# The Gradle build system - Tutorial

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This tutorial describes how to the the Gradle build tool.

## 1. Introduction to the Gradle build system

### 1.1. What is the Gradle build system?

*Gradle* is an advanced general purpose build management system based on Groovy and Kotlin. Gradle supports the automatic download and configuration of dependencies or other libraries. It

supports Maven and Ivy repositories for retrieving these dependencies. This allows reusing the artifacts of existing build systems.

Gradle supports multi-project and multi-artifact builds.

Gradle has the notion of *projects* and *tasks*.

## 1.2. Projecs and tasks in Gradle

A Gradle build consists of one or more *projects*. Projects can be something which should be built or something that should be done. Each project consists of *tasks*. A task represents a piece of work which a build performs, e.g., compile the source code or generate the Javadoc.

## 1.3. The Gradle build file - build.gradle

A project using Gradle describes its build via a *build.gradle* file. This file is located in the root folder of the project. The build file for Gradle builds is based on a *Domain Specific Language* (DSL). In this file you can use a combination of declarative and imperative statements. You can also write Groovy or Kotlin code, whenever you need it. Tasks can also be created and extended dynamically at runtime.

This build file defines a project and its tasks. Gradle is a general purpose build system hence this build file can perform any task. The following listing represents a very simple build file.

```
task hello {
    doLast {
        println 'Hello Gradle'
    }
}
```

In older Gradle files you might encounter the use of `<<` instead of `doLast`.

```
task hello << {
    println 'Hello Gradle'
}
```

This option is removed in Gradle v5.0.

To execute the `hello` task in this build file, type `gradle hello` on the command line in the directory of the build file. If the Gradle output should be suppressed, use the `-q` (quiet) parameter.

```
gradle hello

# alternative add the -q flag
gradle -q hello
```

## 1.4. Comments in Gradle build files

You can use single and multiline comments in Gradle build files.

```
// Single line comment

/*
 Multi
 line
```

```
 comment
*/
```

### 1.5. Project settings and description

By default, Gradle uses the directory name as project name. You can change this by creating a *settings.gradle* file in the directory which specifies the project name.

```
rootProject.name ='com.vogella.gradle.first'
```

You can also add a description to your project via the *build.gradle* file.

```
description ="""
Example project for a Gradle build

Project name: ${project.name}

More detailed information here... """

task hello {
    doLast {
        println 'Hello Gradle'
    }
}
```

Use the `gradle project` command to get information about your project. The following listing shows the output.

```
:projects

------------------------------------------------------------
Root project -
Example project for a Gradle build

Project name: com.vogella.gradle.first

More detailed information here...
------------------------------------------------------------

Root project 'com.vogella.gradle.first' -
Example project for a Gradle build

Project name: com.vogella.gradle.first

More detailed information here...
No sub-projects

To see a list of the tasks of a project, run gradle <project-path>:tasks
For example, try running gradle :tasks

BUILD SUCCESSFUL

Total time: 1.048 secs
```

## 2. Gradle plug-ins

The Gradle build system uses plug-ins to extend its core functionality. A plug-in is an extension to Gradle which typically adds some preconfigured tasks. Gradle ships with a number of plug-ins, and you can develop custom plug-ins.

One example is the Java plug-in. This plug-in adds tasks to your project which allow compiling Java source code, run unit tests and to create a JAR file.

A plug-in is included in a *build.gradle* file with the `apply plugin: 'pluginname'` statement.

For example the entry `apply plugin: 'com.android.application'` makes the Android plug-in available for a Gradle build.

Gradle provides also a registry for plug-ins via Gradle Plugin search.

## 2.1. IDE support for Gradle

The Gradleware company is developing Eclipse Gradle tooling via the Eclipse Buildship project. Other IDEs like IntelliJ and Android Studio already include also good Gradle support. See Eclipse Gradle tutorial for the usage of Gradle with Eclipse. == Installing and configuring Gradle

## 2.2. Requirements

The usage of Gradle requires an JDK (Java Development Kit) installation.

## 2.3. Download and extract Gradle

The latest version of Gradle can be found on the Gradle Download page. Download the latest *Complete distribution*.

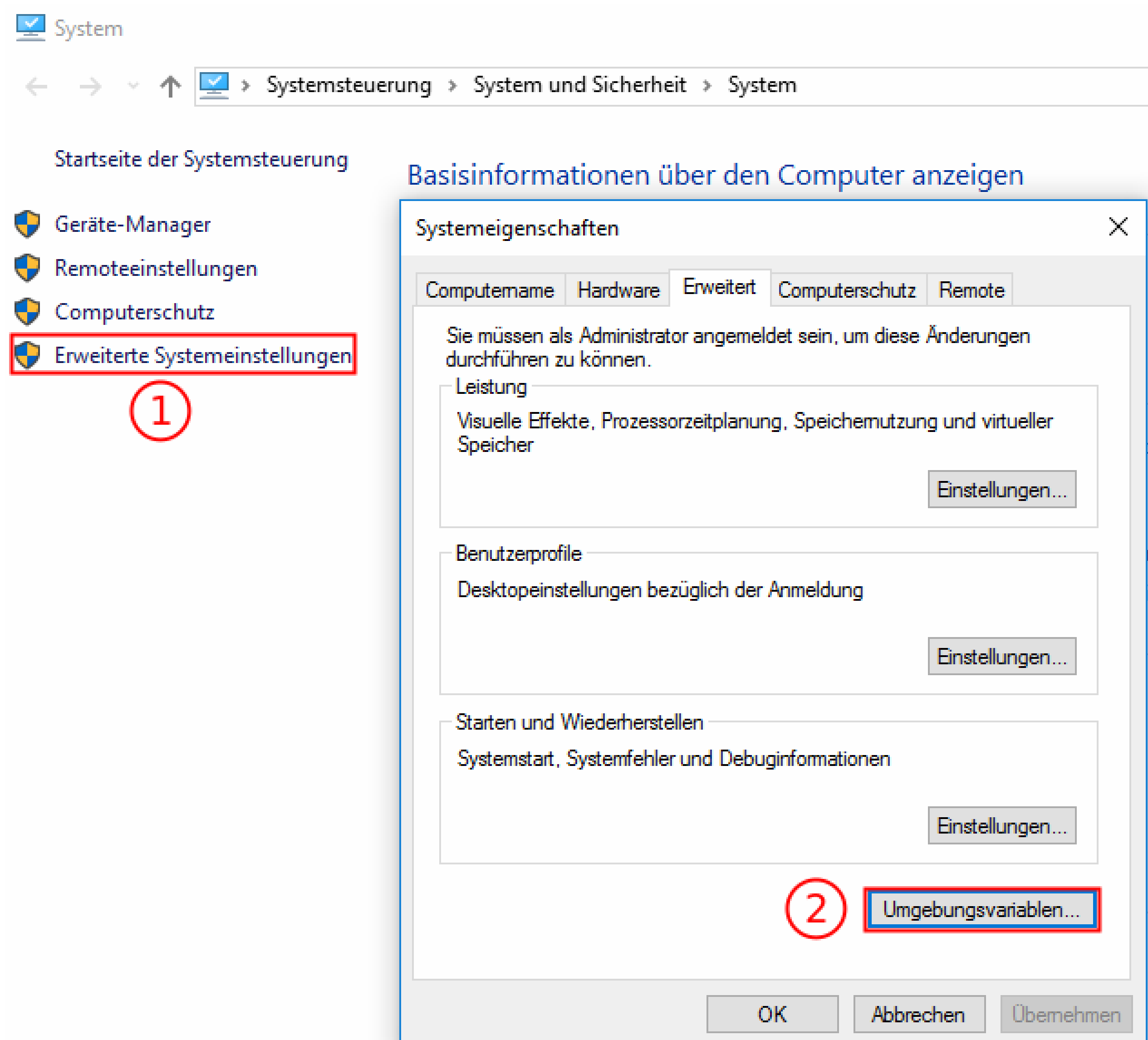
It is a gradle-${version}-all.zip, where ${version} is a placeholder for the current version.

Extract the contents of the downloaded zip file a new folder.

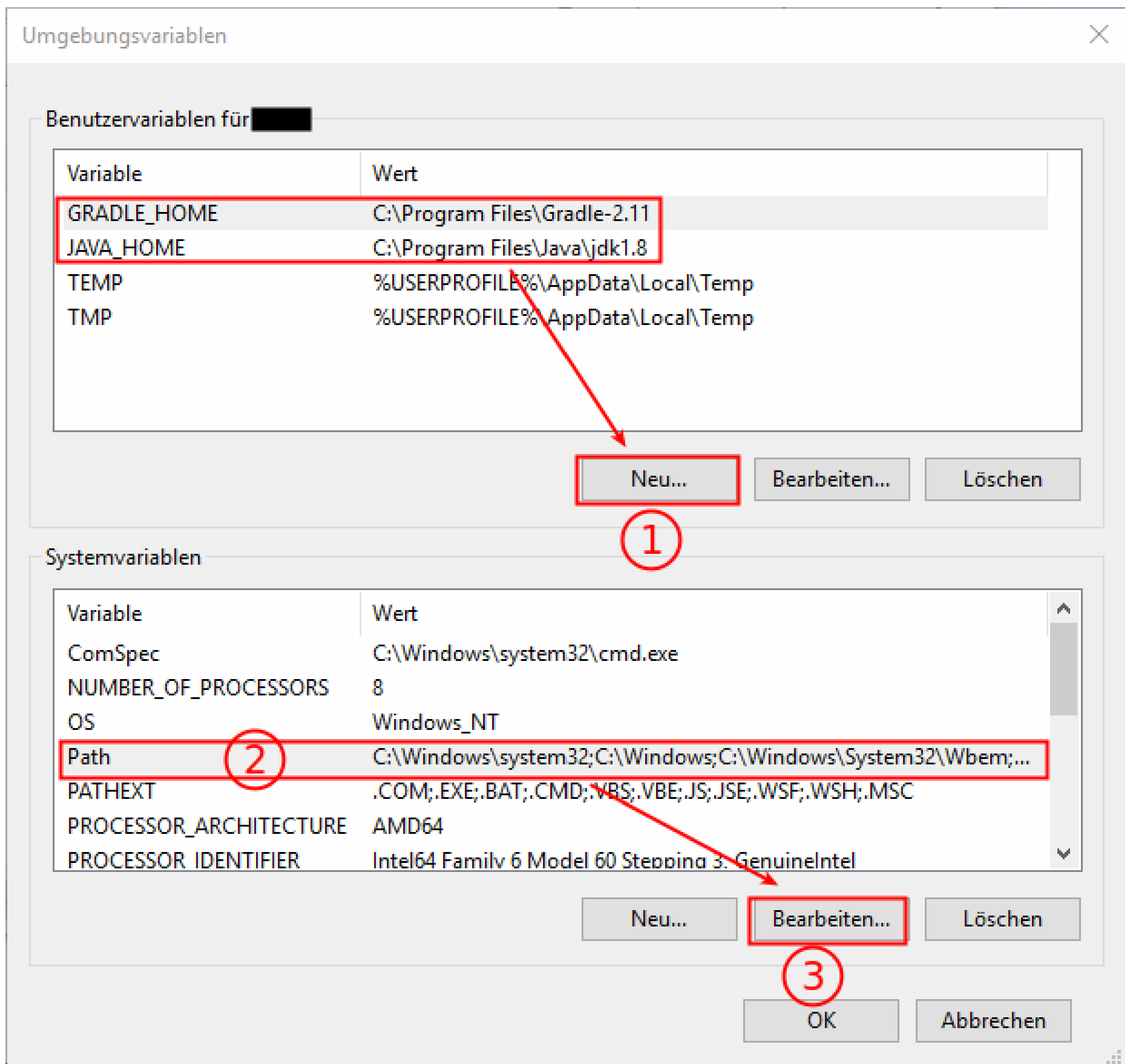
## 2.4. Installing Gradle on Windows

Add the folder to which you extracted Gradle to your `PATH` environment variable.

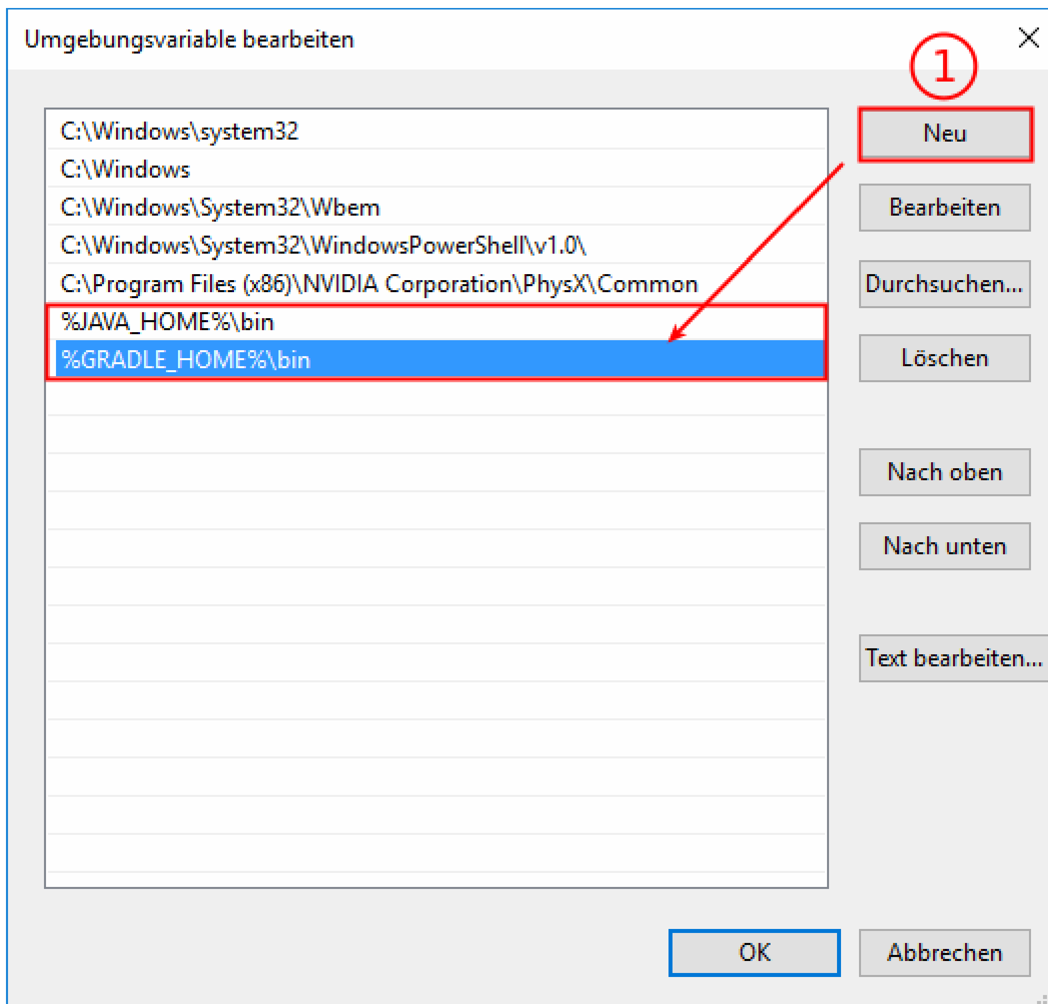
By pressing Win + Pause the system settings can be opened.




First the *Advanced System Settings* have to be selected and then the btn:[Environment Variables] button needs to be pressed.




In the *Environment Variables* dialog the (1) GRADLE_HOME and JAVA_HOME user variables should be set. After that the (2) Path entry in the *system variables* is selected, the btn:[modify] button can be pressed to add the *bin* folder of the Gradle installation to the Path.




## 2.5. Installing Gradle on Linux/Mac

### 2.5.1. Manual installation

The `JAVA_HOME` variable must point to a proper jdk and `$JAVA_HOME/bin` must be part of the PATH environment variable.

Add Gradle to the path by running `export PATH=/usr/local/gradle/FOLDER_TO_WHICH_YOU_EXTRACTED_GRADLE/bin:$PATH` in a terminal.

### 2.5.2. Installation with SDKMAN!

SDKMAN! is a command-line tool that allows you to install multiple Gradle versions and switch between them. It runs on any UNIX based operating system.

**Installing SDKMAN!**

You install it from the command-line. If you have already installed SDKMAN! you can skip this step.

```
curl -s "https://get.sdkman.io" | bash
```

After you’ve installed SDKMAN! you have to restart you terminal before using it.

**Installing Gradle and setting default version**

```
sdk install gradle 3.2
sdk default gradle 3.2
gradle -v
```

**Switching Gradle version**

```
sdk install gradle 2.13
# use 2.13 for current terminal session
sdk use gradle 2.13
gradle -v
```

#### 2.5.3. Check if Gradle installation was successful

Open a command line and type `gradle`, which will run Gradle's help task by default.

### 2.6. Using the Gradle daemon for improved startup time

Gradle allows to start Gradle as daemon to avoid starting the Java virtual machine for every build. To configure that create a file called *gradle.properties* in the *${HOME}/.gradle* and add the following line to it:

```
org.gradle.daemon=true
```

You can also place the *gradle.properties* file to the root directory of your project and commit it to your version control system.

If Gradle is not used for a few hours, the daemon stops automatically.

Executing gradle with the `--daemon` parameter on the command line starts the gradle daemon.

To stop the daemon interactively use the `gradle --stop` command.

### 2.7. Specify custom JVM settings for Gradle

The GRADLE_OPTS environment variable offers the opportunity to set specific JVM options for Gradle.

In Using the Gradle daemon for improved startup time the performance for the JVM startup is improved, but another performance killer for large builds can be a too small maximum heap space. Therefore it makes sense to increase it for Gradle.

`export GRADLE_OPTS=-Xmx1024m` defines that Gradle can use 1 GB as maximum heap size.

On Windows OS environment variables are usually defined via the system property UI.

If you want to set JVM settings not globally but on a per project basis you can place them in `<Your app folder>/gradle.properties`:

```
org.gradle.jvmargs=-Xms2g -Xmx4g -XX\:MaxHeapSize\=3g
```

### 2.8. Typical .gitignore file for Gradle projects

If you are using Git as version control system, you can use the following *.gitignore* file as template for a Gradle project.

```
# Android built artifacts
*.apk
*.ap_
*.dex

# Java build artifacts class files
*.class

# other generated files
bin/
gen/
build/

# local configuration file (for Android sdk path, etc)
local.properties

# OSX files
.DS_Store

# Eclipse project files
.classpath
.project

# Android Studio
*.iml
.idea
.gradle


#NDK
obj/
```

# 3. Exercise: Setup the Gradle Daemon

## 3.1. Target

In this exercise the Gradle Daemon will be configured, so that it starts automatically when a build is run.

## 3.2. Configuring the Gradle Daemon

When using the Gradle command the first time a *.gradle* folder is created in the ${USER_HOME} directory.

On Linux this is usually /home/${yourUserName}/.gradle On Windows this is usually C:\Users\${yourUserName}\.gradle

On Mac this is usually /Users/${yourUserName}/.gradle

Inside this *.gradle* folder a *gradle.properties* file with the following contents has to be created.

```
org.gradle.daemon=true
```

## 3.3. Validate

Open a command line and again run the `gradle` command.

This time the following message should not be present at the end of the build any more.

```
This build could be faster, please consider using the Gradle Daemon:
https://docs.gradle.org/2.11/userguide/gradle_daemon.html
```

# 4. Dependency management for Java projects

## 4.1. Managing dependencies with Gradle

Gradle allows managing the classpath of your projects. It can add JAR files, directories or other projects to the build path of your application. It also supports the automatic download of your Java library dependencies. Simply specify the dependency in your Gradle build file. This triggers Gradle to download the library including its transient dependencies during the build.

A Java library is identified by Gradle via its project's `groupId:artifactId:version` (also known as GAV in Maven). This GAV uniquely identifies a library in a certain version. You can use the Search Maven Website to search for the GAV of a library in Maven Central.

To add a dependency add an entry to the dependency section in your build.gradle file as demonstrated by the following listing.

```
dependencies {
    compile fileTree(dir: 'libs', include: ['*.jar'])
    compile 'com.squareup.okhttp:okhttp:2.5.0'
    testCompile 'junit:junit:4.12'

}
```

## 4.2. Specifying the repositories to search for dependencies

In your build file you specify the remote repositories to look for dependencies. Gradle supports Maven and Ivy repositories to search for dependencies. The following listing shows how to configure Maven central as dependency source.

```
repositories {
    mavenCentral()
}
```

It is also possible to configure the target as a URL.

```
repositories {
    maven {
        url "http://repo.mycompany.com/maven2"
    }
}
```

You can also specify other targets, for example Bintray as Maven repository.

```
repositories {
    maven ("http://jcenter.bintray.com/")
}
```

The next listing demonstrates how to define an Ivy dependency.

```
repositories {
    ivy {
        url "http://repo.mycompany.com/repo"
    }
```

```
}
```

You can also add different repositories at once.

```
repositories {
    maven ("https://repository-achartengine.forge.cloudbees.com/snapshot/")
    jcenter {
        url "http://jcenter.bintray.com/"
    }
}
```

You can also reference artifacts from the file system.

```
apply plugin: 'java'

repositories {
    mavenCentral()
}

dependencies {
    compile group: 'commons-collections', name: 'commons-collections', version:
'3.2'
    testCompile group: 'junit', name: 'junit', version: '4.+'
    runtime files('libs/library1.jar', 'libs/library2.jar')
    runtime fileTree(dir: 'libs', include: '*.jar')
    compile fileTree(dir: "${System.properties['user.home']}/libs/cargo",
include: '*.jar')
}
}
```

## 4.3. Show dependencies of a project (also transient dependencies) .

The following command shows all transient dependencies of a Gradle project.

```
gradle dependencies
```

https://mvnrepository.com allows also to search for an artifact and shows its direct dependencies.

## 4.4. Gradle cache and deleting the cache

You can refresh dependencies in your cache with the command line option `--refresh-dependencies`. You can also delete the cached files under *~/.gradle/caches*. With the next build Gradle attempts to download the dependencies again.

## 4.5. Excluding transitive dependencies

Sometimes you have dependencies on packages that define conflicting transitive dependencies. One solution is to exclude a dependency from a specific module:

```
compile 'org.springframework:spring-web:4.3.10.RELEASE' {
    exclude group: 'com.google.code.gson', module: 'gson'
}
```

If you have multiple dependency that define a dependency you want to exclude, you can do so at the project level:

```
configurations.all {
    exclude group: 'com.google.code.gson', module: 'gson'
```

```
}
```

Following the same approach we can exclude a dependency only during runtime:

```
configurations.runtime {
    exclude group: 'com.google.code.gson', module: 'gson'
}
```

### 4.6. Forcing a specific version of a transitive dependency

It is possible to force gradle to pick a specific version when it encounters conflicting transitive dependencies. Keep in mind that you might have to manually update this version when you are upgrading the packages that depend on it.

```
configurations.all {
    resolutionStrategy.force 'com.google.code.gson:gson:2.8.1'
}
```

## 5. Running a build

When starting a Gradle build via the command line, the `gradle` command tool looks for a file called `build.gradle` in the current directory.

Gradle also supports abbreviation of tasks, e.g,. to start the task `lars` using the `gradle l` command is sufficient. The abbreviation must uniquely identify a task, otherwise Gradle gives you an error message, which tell that the abbreviation is ambiguous. CamelCase can also be used for an abbreviation, e.g., the task `gradle vogellaCompany` can also be called with the `gradle vC` command.

A Gradle build can be triggered via the `gradle` or `gradle -q` command. The `-q` or `--quiet` parameter makes the execution of Gradle less verbose. A specific task can be addressed like this: `gradle -q other`, which runs the "other" task. You can of course also use the Gradle wrapper script, if that is avaiable.

To define a different build file the `-b buildFileName` option can be used.

In scenarios where no network connection is available the `--offline` parameter can be used. This runs the Gradle build offline, which means that Gradle does not try to reach resources from the network during a build. E.g., for dependencies from an artifact repository like Maven Central or Bintray.

To get a detailed output of what Gradle is doing you can specify the `--info` parameter.

## 6. Gradle Tasks

### 6.1. Default Gradle tasks

Gradle also offers tasks for introspection of Gradle itself, so a Gradle project can be analyzed by using Gradle’s default tasks.

A good example is the `tasks` task, which shows the available tasks of a project. When typing `gradle -q tasks`, a list of tasks is shown. This command lists the base tasks even without an `build.gradle` file.

```
simon@simon:~$ gradle -q tasks

------------------------------------------------------------
All tasks runnable from root project
------------------------------------------------------------

Build Setup tasks
-----------------
init - Initializes a new Gradle build. [incubating]
wrapper - Generates Gradle wrapper files. [incubating]

Help tasks
----------
components - Displays the components produced by root project 'simon'. [incubat
dependencies - Displays all dependencies declared in root project 'simon'.
dependencyInsight - Displays the insight into a specific dependency in root pro
help - Displays a help message.
model - Displays the configuration model of root project 'simon'. [incubating]
projects - Displays the sub-projects of root project 'simon'.
properties - Displays the properties of root project 'simon'.
tasks - Displays the tasks runnable from root project 'simon'.

To see all tasks and more detail, run gradle tasks --all

To see more detail about a task, run gradle help --task <task>
```

Gradle also tries to give some guidance for the usage of invoked tasks, as shown in the bottom of the console output. The `gradle tasks --all` command would also list dependent tasks, which are invoked before the actual task.

When running `gradle tasks --all` the output looks quite similar to the one before, except of the `init` task, which depends on the `wrapper` task.

## 6.2. Creating custom Gradle tasks

In the The Gradle build file - build.gradle section the first minimalist task in a `build.gradle` file has been created.

```
task hello {
    doLast {
        println 'Hello Gradle'
    }
}
```

When running the `gradle -q tasks` task with this `build.gradle` file, the `hello` task will be listed under "Other tasks".

```
Build Setup tasks
-----------------
init - Initializes a new Gradle build. [incubating]
wrapper - Generates Gradle wrapper files. [incubating]

Help tasks
----------
components - Displays the components produced by root project 'gradle'. [incubat
dependencies - Displays all dependencies declared in root project 'gradle'.
dependencyInsight - Displays the insight into a specific dependency in root proj
help - Displays a help message.
model - Displays the configuration model of root project 'gradle'. [incubating]
projects - Displays the sub-projects of root project 'gradle'.
properties - Displays the properties of root project 'gradle'.
tasks - Displays the tasks runnable from root project 'gradle'.

Other tasks  <------------  All tasks without group will be listed h
-----------
hello        No description for the hello task
```

Tasks without a group are considered as private tasks. For instance, the *Gradle Task View* of the Eclipse Gradle Plug-in does not show such tasks. But they can be shown by activating the right entry in the view's menu.

Groups can be applied with the `group` property and a description can be applied by using the `description` property. In case the group already exists the `hello` task is added to it. If the group does not exist, it is created.

```
task hello {
     group 'vogella'
     description 'The hello task greets Gradle by saying "Hello Gradle"'

     doFirst {
        println 'Hello Gradle'
     }
     doLast {
        println 'Bye bye Gradle'
     }
}
```

## 6.3. Task structure

Gradle has different phases, when working with tasks. First of all there is a configuration phase, where the code, which is specified directly in a task's closure, is executed. The configuration block is executed for every available task and not only for those tasks, which are later actually executed.

After the configuration phase, the execution phase then runs the code inside the `doFirst` or `doLast` closures of those tasks, which are actually executed.

```
task onlySpecifiesCodeForConfigurationPhase {
    group 'vogella'
    description 'Configuration phase task example.'

    println 'I always get printed even though, I am not invoked'
}
```

```
task anotherUnrelatedTask {
    doLast {
        println 'I am in the doLast execution phase'
    }
}
```

When running `gradle -q anotherUnrelatedTask` the following is printed:

```
I always get printed even though, I am not invoked
I am in the doLast execution phase
```

The first statement comes from the configuration phase in which the task definition of the `onlySpecifiesCodeForConfigurationPhase` is evaluated.

## 6.4. Task dependencies

Gradle allows the definition of default tasks in the build file. These are executed, if no other tasks are specified. Tasks can also define their dependencies. Both settings are demonstrated in the following build file.

```
defaultTasks 'clean', 'compile'

task clean {
    doLast {
        println 'Executing the clean task'
    }
}

task compile {
    doLast {
        println 'Executing the compile task'
    }
}

task other(dependsOn: 'compile') {
    doLast {
        println "I'm not a default task!"
    }
}

task cleanOther {
    doLast {
        println "I want to clean up before running!"
    }
}

cleanOther.dependsOn clean, compile
```

Hooking into predefined task executions for default tasks or tasks from plug-ins can also be done by using the `dependsOn` method.

For instance when certain things have to be done right after the compilation of java code:

```
apply plugin: 'java'

task invokedAfterCompileJava(dependsOn: 'compileJava')  {
    doLast {
        println 'This will be invoked right after the compileJava task is done'
    }
```

```
}
```

An alternative to creating a new task, which depends on the `'compileJava'` task, a new execution block can also be directly applied to an existing task, e.g., the `'compileJava'` task.

```
apply plugin: 'java'

compileJava.doFirst { println 'Another action applied to the "compileJava" task' }
compileJava.doLast { println 'Another doLast action is also applied' }
```

When running the javaCompile task all actions, which have been applied to the javaCompile task, are run one by one according to the order they have been applied to the task.

## 6.5. Skipping Tasks

Skipping tasks can be done by passing a predicate closure to the `onlyIf` method of a task or by throwing a `StopExecutionException`.

```
task eclipse {
    doLast {
        println 'Hello Eclipse'
    }
}

// #1st approach - closure returning true, if the task should be executed, false if not.
eclipse.onlyIf {
    project.hasProperty('usingEclipse')
}

// #2nd approach - alternatively throw an StopExecutionException() like this
eclipse.doFirst {
    if(!usingEclipse) {
        throw new StopExecutionException()
    }
}
```

Tasks depending on the eclipse task will be run even, if a `StopExecutionException` is thrown.

### 6.5.1. Accessing system variables like the user home directory

You can access system variables. For example, to get the user home directory use the following:

```
def homePath = System.properties['user.home']
```

# 7. Exercise: Gradle Tasks

## 7.1. Using the tasks Gradle task

The target of this exercise is to get an overview about the default tasks, which are delivered by default.

Open a command line and execute the following command:

```
gradle -q tasks
```

## 7.2. Using the help task

The target of this exercise is to make use of the `help` task to get more information about other tasks, e.g., the init task.

```
gradle -q help --task init
```

## 7.3. Create a Groovy project

The previous exercise informed about the usage of the init task.

```
gradle -q init --type groovy-library
```

# 8. Using the Gradle wrapper

The *Gradle wrapper* allows that a user can run the build with a predefined version and settings of Gradle without a local Gradle installation. This wrapper is a batch script on Windows, and a shell script for other operating systems. When you start a Gradle build via the wrapper, the specified version of Gradle is automatically downloaded and used to run the build.

The wrapper is the preferred way of starting a Gradle build, as it make the execution of the build independent of the installed Gradle version. The wrapper script can be created via `gradle wrapper`.

As a result you find a *gradlew* for *nix based systems and *gradlew.bat* for window systems. These files can be used instead for the `gradle` command, and if Gradle is not installed on the machine, Gradle is automatically downloaded and installed.

It is also possible to define a task which defines the version of the wrapper. If this task is executed, it creates the wrapper and downloads the correct version of Gradle.

```
task wrapper(type: Wrapper) {
    gradleVersion = '2.11'
}
```

The version of the Gradle Wrapper can also be defined, when creating it via the command line.

```
gradle wrapper --gradle-version 2.9
```

Without this explicit version parameter Gradle will automatically pick the latest version.

## 8.1. Configure GRADLE_OPTS for the Gradle wrapper

GRADLE_OPTS can also be defined inside the *gradlew* or *gradlew.bat* file.

```
#!/usr/bin/env bash

##############################################################################
##
##  Gradle start up script for UN*X
##
##############################################################################

# Add default JVM options here.
# You can also use JAVA_OPTS and GRADLE_OPTS to pass JVM options to this script.
```

```
DEFAULT_JVM_OPTS="-Xmx1024m"

#... {more lines}

@if "%DEBUG%" == "" @echo off
@rem ##########################################################################
@rem
@rem  Gradle startup script for Windows
@rem
@rem ##########################################################################

@rem Set local scope for the variables with windows NT shell
if "%OS%"=="Windows_NT" setlocal

@rem Add default JVM options here. You can also use JAVA_OPTS
# and GRADLE_OPTS to pass JVM options to this script.
set DEFAULT_JVM_OPTS=-Xmx1024m

@rem ... {more lines}
```

# 9. Exercise: Create Custom Gradle Tasks

## 9.1. Exercise: Specifying a Wrapper Task

Gradle's Wrapper Task can be implemented like this:

```
task wrapper(type: Wrapper) {
    gradleVersion = '2.11'
}
```

## 9.2. Exercise: Creating a Copy Task

The `Copy` task type can be used to specify a task, which is able to copy files.

Create a new project with the following *build.gradle* file:

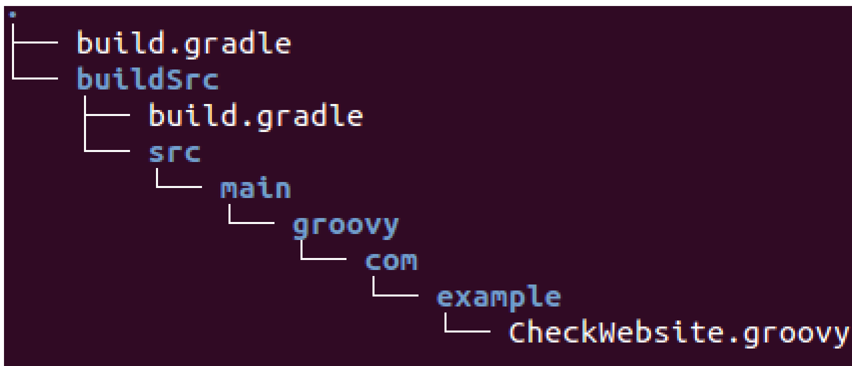
```
task copyFile(type: Copy) {
    from 'source'
    into 'destination'
}
```

Create a *source* folder inside this project and add a text file to this folder.

When running the `copyFile` task it copies the text file to a new *destination* folder.

## 9.3. Exercise: Specifying a custom Task in another gradle file

Create a new Gradle project, which contains the following structure.




The *CheckWebsite.groovy* class looks like this:

```
package com.example

import org.gradle.api.DefaultTask
import org.gradle.api.tasks.TaskAction

import java.io.IOException;

import org.jsoup.Jsoup;
import org.jsoup.nodes.Document;

class CheckWebsite extends DefaultTask {

    String url = 'www.vogella.com'

    @TaskAction
    void checkWebsite() {
        // check the given website by using the url
    try {
        Document doc = Jsoup.connect(url).get();
        String title = doc.title();
        println title
        println url
    } catch (IOException e) {
        e.printStackTrace();
    }
    }
}
```

Since this class has external dependencies to jsoup, a *build.gradle* file for this class has to be created.

So the *build.gradle* inside the *buildSrc* folder, which is responsible for building the `CheckWebsite` class, looks like this:

```
repositories {
   jcenter()
}

dependencies {
    compile 'org.jsoup:jsoup:1.8.3'
}
```

Finally the main *build.gradle* file in the root folder makes use of the new `com.example.CheckWebsite` task type.

```
task defaultWebsiteCheck(type: com.example.CheckWebsite)
```

```
task checkGradleWebsite(type: com.example.CheckWebsite) {
    url = 'https://docs.gradle.org/'
}

task wrapper(type: Wrapper) {
    gradleVersion = '2.9'
}
```

# 10. Exercise: Trigger Gradle build from Java code

This exercise describes how to trigger a gradle build from Java code.

## 10.1. Create new gradle projects

Create two new gradle projects with the names *BaseProject* (this project starts the gradle build) and *TargetProject* (this project is built by the BaseProject). Make sure the BaseProject applies the *java* plugin.

## 10.2. Add dependencies

Add the following dependency to the BaseProject.

```
compile 'org.gradle:gradle-tooling-api:4.0-rc-2'
```

## 10.3. Build TargetProject

Create a class named *Application* with a static main method like the following.

```
import java.io.File;

import org.gradle.tooling.BuildLauncher;
import org.gradle.tooling.GradleConnector;
import org.gradle.tooling.ProjectConnection;

public class Application {

    public static void main(String[] args) {
        ProjectConnection connection =
GradleConnector.newConnector().forProjectDirectory(new
File("path/to/targetproject")).connect();
        try {
            BuildLauncher build = connection.newBuild();
            build.forTasks("build");
            build.run();
        } catch (Exception e) {
            e.printStackTrace();
        } finally {
            connection.close();
        }
    }
}
```

This method first creates a *ProjectConnection* to the project that should be build and connects to it. Make sure to replace *path/to/targetproject* with the path of the TargetProject. From the project connection, a new *BuildLauncher* can be obtained. With the help of the method *forTasks()* you can specify the gradle tasks that should be executed. The BuildLauncher also provides some other

methods to configure the build. You can, for example, set gradle build arguments or change the Java version to build the project with. By calling the *run()* method the build is finally executed. Make sure to close the connection in the finally block.

# 11. Building Java projects

## 11.1. The Java plug-in

The Java plug-in provides tasks to compile Java source code, run unit tests, create Javadoc and create a JAR file.

## 11.2. Default project layout of Java projects

This plug-ins assume a certain setup of your Java project (similar to Maven).

- src/main/java contains the Java source code
- src/test/java contains the Java tests

If you follow this setup, the following build file is sufficient to compile, test and bundle a Java project.

```
apply plugin: 'java'
```

To start the build, type `gradle build` on the command line.

`SourceSets` can be used to specify a different project structure, e.g., the sources are stored in a *src* folder rather than in *src/main/java*.

```
apply plugin: 'java'

sourceSets {
    main {
         java {
              srcDir 'src'
              }
         }
    test {
         java {
              srcDir 'test'
              }
         }
}
```

## 11.3. Java project creation with the init task

Gradle does not yet support multiple project templates (called archetypes) like Maven. But it offers an `init` task to create the structure of a new Gradle project. Without additional parameters, this task creates a Gradle project, which contains the gradle wrapper files, a *build.gradle* and *settings.gradle* file.

When adding the `--type` parameter with `'java-library'` as value, a java project structure is created and the *build.gradle* file contains a certain Java template with JUnit.

```
simon@simon:~/gradle/init$ gradle init --type 'java-library'
:wrapper
:init

BUILD SUCCESSFUL

Total time: 2.161 secs

This build could be faster, please consider using the Gradle Daemon:
simon@simon:~/gradle/init$ tree
.
├── build.gradle
├── gradle
│   └── wrapper
│       ├── gradle-wrapper.jar
│       └── gradle-wrapper.properties
├── gradlew
├── gradlew.bat
├── settings.gradle
└── src
    ├── main
    │   └── java
    │       └── Library.java
    └── test
        └── java
            └── LibraryTest.java

7 directories, 8 files
```

The *build.gradle* file will look similar to this:

```
/*
 * ... deleted the generated text for brevity
 */

// Apply the java plugin to add support for Java
apply plugin: 'java'

// In this section you declare where to find the dependencies of your project
repositories {
    // Use 'jcenter' for resolving your dependencies.
    // You can declare any Maven/Ivy/file repository here.
    jcenter()
}

// In this section you declare the dependencies for your production and test
code
dependencies {
    // The production code uses the SLF4J logging API at compile time
    compile 'org.slf4j:slf4j-api:1.7.12'

    // Declare the dependency for your favourite test framework you want to use
    // TestNG is also supported by the Gradle Test task. Just change the
    // testCompile dependency to testCompile 'org.testng:testng:6.8.1' and add
    // 'test.useTestNG()' to your build script.
    testCompile 'junit:junit:4.12'
}
```

A project hosted at Github Gradle-templates project provides more templates beyond the init task. The Gradle team is also working on this archetype/template topic.

### 11.4. Specifying the Java version in your build file

Usually a Java project has a version and a target JRE on which it is compiled. The `version` and `sourceCompatibility` property can be set in the *build.gradle* file.

```
version = 0.1.0
sourceCompatibility = 1.8
```

When the `version` property is set, the name of the resulting artifact will be changed accordingly, e.g., *{my-lib-name}-0.1.0.jar*.

If the artifact is an executable java application the *MANIFEST.MF* file must be aware of the class with the main method.

```
apply plugin: 'java'

jar {
    manifest {
        attributes 'Main-Class': 'com.example.main.Application'
    }
}
```

## 12. Building Groovy projects

### 12.1. The Groovy plug-in

The Groovy plug-in for Gradle extends the Java plug-in and provides tasks for Groovy programs.

```
apply plugin: 'groovy'

repositories {
  mavenCentral()
}
dependencies {
    compile 'org.codehaus.groovy:groovy-all:2.4.5'
    testCompile 'junit:junit:4.12'
}
```

To start the build, type `gradle build` on the command line.

### 12.2. Default project layout of Groovy projects

This plug-ins assume a certain setup of your Groovy project.

- src/main/groovy contains the Groovy source code
- src/test/groovy contains the Groovy tests
- src/main/java contains the Java source code
- src/test/java contains the Java tests

If you follow this setup, the following build file is sufficient to compile, test and bundle a Groovy project.

# 13. Testing with Gradle

## 13.1. Test naming conventions for Gradle

If you are using the Gradle build system, the Gradle "test" task scans all compiled classes in the source folder of the project, e.g., */src/test/java* or */src/test/groovy*. JUnit classes are identified by:

- Class or a super class extends TestCase or GroovyTestCase
- Class or a super class is annotated with @RunWith
- Class or a super class contain a method annotated with @Test

You can set the `scanForTestClasses` property to false, if you do not want automatic test class detection. In this case, if no additional include / exclude patterns are specified, the default for included classes are **/Tests.class”, “/*Test.class” and the default excluded classes are “** */Abstract*.class”.

## 13.2. Include and Exclude particular Tests

The test configuration in general is described at Gradle Test tasks description.

The `Test` class has a `include` and `exclude` method. These methods can be used to specify, which tests should actually be run.

Only run included tests:

```
test {
    include '**my.package.name/*'
}
```

Skip excluded tests:

```
test {
    exclude '**my.package.name/*'
}
```

# 14. Building multiple projects with Gradle

## 14.1. Creating a multi project build structure

A business application usually does not consist of only one single project/module, but has many projects, which should be build.

Gradle has the concept of a root project, which can have many sub projects. The root project is specified by a *build.gradle* file, like the single projects before. To specify, which projects belong to the build a *settings.gradle* file is used.

For instance there might be this project structure:

- root_project
    - core
    - ui
    - util
- settings.gradle

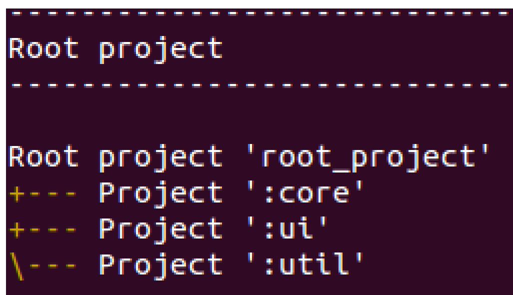
Having this project structure the *settings.gradle* file would look like this:

```
include 'core', 'ui', 'util'

# altenative way would be
#include 'core'
#include 'ui'
#include 'util'
```

Besides the `tasks` task Gradle also provides a `projects` help task, which can be run in the *root_project* folder.

```
> gradle projects
```




## 14.2. Specifying a general build configuration

In a *build.gradle* file in the root_project general configurations can be applied to all projects or just to the sub projects.

```
allprojects {
    group = 'com.example.gradle'
    version = '0.1.0'
}

subprojects {
    apply plugin: 'java'
    apply plugin: 'eclipse'
}
```

This specifies a common `com.example.gradle` group and the `0.1.0` version to all projects.

The `subprojects` closure applies common configurations for all sub projects, but not to the root project, like the `allprojects` closure does.

### 14.3. Project specific configurations and dependencies

The `core`, `ui` and `util` sub projects can also have their own *build.gradle* file. If they have specific needs, which are not already applied by the general configuration of the root project.

For instance the ui project usually has a dependency to the core project. So the ui project needs its own build.gradle file to specify this dependency.

```
dependencies {
    compile project(':core')
    compile 'log4j:log4j:1.2.17'
}
```

Project dependencies are specified with the project method.

The `':'` before the core project reference is Gradle specific and acts pretty much like a slash (`'/'`), when referencing a folder structure.

Alternatively you can also define the dependencies of a project in the root build.gradle file. But it is considered good practice to define the dependencies in the project specific build.gradle files, hence the following approach is only included for demonstration purpose.

```
allprojects {
 apply plugin: 'java'

 repositories {
  mavenCentral()
 }

}

project(':com.example.core').dependencies {
    compile project(':com.example.model')
    compile 'log4j:log4j:1.2.17'
}
```

## 15. Deployment with Gradle

### 15.1. How to deploy with Gradle

Gradle offers several ways to deploy build artifacts to artifact repositories, like Artifactory or Sonatype Nexus.

### 15.2. Using the maven-publish plugin

The most common way is to use the `maven-publish` plugin, which is provides by Gradle by default.

```
// other plug-ins
apply plugin: 'maven-publish'

publishing {
```

```
    publications {
        mavenJava(MavenPublication) {
            from components.java
        }
    }

    repositories {
        maven {
            url "$buildDir/repo"
        }
    }
}
```

There are several publish options, when the `java` and the `maven-publish` plugin is applied.

```
Publishing tasks
----------------
generatePomFileForMavenJavaPublication - Generates the Maven POM file for public
publish - Publishes all publications produced by this project.
publishMavenJavaPublicationToMavenLocal - Publishes Maven publication 'mavenJava
publishMavenJavaPublicationToMavenRepository - Publishes Maven publication 'mave
publishToMavenLocal - Publishes all Maven publications produced by this project
```

The deployment to a remote repository can be done like this:

```
apply plugin: 'groovy'
apply plugin: 'maven-publish'

group 'workshop'
version = '1.0.0'

publishing {
    publications {
        mavenJava(MavenPublication) { from components.java }
    }

    repositories {
        maven {
            // default credentials for a nexus repository manager
            credentials {
                username 'admin'
                password 'admin123'
            }
            // url to the releases maven repository
            url "http://localhost:8081/nexus/content/repositories/releases/"
        }
    }
}
```

More information about the deployment to a Maven artifact repository can be found here: Publish to Maven repository with Gradle.

# 16. Integration with Ant

Gradle supports running Ant tasks via the Groovy AntBuilder.

# 17. Convert Maven Projects to Gradle

Gradle provides an incubating [gradle_init_task], which helps with the creation of new Gradle projects. This task can also convert Apache Maven *pom.xml* files to Gradle build files, if all used Maven plug-ins are known to this task.

In this section the following *pom.xml* maven configuration will be converted to a Gradle project.

```
<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/xsd/maven-4.0.0.xsd">
    <modelVersion>4.0.0</modelVersion>
    <groupId>com.example.app</groupId>
    <artifactId>example-app</artifactId>
    <packaging>jar</packaging>
    <version>1.0.0-SNAPSHOT</version>
    <dependencies>
        <dependency>
            <groupId>junit</groupId>
            <artifactId>junit</artifactId>
            <version>4.11</version>
            <scope>test</scope>
        </dependency>
    </dependencies>
</project>
```

Running the `gradle init --type pom` command on the command line results in the following Gradle configuration.

```
simon@simon:~/gradle$ gradle init --type pom
:wrapper
:init
Maven to Gradle conversion is an incubating feature.

BUILD SUCCESSFUL

Total time: 3.145 secs

This build could be faster, please consider using the Gradle Daemon: https://do
simon@simon:~/gradle$ tree
.
├── build.gradle
├── gradle
│   └── wrapper
│       ├── gradle-wrapper.jar
│       └── gradle-wrapper.properties
├── gradlew
├── gradlew.bat
├── pom.xml
└── settings.gradle

2 directories, 7 files
```

The init task depends on the wrapper task so that also a Gradle wrapper is created.

The resulting *build.gradle* file looks similar to this:

```
apply plugin: 'java'
apply plugin: 'maven'

group = 'com.example.app'
version = '1.0.0-SNAPSHOT'

description = """"""

sourceCompatibility = 1.5
targetCompatibility = 1.5

repositories {
     maven { url "http://repo.maven.apache.org/maven2" }
}

dependencies {
    testCompile group: 'junit', name: 'junit', version:'4.11'
}
```

# 18. Developing custom Gradle plug-ins

## 18.1. Why creating Gradle plug-ins

As a general rule, it is useful to have a build that is as much declarative as possible as this simplifies future maintenance. Therefore it is advised to avoid complex code in your Gradle build file. If you need customer logic you should place it, into a custom Gradle plugin.

## 18.2. Gradle DSL

Each Gradle plug-in comes with a DSL. To see all properites of a Gradle object, you can use the following code snippet:

```
println variants.properties
            .sort{it.key}
            .collect{it}
            .findAll{!filtered.contains(it.key)}
            .join('\n')
```

For example to define a tasks which show the properties of all `android.applicationVariants` (in an Android project), use:

```
task showAndoidVariantsInformation {
    doLast {
        android.applicationVariants.all { variants ->
            println variants.properties
            .sort{it.key}
            .collect{it}
            .findAll{!filtered.contains(it.key)}
            .join('\n')
        }
    }
}
```

## 18.3. Example: Creating a simple Gradle plugin

To create a custom Gradle plug-in you have to create the following directories for your Gradle project. The Java or Groovy directory is only required if you want to use Java or Groovy for writing your plugin.

- projectroot/plugin/src/main/java
- projectroot/plugin/src/main/resources/META-INF/gradle-plugins
- projectroot/plugin/src/main/groovy

Change your main *build.gradle* build file to the following.

```
apply plugin: 'java'
apply plugin: 'maven'

dependencies {
    compile gradleApi()
}
```

Create a file *vogella.properties* in the *META-INF/gradle-plugins* folder. The name of the properties file defines your plugin name and its content points to the class which implements the plugin.

```
implementation-class=com.vogella.gradle.exampleplugin.MyPlugin
```

In the *plugin/src/main/java* folder create the following two classes.

```
package com.vogella.gradle.exampleplugin;

import org.gradle.api.Plugin;
import org.gradle.api.Project;

public class MyPlugin implements Plugin<Project> {

    @Override
    public void apply(Project target) {
        target.task("javaTask");
    }

}
```

```
package com.vogella.gradle.exampleplugin;

import org.gradle.api.DefaultTask;
import org.gradle.api.tasks.TaskAction;

public class MyTask extends DefaultTask {

    @TaskAction
    public void javaTask() {
        System.out.println("Hello from vogella task");
    }

}
```

In your *plugin* folder, create the following build.gradle file.

```
apply plugin: 'java'
apply plugin: 'maven'
```

```
dependencies {
    compile gradleApi()
}


repositories {
    mavenCentral()
}

dependencies {
    testCompile 'junit:junit:4.12'
}

group = 'com.vogella.gradle'
version = '1.0-SNAPSHOT'

uploadArchives {
    repositories {
        mavenDeployer {
        repository(url: mavenLocal().url)
        }
    }
}
```

In your *plugin* folder, create the following *settings.gradle* file.

```
rootProject.name = 'exampleplugin'
```

## 18.4. Example: Deploy your custom Gradle plug-in to your local Maven repository

Publish your Gradle plug-in to the Maven repo defined in your plugin/build.gradle file via the following command. We use the `clean` task to first delete the `/build` folder to remove old build artifacts. The `clean` task gets provided by the java plugin.

```
gradle clean uploadArchives --info
```

## 18.5. Example: Using your new plugin

To use your new plug-in, define a dependency to it and a task extending the defined task. If you pushed your plug-in to your local Maven repository, Gradle should find it and make it available.

```
buildscript {
     repositories {
         mavenLocal()
     }
 dependencies {
    classpath group: 'com.vogella.gradle',
               name: 'exampleplugin',
            version: '1.0-SNAPSHOT'
    }
 }

apply plugin: 'vogella'

task testing(type: com.vogella.gradle.exampleplugin.MyTask) {
    println("running consumer task!")
}
```

# 19. Using code analysis tools

Gradle provides several plugins for analyzing the code base of a Gradle project.

Table 1. Gradle Code Analysis Tools

| Tool | Plugin | Description |
|---|---|---|
| Checkstyle | checkstyle | Validates checkstyle rules, which are applied for a project |
| Jacoco | jacoco | Checks for test coverage of the code being built |
| FindBugs | findbugs | Static Code Analysis for Java |
| CodeNarc | codenarc | Static Code Analysis for Groovy |
| PMD | pmd | Adds code quality checks for several programming languages to the build |
| JDepend | jdepend | Another code analysis tool for analyzing dependencies in Java code |

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Eclipse Gradle tooling

Publish to Maven repositories

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