise: Adding JSON output to Groovy class, the ugly and the smart way

Create the following Groovy class.

```
package mop;

import groovy.json.JsonBuilder
import groovy.json.JsonOutput

public class Task {
    String summary
    String description

    def methodMissing (String name, args){
        if (name=="toJson") {
            JsonBuilder b1 = new JsonBuilder(this)
            return JsonOutput.prettyPrint(b1.toString())
        }
    }
}
```

Is uses the `methodMissing` to respond to a `toJson` method call. This implementation is a bit ugly as it "pollutes" our domain model with "framework" code.

This script trigger the JSON generation.

```
package mop

def t = new Task(summary: "Mop",description:"Learn all about Mop" );
println t.toJson()
```

Groovy allows to created an instance of `MetaClass` and register it automatic for a certain class. This registration is based on a package naming conversion:

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Create the following class in the listed package to register it as `MetaClass` for your class.

```
package groovy.runtime.metaclass.mop;

import groovy.json.JsonBuilder
import groovy.json.JsonOutput

class TaskMetaClass extends DelegatingMetaClass {

    TaskMetaClass(MetaClass meta) {
        super(meta)
    }

    @Override
    def invokeMethod(Object object, String method, Object[] args) {
        println method
        if (method == "toJson") {
            JsonBuilder b1 = new JsonBuilder(object)
            return JsonOutput.prettyPrint(b1.toString())
        }
        super.invokeMethod(object, method, args)
    }
}
```

This allows you to clean up your domain model.

```
package mop;

import groovy.json.JsonBuilder
import groovy.json.JsonOutput

public class Task {
    String summary
    String description
}
```

Run your small test script again and validate that the conversion to JSON still works.

```
package mop

def t = new Task(summary: "Mop",description:"Learn all about Mop" );
println t.toJson()
```

24.4. Exercise: Adding a method to String

The following example demonstrates how you can add a method to the String class using closures.

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```
    (s.reverse()<<"Lars").toString()
}

String.metaClass.reverseStringAndAddLars = { ->
reverseStringAndAddLars(delegate) }

println 'Hamburg'.reverseStringAndAddLars()
println 'grubmaHLars'

def test = 'Hamburg'.reverseStringAndAddLars()

assert test == "grubmaHLars"
```

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25. Using Groovy classes in Java

25.1. Calling Groovy classes directly

To use Groovy classes in Java classes you need to add the Groovy runtime to the Java classpath.

Create a new Java project "de.vogella.groovy.java". Create package "de.vogella.groovy.java"

Create the following Groovy class.

JAVA
```
package de.vogella.groovy.java


public class Person{
    String firstName
    String lastName
    int age
    def address
}
```

Create the following Java class.

JAVA
```
package de.vogella.groovy.java;

public class Main {
    public static void main(String[] args) {
        Person p = new Person();
        p.setFirstName("Lars");
        p.setLastName("Vogel");
        System.out.println(p.getFirstName() + " " + p.getLastName());
    }
}
```

You should be able to run this Java program. Right-click your project, select "Properties" and check that the build path includes the Groovy libraries.

25.2. Calling a script

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```
import javax.script.ScriptEngine;
import javax.script.ScriptEngineManager;
import javax.script.ScriptException;

public class ExecuteGroovyViaJSR223 {
    public static void main(String[] args) {
        ScriptEngine engine = new ScriptEngineManager()
                .getEngineByName("groovy");
        try {
            engine.put("street", "Haindaalwisch 17a");
            engine.eval("println 'Hello, Groovy!'");
            engine.eval(new FileReader("src/hello.groovy"));
        } catch (ScriptException e) {
            e.printStackTrace();
        } catch (FileNotFoundException e) {
            e.printStackTrace();
        }
    }
}
```

```
JAVA
println "hello"
// if not defined it becomes part of the binding
println street
```

26. Using Groovy in a Maven or Gradle build

26.1. Using Groovy in a Maven build

Maven is a well established build tool in the Java world. Integrating Gradle in the build is trivial. You basically only have to add one dependency to your pom file. To use Groovy code in your plug-in simply add the following dependency to your `pom.xml` file.

```
XML
<dependencies>
    ... other dependencies
    <dependency>
        <groupId>org.codehaus.groovy</groupId>
        <artifactId>groovy-all</artifactId>
        <version>2.4.5</version>
    </dependency>
</dependencies>
```

26.2. Using Groovy in a Gradle build

To use Groovy code in your Gradle build, simply add the following dependency to your `pom.xml` file.

```
JAVA
apply plugin: 'groovy'

repositories {
    mavenCentral()
}

dependencies {
    implementation 'org.codehaus.groovy:groovy-all:2.4.5'
}
```

27. Groovy Links

Groovy Homepage (http://www.groovy-lang.org/)

Groovy API page - Groovy documentation (http://docs.groovy-lang.org/latest/html/gapi/)

Groovy Goodness blog series from Hubert Klein Ikkink (http://mrhaki.blogspot.de/search/label/Groovy)

Groovy Koans from Nadav Cohen partially reused in this description (https://github.com/martofeld/groovykoans-master-resolve)

Java regular expression tutorial (https://www.vogella.com/articles/JavaRegularExpressions/article.html)

Regular expressions in Groovy (http://docs.groovy-lang.org/latest/html/documentation/index.html#_regular_expression_operators)

Groovy JSonSlurper documentation (http://www.groovy-lang.org/json.html)

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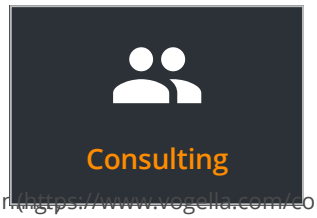

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