

Getting Started Building Docker Images with Gradle

1. Getting Started

In this Gradle Guide, you will learn how to build a simple Docker image using the [Gradle Docker Plugin](#).

1.1. What You'll Build

You will build a Java application that generates a simple **Dockerfile**, builds the Docker image and creates the Docker container. You will be using the Gradle Docker Plugin to achieve this goal.

1.2. What You'll Need

- A text editor or IDE such as [IntelliJ IDEA](#)
- A Java Development Kit (JDK), version 11+
- The latest version of [Docker](#)
- The latest [Gradle](#) distribution
- The [Docker Java](#) library



The Gradle Docker Plugin requires Gradle $\geq 7.4.0$.

1.3. Create a Project Folder

Gradle provides a built-in task, **init**, that initializes a new Gradle project in an empty folder. The **init** task also uses the built-in **wrapper** task to create a Gradle wrapper script, **gradlew**.

The first step is to create a folder for the new project and change directory into it.

```
$ mkdir demo
$ cd demo
```

1.4. Execute the **init** Task

From inside your new project directory, run the **init** task using the following command in a terminal:

```
$ gradle init
```

You will be presented with an interactive application to select various options. For this example application, select the options as shown in the output:

```
Starting a Gradle Daemon (subsequent builds will be faster)
```

```
Select type of project to generate:
```

- 1: basic
- 2: application
- 3: library
- 4: Gradle plugin

```
Enter selection (default: basic) [1..4] 2
```

```
Select implementation language:
```

- 1: C++
- 2: Groovy
- 3: Java
- 4: Kotlin
- 5: Scala
- 6: Swift

```
Enter selection (default: Java) [1..6] 3
```

```
Split functionality across multiple subprojects?:
```

- 1: no - only one application project
- 2: yes - application and library projects

```
Enter selection (default: no - only one application project) [1..2] 1
```

```
Select build script DSL:
```

- 1: Groovy
- 2: Kotlin

```
Enter selection (default: Groovy) [1..2] 1
```

```
Generate build using new APIs and behavior (some features may change in the next minor release)? (default: no) [yes,
```

```
Select test framework:
```

- 1: JUnit 4
- 2: TestNG
- 3: Spock
- 4: JUnit Jupiter

```
Enter selection (default: JUnit Jupiter) [1..4] 1
```

```
Project name (default: test-application):
```

```
Source package (default: test.application): org.gradle
```

```
> Task :init
```

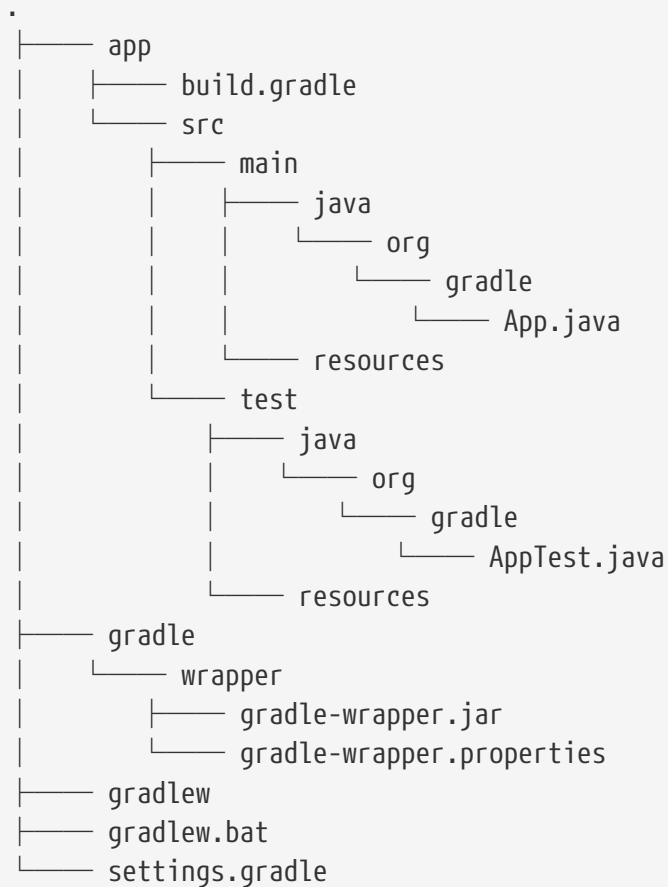
```
Get more help with your project:
```

```
https://docs.gradle.org/7.6/samples/sample\_building\_java\_applications.html
```

```
BUILD SUCCESSFUL in 1m 31s
```

```
2 actionable tasks: 2 executed
```

The `init` task generates the new project with the following structure:



14 directories, 8 files

1.5. Project Files

As you can see, the `init` task provides a comprehensive project complete with a basic application, `App.java`, and corresponding test, `AppTest.java`. However, this example application will primarily focus on building upon the `build.gradle` file as we will be working with Gradle Tasks. You will learn more about Gradle Tasks later in this guide.

The generated `build.gradle` file contains:

```

plugins {
    id 'application'
}

repositories {
    mavenCentral()
}

dependencies {
    testImplementation 'junit:junit:4.13.2'
    implementation 'com.google.guava:guava:31.1-jre'
}

application {
    mainClass = 'org.gradle.App'
}

```

1.6. Update the `build.gradle` File

Now that you have an application structure in place, let's build upon the `build.gradle` file that was generated by `gradle init` command.

First, you will need to import the required classes, which are Gradle Tasks, and place these statements at the very top of the `build.gradle` file:

```

import com.bmuschko.gradle.docker.tasks.DockerInfo
import com.bmuschko.gradle.docker.tasks.DockerVersion

import com.bmuschko.gradle.docker.tasks.container.DockerCreateContainer
import com.bmuschko.gradle.docker.tasks.container.DockerExecContainer
import com.bmuschko.gradle.docker.tasks.container.DockerStartContainer
import com.bmuschko.gradle.docker.tasks.container.DockerStopContainer

import com.bmuschko.gradle.docker.tasks.image.Dockerfile
import com.bmuschko.gradle.docker.tasks.image.DockerBuildImage
import com.bmuschko.gradle.docker.tasks.image.DockerListImages

```

You will need to provide additional plugins for this example application. You can do so by editing the `plugins` block:

```
plugins {  
    id 'java'  
    id 'application'  
    id 'java-gradle-plugin'  
    id 'com.bmuschko.docker-java-application' version '9.1.0'  
    id 'com.bmuschko.docker-remote-api' version '9.1.0'  
}
```

You will also need to provide additional dependencies for this example application. You can do so by editing the `dependencies` block:

```
dependencies {  
    testImplementation 'junit:junit:4.13.2'  
    implementation group: 'com.bmuschko', name: 'gradle-docker-plugin', version:  
'6.7.0'  
    implementation group: 'com.bmuschko', name: 'asciidoctorj-tabbed-code-extension',  
version: '0.3'  
}
```

Now that you have initially updated your `build.gradle` file, it's time to define the tasks.

2. Plugins

The Gradle Docker Plugin provides three specific-use plugins to create and build a Docker image:

- `DockerRemoteApiPlugin`
- `DockerJavaApplicationPlugin`
- `DockerSpringBootApplicationPlugin`

For our example application, you will be using the `DockerJavaApplicationPlugin` as described in the [Java Application Plugin](#) section of the user guide.

Details on use cases and corresponding details on all three of these plugins may be found in the [Provided Plugins](#) section of the Gradle Docker Plugin User Guide and Examples guide.

3. Tasks

A Gradle Task represents a single atomic piece of work for a Gradle build, such as compiling classes or generating JavaDocs. Tasks are comprised by series of actions as defined by implementations of the `Action` interface. Tasks are allowed to depend on other tasks.

You can create your own custom tasks by extending the `DefaultTask` class which implements the `Task` interface.

In the Getting Started section, you imported all the required Gradle Tasks for this example application.



Directly instantiating these classes is **not** supported. You can only instantiate them in the Gradle API or DSL, such as the `build.gradle` file. Attempting to directly instantiate these classes will result in an exception of type `TaskInstantiationException`.

3.1. Defined Tasks

Let's review a list of defined task names and their dependencies that you will use for the example application:

- `createMyAppDockerfile` generates a working `Dockerfile` file based on the template, `Dockefile.tpl`.
- `buildMyAppImage` builds the Docker image from the generated `Dockerfile`.
 - depends on `createMyAppDockerfile`
- `createMyAppContainer` creates the Docker container.
 - depends on `buildMyAppImage`
- `startMyAppContainer` starts the Docker container.
 - depends on `createMyAppContainer`
- `stopMyAppContainer`
- `executeMyAppContainer`
- `getMyDockerInfo`
- `getMyDockerVersion`
- `getMyDockerImageList`

You will be providing the definitions to all of these tasks within your `build.gradle` file as we review each one.

3.2. Dockerfile Template

As a starting point, you will need a Docker file template for this application. In the root directory of your project, create a file named `Dockerfile.tpl` and add the following comment:

```
# template for generated Dockerfile
```

3.3. Create the `Dockerfile` File

This task instantiates the `Dockerfile` class to generate a standard `Dockerfile` based on a template file, `Dockerfile.tpl` that you just created. You can add the following content to your `build.gradle` file:

```

task createMyAppDockerfile(type: Dockerfile) {
    instruction('FROM openjdk:11.0.15-jre-slim')
    instruction('LABEL maintainer=\\"Michael Redlich\\"')
    instruction('WORKDIR /app2')
    instruction('ENTRYPOINT ["java", "-Xms256m", "-Xmx2048m", "-cp",
"/app2/resources:/muDockerApp/classes:/app2/libs/*", "org.gradle.MainApp"]')
    instruction('EXPOSE 9090 5701')
    instruction('RUN ls -la')
    environmentVariable('JAVA_OPTS', '-XX:+UnlockExperimentalVMOptions
-XX:+UseCGroupMemoryLimitForHeap')
    instructionsFromTemplate(file('Dockerfile.tpl'))
}

```

There are three methods defined in this task:

- The `instruction()` method specifies Docker commands
- The `environmentalVariable()` method specifies any environmental variables
- The `instructionsFromTemplate()` method specifies the `Dockerfile.tpl` file as a template

3.4. Build the Docker Image

The `buildMyAppImage` task instantiates the `DockerBuildImage` class to build the Docker image. You can add the following content to your `build.gradle` file:

```

task buildMyAppImage(type: DockerBuildImage) {
    dependsOn(createMyAppDockerfile)
    inputDir.set(file('build/docker'))
    images.add('test/app2:latest')
}

```

There are three methods define in this task:

- The `dependsOn()` method specifies a task that should be executed before this task
- The `inputDir()` method specifies a location where to place the generated `Dockerfile`
- The `images.add()` method specifies the name of the Docker image

3.5. Create the Docker Container

The `createMyAppContainer` task instantiates the `DockerCreateContainer` class to create a Docker container. You can add the following content to your `build.gradle` file:

```
task createMyAppContainer(type: DockerCreateContainer) {  
    dependsOn(buildMyAppImage)  
    targetImageId(buildMyAppImage.getImageId())  
}
```

There are two methods defined in this task:

- The `dependsOn()` method specifies a task that should be execute before this task
- The `targetImageId()` method specifies a Docker image ID

3.6. Start the Docker Container

The `startMyAppContainer` task instantiates the `DockerStartContainer` class to start a Docker container. You can add the following content to your `build.gradle` file:

```
task startMyAppContainer(type: DockerStartContainer) {  
    dependsOn(createMyAppContainer)  
    targetContainerId(createMyAppContainer.getContainerId())  
}
```

There are two methods defined in this task:

- The `dependsOn()` method specifies a task that should be execute before this task
- The `targetContainerId()` method specifies the Docker image ID to use to start the Docker container

3.7. Stop the Docker Container

The `stopMyAppContainer` task instantiates the `DockerStopContainer` class to stop a running Docker container. You can add the following content to your `build.gradle` file:

```
task stopMyAppContainer(type: DockerStopContainer) {  
    targetContainerId(createMyAppContainer.getContainerId())  
}
```

There is only one method defined in this task:

- The `targetContainerId()` method specifies the Docker image ID to use to stop the running container

3.8. Execute the Docker Container

The `executeMyAppContainer` task instantiates the `DockerExecContainer` class to execute a Docker container. You can add the following content to your `build.gradle` file:


```
task executeMyAppContainer(type: DockerExecContainer) {  
    targetContainerId(createMyAppContainer.getContainerId())  
}
```

There is only one method defined in this task:

- The `targetContainerId()` method specifies the Docker image ID to use for executing a Docker container.

3.9. Obtain Information about Docker Installation

The `getMyDockerInfo` task instantiates the `DockerInfo` class to retrieve your local Docker installation. You can add the following content to your `build.gradle` file:

```
task getMyDockerInfo(type: DockerInfo) {  
}
```

There are no defined methods in this task, however, executing this task invokes the `runRemoteCommand()` method defined in the `DockerInfo` class.

3.10. Obtain the Docker Version

The `getMyDockerVersion` task instantiates the `DockerVersion` class to retrieve the version of your local Docker installation. You can add the following content to your `build.gradle` file:

```
task getMyDockerVersion(type: DockerVersion) {  
}
```

There are no defined methods in this task, however, executing this task invokes the `runRemoteCommand()` method defined in the `DockerVersion` class.

3.11. Obtain the List of Docker Images

The `getMyDockerImageList` task instantiates the `DockerListImages` class to retrieve a list of your local Docker images. You can add the following content to your `build.gradle` file:

```
task getMyDockerImageList(type: DockerListImages) {  
}
```

There are no defined methods in this task, however, executing this task invokes the `runRemoteCommand()` method defined in the `DockerListImages` class.

Now that you have added these tasks to your `build.gradle` file, it's time to exercise the example application!

4. Build and Execute the Application

Applications built with Gradle are launched using the `gradle` command along with built-in and user-defined tasks.

4.1. Execute Java Applications

While you won't be required to execute the `public static void main(String[] args)` method defined in the `App.java` file for this example application, you can see at least how this gets executed by issuing the following command:

```
$ gradle clean run --warning-mode all
```

The `warning-mode` flag is used for listing any deprecated Gradle features that may be incompatible with the upcoming release of Gradle 8.0.

The output will look like:

```
> Task :run
Getting Started Building Docker Images with Gradle

BUILD SUCCESSFUL in 1s
4 actionable tasks: 3 executed, 1 from cache
```

This displays the string, "Getting Started Building Docker Images with Gradle," defined in the `getGreeting()` method in `App.java` that generated using the `gradle init` command.

4.2. Execute Tasks

This example application was designed to initiate the `startMyAppContainer` task and allow the dependency tasks to be executed first, but let's individually execute those task dependencies.

4.2.1. `createMyAppDockerfile`

```
$ gradle clean createMyAppDockerfile
```

The only output is verification that the task successfully completed:

```
BUILD SUCCESSFUL in 540ms
2 actionable tasks: 1 executed, 1 from cache
```

However, a `Dockerfile` was quietly generated based on the `Dockerfile.tpl` template. You can find the generated `Dockerfile` file in the `/build/docker` folder.

Let's take a look:

```
FROM openjdk:11.0.15-jre-slim
LABEL maintainer="Michael Redlich"
WORKDIR /app2
ENTRYPOINT ["java", "-Xms256m", "-Xmx2048m", "-cp",
"/app2/resources:/muDockerApp/classes:/app2/libs/*", "org.gradle.MainApp"]
EXPOSE 9090 5701
RUN ls -la
ENV JAVA_OPTS="-XX:+UnlockExperimentalVMOptions -XX:+UseCGroupMemoryLimitForHeap"
# template for generated Dockerfile
```

Notice how the Docker commands were prepended on top of the original comment, **# template for generated Dockerfile**.

4.2.2. buildMyAppImage

Now you can execute the **buildMyAppImage** task:

```
$ gradle clean buildMyAppImage
```

Keep in mind that this task depends on the **createMyAppDockerfile** that you just executed, so the **Dockerfile** will once-again be generated.

Let's review the output:

```
> Task :buildMyAppImage
Building image using context '/usr/local/apps/gradle-apps/getting-started-building-
docker-images-with-gradle/build/docker'.
Using images 'test/app2:latest'.
Step 1/7 : FROM openjdk:11.0.15-jre-slim
---> 699c24828c34
Step 2/7 : LABEL maintainer="Michael Redlich"
---> Using cache
---> c7f43ff98289
Step 3/7 : WORKDIR /app2
---> Using cache
---> 7eb1b1aaa358
Step 4/7 : ENTRYPOINT ["java", "-Xms256m", "-Xmx2048m", "-cp",
"/app2/resources:/muDockerApp/classes:/app2/libs/*", "org.gradle.MainApp"]
---> Using cache
---> 7a6087ee375c
Step 5/7 : EXPOSE 9090 5701
---> Using cache
---> c2752b3bb2be
Step 6/7 : RUN ls -la
---> Using cache
---> 8b5c28802e00
Step 7/7 : ENV JAVA_OPTS="-XX:+UnlockExperimentalVMOptions
-XX:+UseCGroupMemoryLimitForHeap"
---> Using cache
---> c2f34a8c1df6
Successfully built c2f34a8c1df6
Successfully tagged test/app2:latest
Created image with ID 'c2f34a8c1df6'.

BUILD SUCCESSFUL in 1s
3 actionable tasks: 2 executed, 1 from cache
```

You can verify creation of the new image by executing the **docker** command:

```
$ docker images
```

Let's review the output:

test/app2		latest	c2f34a8c1df6	
28 hours ago	227MB			
test/app		latest	13e86aa2705c	
29 hours ago	227MB			
test/myapp		latest	ec013200a08d	
42 hours ago	426MB			
mongo		latest	0850fead9327	4
weeks ago	700MB			
cassandra		latest	5b647422e184	2
months ago	353MB			
arangodb/arangodb		latest	d81cf81aaa4b	3
months ago	440MB			
jakartaee-cafe		v1	f03eac10057c	3
months ago	484MB			

4.2.3. createMyAppContainer

Now, let's execute the `createMyAppContainer` task:

```
$ gradle clean createMyAppContainer
```

Again, keep in mind that this task depends on the `buildMyAppImage` task.

Let's review the output:

```
> Task :createMyAppContainer
Created container with ID
'ea83da3cc17681424105d4c3602789b858cb0daee45b40efd2d36bac1b22f59c'.

BUILD SUCCESSFUL in 1s
4 actionable tasks: 3 executed, 1 from cache
```

4.2.4. startMyAppContainer

Now let's run the entire process by executing the `startMyAppContainer` task that executes all the dependencies:

```
$ gradle clean startMyAppContainer
```

Let's review the output:

```
> Task :startMyAppContainer
Starting container with ID
'0f150837001528439c9957b7b077b3d85be25fd86b98c3f491044f0a65083e29'.

BUILD SUCCESSFUL in 2s
5 actionable tasks: 4 executed, 1 from cache
```

The next few tasks may be executed independently from the `startMyAppContainer` task.

4.2.5. `getMyDockerVersion`

```
$ gradle getMyDockerVersion
```

```
> Task :getMyDockerVersion
Retrieving Docker version.
Version          : 20.10.21
Git Commit       : 3056208
Go Version       : go1.18.7
Kernel Version   : 5.15.49-linuxkit
Architecture     : amd64
Operating System : linux

BUILD SUCCESSFUL in 1s
1 actionable task: 1 executed
```

4.2.6. `getMyDockerInfo`

```
$ gradle getMyDockerInfo
```

```

> Task :getMyDockerInfo
Retrieving Docker info.
Debug                : false
Containers           : 25
Driver               : overlay2
Driver Statuses      : [[Backing Filesystem, extfs], [Supports d_type, true], [Native
Overlay Diff, true], [userxattr, false]]
Images               : 53
IPv4 Forwarding      : true
Index Server Address : https://index.docker.io/v1/
Init Path            : null
Init SHA1            : null
Kernel Version       : 5.15.49-linuxkit
Sockets              : null
Memory Limit         : true
nEvent Listener      : 4
NFd                  : 46
NGoroutines          : 49
Swap Limit           : true
Execution Driver      : null

BUILD SUCCESSFUL in 1s
1 actionable task: 1 executed

```

4.2.7. `getMyDockerImageList`

```
$ gradle getMyDockerImageList
```

```

> Task :getMyDockerImageList
Repository Tags : test/app2:latest
Image ID       :
sha256:c2f34a8c1df67b413537f9d706c85724bec78cfcaa85374194b10fda76e2fbae
Created        : Sun Jan 08 10:41:03 EST 2023
Virtual Size   : 227459049
-----
Repository Tags : test/app:latest
Image ID       :
sha256:13e86aa2705c759b869ecc3c4de2e3d3a0c44cd13e7d1fa573693e34ebcbefdf
Created        : Sun Jan 08 09:25:07 EST 2023
Virtual Size   : 227459049
-----
Repository Tags : test/myapp:latest
Image ID       :
sha256:ec013200a08d606abdf922e4941d5d557ed7a1718ad0a7f83a32e236503a70f4
Created        : Sat Jan 07 20:14:53 EST 2023
Virtual Size   : 425724205
-----

```

```

Repository Tags : mongo:latest
Image ID       :
sha256:0850fead9327a6d88722c27116309022d78e9daf526b407a88de09762c32e620
Created        : Thu Dec 08 21:37:35 EST 2022
Virtual Size   : 699901543
-----
Repository Tags : cassandra:latest
Image ID       :
sha256:5b647422e184fb0fd8f6d5513541e85c06876bdaa68decc026abcb65c3fe4ec5
Created        : Fri Nov 04 19:47:02 EDT 2022
Virtual Size   : 353334938
-----
Repository Tags : arangodb/arangodb:latest
Image ID       :
sha256:d81cf81aaa4b1b637874eab9b877e34dcdee97a00800aaece837fd3d32f7eb56
Created        : Thu Sep 29 10:22:06 EDT 2022
Virtual Size   : 439791606
-----
Repository Tags : jakartaee-cafe:v1
Image ID       :
sha256:f03eac10057c875306561572ce9ce338aa14f4d73917689ec911e891d0a9ce4d
Created        : Tue Sep 13 13:38:25 EDT 2022
Virtual Size   : 484008628
-----
Repository Tags : openjdk:11.0.15-jre-slim
Image ID       :
sha256:699c24828c341c27d15a4f62b5c8fa3c5c986bf52fa76228906c50634f430311
Created        : Mon Jul 11 22:00:45 EDT 2022
Virtual Size   : 227459049
-----

BUILD SUCCESSFUL in 1s
1 actionable task: 1 executed

```

5. Summary

That's it! You've now successfully configured and built a Java application project with Gradle. You've learned how to:

- Initialize a Java project using the **gradle init** command
- Add additional plugins and dependencies in the generated **build.gradle** file
- Define custom tasks that apply the classes defined within the Gradle Docker Plugin
- Build and run the application

6. Next Steps

If you are interested in learning more, please visit these resources.

6.1. Resources

- JavaDocs: [Gradle Docker Plugin](#)
- User Guide: [Gradle Docker Plugin User Guide and Examples](#)
- User Guide: [Java Application Plugin](#) for this example application.
- [Gradle Plugin Portal](#)
- Documentation: [Using Gradle Plugins](#)