# Kotlin / Android Studio 3.0 Development Essentials

Android 8 Edition

Kotlin / Android Studio 3.0 Development Essentials – Android 8 Edition



Rev: 1.0

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Chapter 1

# 1. Introduction

Fully updated for Android Studio 3.0 and Android 8, the goal of this book is to teach the skills necessary to develop Android based applications using the Android Studio Integrated Development Environment (IDE), the Android 8 Software Development Kit (SDK) and the Kotlin programming language.

Beginning with the basics, this book provides an outline of the steps necessary to set up an Android development and testing environment followed by an introduction to programming in Kotlin including data types, flow control, functions, lambdas and object-oriented programming.

An overview of Android Studio is included covering areas such as tool windows, the code editor and the Layout Editor tool. An introduction to the architecture of Android is followed by an in-depth look at the design of Android applications and user interfaces using the Android Studio environment. More advanced topics such as database management, content providers and intents are also covered, as are touch screen handling, gesture recognition, camera access and the playback and recording of both video and audio. This edition of the book also covers printing, transitions and cloud-based file storage.

The concepts of material design are also covered in detail, including the use of floating action buttons, Snackbars, tabbed interfaces, card views, navigation drawers and collapsing toolbars.

In addition to covering general Android development techniques, the book also includes Google Play specific topics such as implementing maps using the Google Maps Android API, and submitting apps to the Google Play Developer Console.

Other key features of Android Studio 3 and Android 8 are also covered in detail including the Layout Editor, the ConstraintLayout and ConstraintSet classes, constraint chains and barriers, direct reply notifications and multi-window support.

Chapters also cover advanced features of Android Studio such as App Links, Instant Apps, the Android Studio Profiler and Gradle build configuration.

Assuming you already have some programming experience, are ready to download Android Studio and the Android SDK, have access to a Windows, Mac or Linux system and ideas for some apps to develop, you are ready to get started.

## 1.1 Downloading the Code Samples

The source code and Android Studio project files for the examples contained in this book are available for download at:

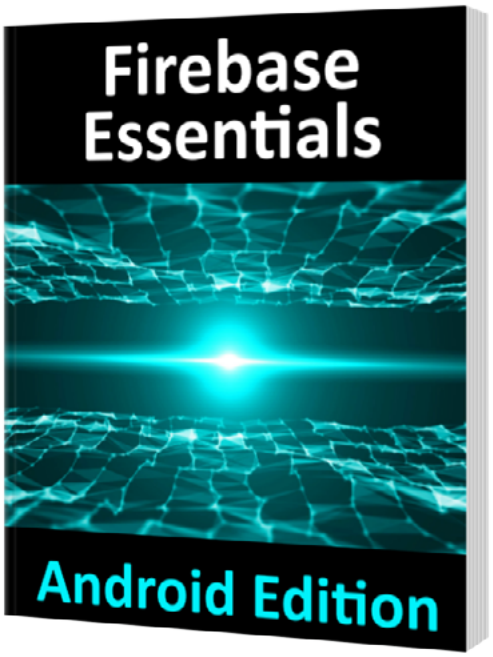
*http://www.ebookfrenzy.com/retail/as30kotlin/index.php*

The steps to load a project from the code samples into Android Studio are as follows:

1. From the Welcome to Android Studio dialog, select the Open an existing Android Studio project option.
2. In the project selection dialog, navigate to and select the folder containing the project to be imported and click on OK.

## 1.2 Firebase Essentials Book Now Available

*Firebase Essentials - Android Edition*, a companion book to Android Studio Development Essentials provides everything you need to successfully integrate Firebase cloud features into your Android apps.




The Firebase Essentials book covers the key features of Android app development using Firebase including integration with Android Studio, User Authentication (including email, Twitter, Facebook and phone number sign-in), Realtime Database, Cloud Storage, Firebase Cloud Messaging (both upstream and downstream), Dynamic Links, Invites, App Indexing, Test Lab, Remote Configuration, Cloud Functions, Analytics and Performance Monitoring.

Find out more at *https://goo.gl/5F381e*.

## 1.3 Feedback

We want you to be satisfied with your purchase of this book. If you find any errors in the book, or have any comments, questions or concerns please contact us at *feedback@ebookfrenzy.com*.

## 1.4 Errata

While we make every effort to ensure the accuracy of the content of this book, it is inevitable that a book covering a subject area of this size and complexity may include some errors and oversights. Any known issues with the book will be outlined, together with solutions, at the following URL:

*http://www.ebookfrenzy.com/errata/as30kotlin.html*

In the event that you find an error not listed in the errata, please let us know by emailing our technical support team at *feedback@ebookfrenzy.com*. They are there to help you and will work to resolve any problems you may encounter.

Chapter 2

# 2. Setting up an Android Studio Development Environment

Before any work can begin on the development of an Android application, the first step is to configure a computer system to act as the development platform. This involves a number of steps consisting of installing the Android Studio Integrated Development Environment (IDE) which also includes the Android Software Development Kit (SDK), the Kotlin plug-in and OpenJDK Java development environment.

This chapter will cover the steps necessary to install the requisite components for Android application development on Windows, macOS and Linux based systems.

## 2.1 System Requirements

Android application development may be performed on any of the following system types:

- Windows 7/8/10 (32-bit or 64-bit)
- macOS 10.10 or later (Intel based systems only)
- Linux systems with version 2.19 or later of GNU C Library (glibc)
- Minimum of 3GB of RAM (8GB is preferred)
- Approximately 4GB of available disk space
- 1280 x 800 minimum screen resolution

## 2.2 Downloading the Android Studio Package

Most of the work involved in developing applications for Android will be performed using the Android Studio environment. The content and examples in this book were created based on Android Studio version 3.0 which, at the time writing is the current version.

Android Studio is, however, subject to frequent updates so a newer version may have been released since this book was published.

The latest release of Android Studio may be downloaded from the primary download page which can be found at the following URL:

*https://developer.android.com/studio/index.html*

If this page provides instructions for downloading a newer version of Android Studio it is important to note that there may be some minor differences between this book and the software. A web search for Android Studio 3.0 should provide the option to download the older version in the event that these differences become a problem.

## 2.3 Installing Android Studio

Once downloaded, the exact steps to install Android Studio differ depending on the operating system on which the installation is being performed.

### 2.3.1 Installation on Windows

Locate the downloaded Android Studio installation executable file (named *android-studio-bundle-<version>.exe*) in a Windows Explorer window and double-click on it to start the installation process, clicking the *Yes* button in the User Account Control dialog if it appears.

Once the Android Studio setup wizard appears, work through the various screens to configure the installation to meet your requirements in terms of the file system location into which Android Studio should be installed and whether or not it should be made available to other users of the system. When prompted to select the components to install, make sure that the *Android Studio*, *Android SDK* and *Android Virtual Device* options are all selected.

Although there are no strict rules on where Android Studio should be installed on the system, the remainder of this book will assume that the installation was performed into *C:\Program Files\Android\Android Studio* and that the Android SDK packages have been installed into the user's *AppData\Local\Android\sdk* sub-folder. Once the options have been configured, click on the *Install* button to begin the installation process.

On versions of Windows with a Start menu, the newly installed Android Studio can be launched from the entry added to that menu during the installation. The executable may be pinned to the task bar for easy access by navigating to the *Android Studio\bin* directory, right-clicking on the executable and selecting the *Pin to Taskbar* menu option. Note that the executable is provided in 32-bit (*studio*) and 64-bit (*studio64*) executable versions. If you are running a 32-bit system be sure to use the *studio* executable.

### 2.3.2 Installation on macOS

Android Studio for macOS is downloaded in the form of a disk image (.dmg) file. Once the *android-studio-ide-<version>.dmg* file has been downloaded, locate it in a Finder window and double-click on it to open it as shown in Figure 2-1:


Figure 2-1

To install the package, simply drag the Android Studio icon and drop it onto the Applications folder. The Android Studio package will then be installed into the Applications folder of the system, a process which will typically take a few minutes to complete.

To launch Android Studio, locate the executable in the Applications folder using a Finder window and double-click on it.

For future easier access to the tool, drag the Android Studio icon from the Finder window and drop it onto the dock.

### 2.3.3 Installation on Linux

Having downloaded the Linux Android Studio package, open a terminal window, change directory to the location where Android Studio is to be installed and execute the following command:

```
unzip /<path to package>/android-studio-ide-<version>-linux.zip
```

Note that the Android Studio bundle will be installed into a sub-directory named *android-studio*. Assuming, therefore, that the above command was executed in */home/demo*, the software packages will be unpacked into */home/demo/android-studio*.

To launch Android Studio, open a terminal window, change directory to the *android-studio/bin* sub-directory and execute the following command:

```
./studio.sh
```

When running on a 64-bit Linux system, it will be necessary to install some 32-bit support libraries before Android Studio will run. On Ubuntu these libraries can be installed using the following command:

```
sudo apt-get install libc6:i386 libncurses5:i386 libstdc++6:i386 lib32z1 libbz2-1.0:i386
```

On RedHat and Fedora based 64-bit systems, use the following command:

```
sudo yum install zlib.i686 ncurses-libs.i686 bzip2-libs.i686
```

## 2.4 The Android Studio Setup Wizard

The first time that Android Studio is launched after being installed, a dialog will appear providing the option to import settings from a previous Android Studio version. If you have settings from a previous version and would like to import them into the latest installation, select the appropriate option and location. Alternatively, indicate that you do not need to import any previous settings and click on the OK button to proceed.

Next, the setup wizard may appear as shown in Figure 2-2 though this dialog does not appear on all platforms:

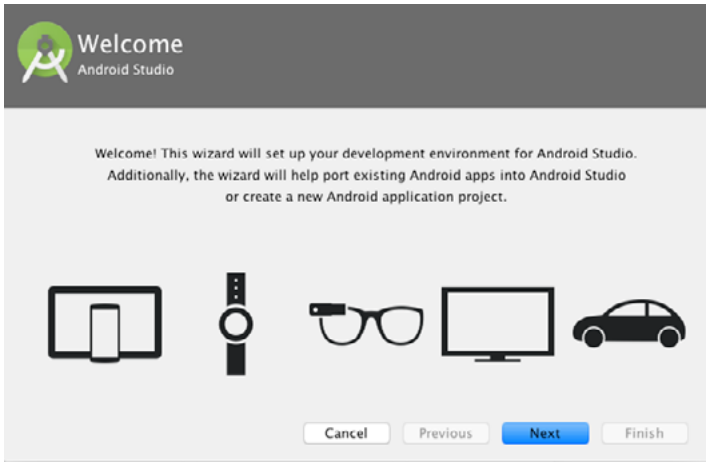



Figure 2-2

If the wizard appears, click on the Next button, choose the Standard installation option and click on Next once again.

Android Studio will proceed to download and configure the latest Android SDK and some additional components and packages. Once this process has completed, click on the *Finish* button in the *Downloading Components* dialog at which point the Welcome to Android Studio screen should then appear:

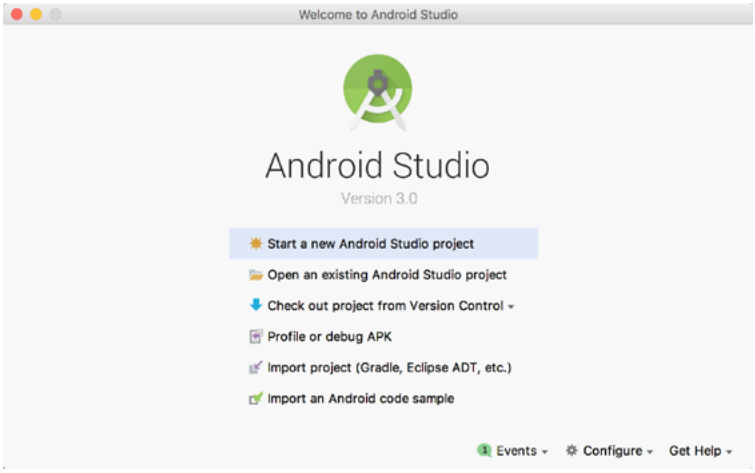



Figure 2-3

## 2.5 Installing Additional Android SDK Packages

The steps performed so far have installed Java, the Android Studio IDE and the current set of default Android SDK packages. Before proceeding, it is worth taking some time to verify which packages are installed and to install any missing or updated packages.

This task can be performed using the *Android SDK Settings* screen, which may be launched from within the Android Studio tool by selecting the *Configure -> SDK Manager* option from within the Android Studio welcome dialog. Once invoked, the *Android SDK* screen of the default settings dialog will appear as shown in Figure 2-4:

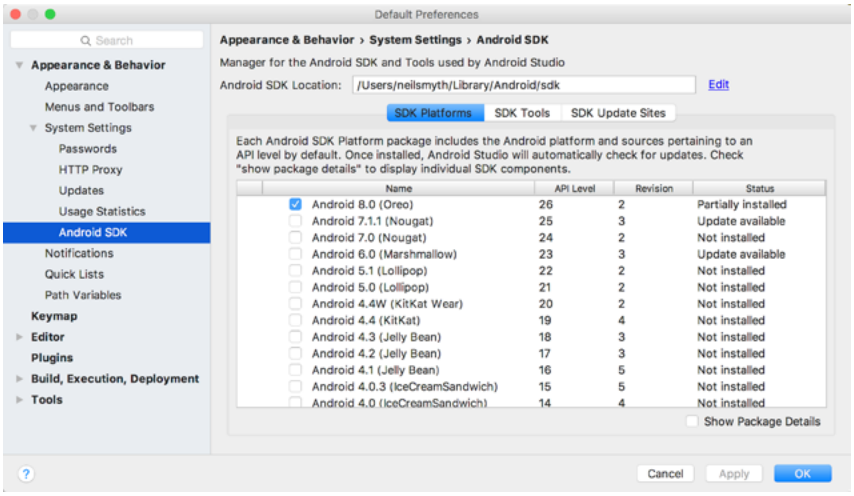



Figure 2-4

Immediately after installing Android Studio for the first time it is likely that only the latest released version of the Android SDK has been installed. To install older versions of the Android SDK simply select the checkboxes corresponding to the versions and click on the *Apply* button.

It is also possible that updates will be listed as being available for the latest SDK. To access detailed information about the packages that are available for update, enable the *Show Package Details* option located in the lower right-hand corner of the screen. This will display information similar to that shown in Figure 2-5:

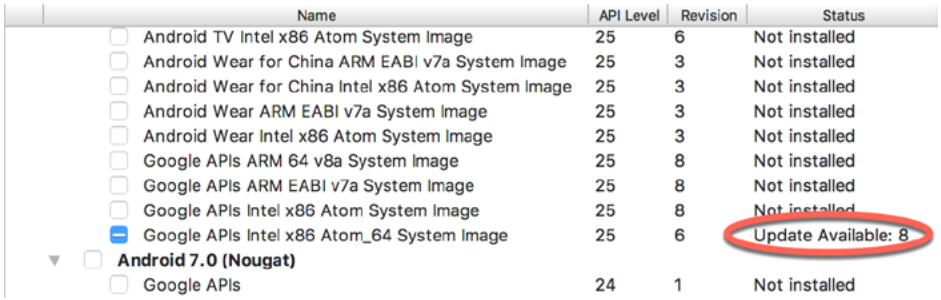



Figure 2-5

The above figure highlights the availability of an update. To install the updates, enable the checkbox to the left of the item name and click on the *Apply* button.

In addition to the Android SDK packages, a number of tools are also installed for building Android applications. To view the currently installed packages and check for updates, remain within the SDK settings screen and select the SDK Tools tab as shown in Figure 2-6:

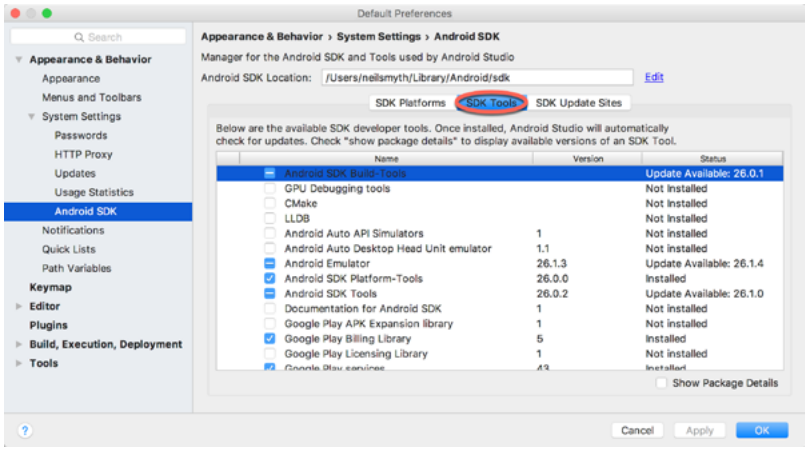



Figure 2-6

Within the Android SDK Tools screen, make sure that the following packages are listed as *Installed* in the Status column:

- Android SDK Build-tools
- Android Emulator
- Android SDK Platform-tools
- Android SDK Tools
- Google Play Services
- Instant Apps Development SDK
- Intel x86 Emulator Accelerator (HAXM installer)
- ConstraintLayout for Android

- Solver for ConstraintLayout
- Android Support Repository
- Google Repository
- Google USB Driver (Windows only)

In the event that any of the above packages are listed as *Not Installed* or requiring an update, simply select the checkboxes next to those packages and click on the *Apply* button to initiate the installation process.

Once the installation is complete, review the package list and make sure that the selected packages are now listed as *Installed* in the *Status* column. If any are listed as *Not installed,* make sure they are selected and click on the *Apply* button again.

## 2.6 Making the Android SDK Tools Command-line Accessible

Most of the time, the underlying tools of the Android SDK will be accessed from within the Android Studio environment. That being said, however, there will also be instances where it will be useful to be able to invoke those tools from a command prompt or terminal window. In order for the operating system on which you are developing to be able to find these tools, it will be necessary to add them to the system's *PATH* environment variable.

Regardless of operating system, the PATH variable needs to be configured to include the following paths (where *<path_to_android_sdk_installation>* represents the file system location into which the Android SDK was installed):

```
<path_to_android_sdk_installation>/sdk/tools
<path_to_android_sdk_installation>/sdk/tools/bin
<path_to_android_sdk_installation>/sdk/platform-tools
```

The location of the SDK on your system can be identified by launching the SDK Manager and referring to the *Android SDK Location:* field located at the top of the settings panel as highlighted in Figure 2-7:

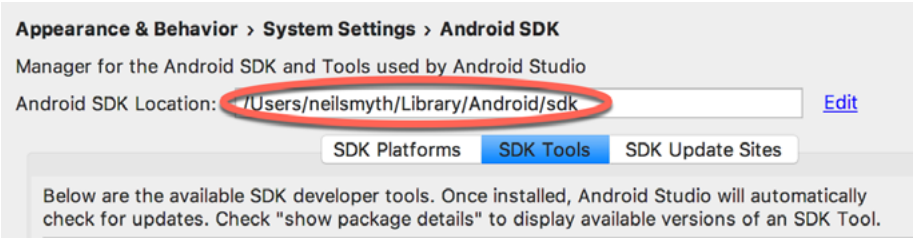



Figure 2-7

Once the location of the SDK has been identified, the steps to add this to the PATH variable are operating system dependent:

### 2.6.1 Windows 7

1. Right-click on Computer in the desktop start menu and select Properties from the resulting menu.
2. In the properties panel, select the Advanced System Settings link and, in the resulting dialog, click on the Environment Variables… button.
3. In the Environment Variables dialog, locate the Path variable in the System variables list, select it and click on *Edit*…. Locate the end of the current variable value string and append the path to the Android platform

tools to the end, using a semicolon to separate the path from the preceding values. For example, assuming the Android SDK was installed into C:\Users\demo\AppData\Local\Android\sdk, the following would be appended to the end of the current Path value:

```
;C:\Users\demo\AppData\Local\Android\sdk\platform-tools; C:\Users\demo\AppData\
Local\Android\sdk\tools; C:\Users\demo\AppData\Local\Android\sdk\tools\bin
```

4. Click on OK in each dialog box and close the system properties control panel.

Once the above steps are complete, verify that the path is correctly set by opening a *Command Prompt* window (*Start -> All Programs -> Accessories -> Command Prompt*) and at the prompt enter:

```
echo %Path%
```

The returned path variable value should include the paths to the Android SDK platform tools folders. Verify that the *platform-tools* value is correct by attempting to run the *adb* tool as follows:

```
adb
```

The tool should output a list of command line options when executed.

Similarly, check the *tools* path setting by attempting to launch the AVD Manager command line tool:

```
avdmanager
```

In the event that a message similar to the following message appears for one or both of the commands, it is most likely that an incorrect path was appended to the Path environment variable:

```
'adb' is not recognized as an internal or external command,
operable program or batch file.
```

### 2.6.2 Windows 8.1

1. On the start screen, move the mouse to the bottom right-hand corner of the screen and select Search from the resulting menu. In the search box, enter Control Panel. When the Control Panel icon appears in the results area, click on it to launch the tool on the desktop.

2. Within the Control Panel, use the Category menu to change the display to Large Icons. From the list of icons select the one labeled System.

3. Follow the steps outlined for Windows 7 starting from step 2 through to step 4.

Open the command prompt window (move the mouse to the bottom right-hand corner of the screen, select the Search option and enter *cmd* into the search box). Select *Command Prompt* from the search results.

Within the Command Prompt window, enter:

```
echo %Path%
```

The returned path variable value should include the paths to the Android SDK platform tools folders. Verify that the *platform-tools* value is correct by attempting to run the *adb* tool as follows:

```
adb
```

The tool should output a list of command line options when executed.

Similarly, check the *tools* path setting by attempting to run the AVD Manager command line tool:

```
avdmanager
```

In the event that a message similar to the following message appears for one or both of the commands, it is most likely that an incorrect path was appended to the Path environment variable:

```
'adb' is not recognized as an internal or external command,
```

```
operable program or batch file.
```

### 2.6.3 Windows 10

Right-click on the Start menu, select *System* from the resulting menu and click on the *Advanced system settings* option in the System window. Follow the steps outlined for Windows 7 starting from step 2 through to step 4.

### 2.6.4 Linux

On Linux, this configuration can typically be achieved by adding a command to the *.bashrc* file in your home directory (specifics may differ depending on the particular Linux distribution in use). Assuming that the Android SDK bundle package was installed into */home/demo/Android/sdk*, the export line in the *.bashrc* file would read as follows:

```
export PATH=/home/demo/Android/sdk/platform-tools:/home/demo/Android/sdk/tools:/
home/demo/Android/sdk/tools/bin:/home/demo/android-studio/bin:$PATH
```

Note also that the above command adds the *android-studio/bin* directory to the PATH variable. This will enable the *studio.sh* script to be executed regardless of the current directory within a terminal window.

### 2.6.5 macOS

A number of techniques may be employed to modify the $PATH environment variable on macOS. Arguably the cleanest method is to add a new file in the */etc/paths.d* directory containing the paths to be added to $PATH. Assuming an Android SDK installation location of */Users/demo/Library/Android/sdk*, the path may be configured by creating a new file named *android-sdk* in the */etc/paths.d* directory containing the following lines:

```
/Users/demo/Library/Android/sdk/tools
/Users/demo/Library/Android/sdk/tools/bin
/Users/demo/Library/Android/sdk/platform-tools
```

Note that since this is a system directory it will be necessary to use the *sudo* command when creating the file. For example:

```
sudo vi /etc/paths.d/android-sdk
```

## 2.7 Updating Android Studio and the SDK

From time to time new versions of Android Studio and the Android SDK are released. New versions of the SDK are installed using the Android SDK Manager. Android Studio will typically notify you when an update is ready to be installed.

To manually check for Android Studio updates, click on the *Configure -> Check for Update* menu option within the Android Studio welcome screen, or use the *Help -> Check for Update* menu option accessible from within the Android Studio main window.

## 2.8 Summary

Prior to beginning the development of Android based applications, the first step is to set up a suitable development environment. This consists of the Java Development Kit (JDK), Android SDKs, and Android Studio IDE. In this chapter, we have covered the steps necessary to install these packages on Windows, macOS and Linux.

Chapter 3

# 3. Creating an Example Android App in Android Studio

The preceding chapters of this book have covered the steps necessary to configure an environment suitable for the development of Android applications using the Android Studio IDE. Before moving on to slightly more advanced topics, now is a good time to validate that all of the required development packages are installed and functioning correctly. The best way to achieve this goal is to create an Android application and compile and run it. This chapter will cover the creation of a simple Android application project using Android Studio. Once the project has been created, a later chapter will explore the use of the Android emulator environment to perform a test run of the application.

## 3.1 Creating a New Android Project

The first step in the application development process is to create a new project within the Android Studio environment. Begin, therefore, by launching Android Studio so that the "Welcome to Android Studio" screen appears as illustrated in Figure 3-1:


Figure 3-1

Once this window appears, Android Studio is ready for a new project to be created. To create the new project, simply click on the *Start a new Android Studio project* option to display the first screen of the *New Project* wizard as shown in Figure 3-2:

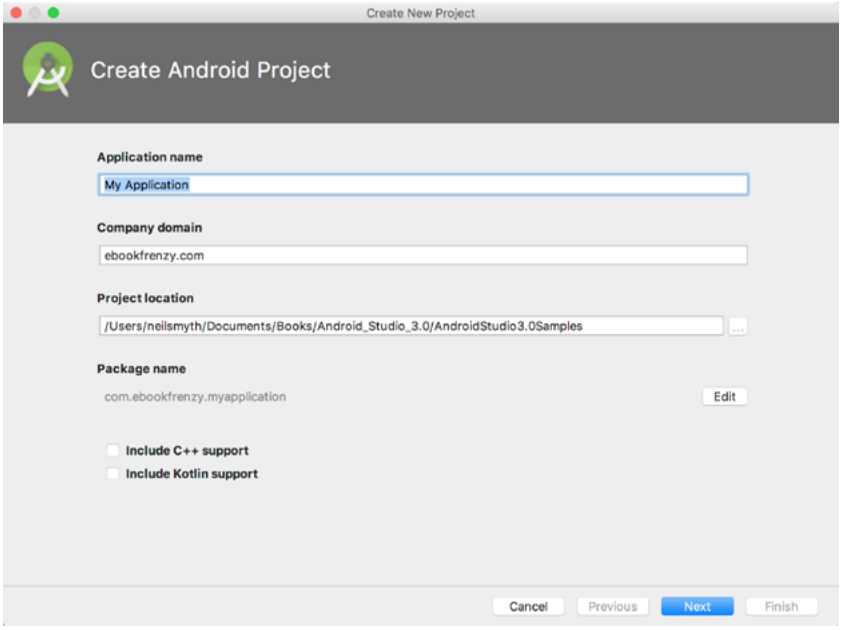



Figure 3-2

## 3.2 Defining the Project and SDK Settings

In the *New Project* window, set the *Application name* field to *AndroidSample*. The application name is the name by which the application will be referenced and identified within Android Studio and is also the name that will be used when the completed application goes on sale in the Google Play store.

The *Package Name* is used to uniquely identify the application within the Android application ecosystem. Although this can be set to any string that uniquely identifies your app, it is traditionally based on the reversed URL of your domain name followed by the name of the application. For example, if your domain is *www.mycompany.com*, and the application has been named *AndroidSample*, then the package name might be specified as follows:

```
com.mycompany.androidsample
```

If you do not have a domain name you can enter any other string into the Company Domain field, or you may use *example.com* for the purposes of testing, though this will need to be changed before an application can be published:

```
com.example.androidsample
```

The *Project location* setting will default to a location in the folder named *AndroidStudioProjects* located in your home directory and may be changed by clicking on the button to the right of the text field containing the current path setting.

Finally, enable the *Include Kotlin support* option.

Click Next to proceed. On the form factors screen, enable the *Phone and Tablet* option and set the minimum SDK setting to API 14: Android 4.0 (IceCreamSandwich). The reason for selecting an older SDK release is that this ensures that the finished application will be able to run on the widest possible range of Android devices. The higher the minimum SDK selection, the more the application will be restricted to newer Android devices. A useful chart (Figure 3-3) can be viewed by clicking on the *Help me choose* link. This outlines the various SDK versions and API levels available for use and the percentage of Android devices in the marketplace on which the

application will run if that SDK is used as the minimum level. In general it should only be necessary to select a more recent SDK when that release contains a specific feature that is required for your application.

To help in the decision process, selecting an API level from the chart will display the features that are supported at that level.

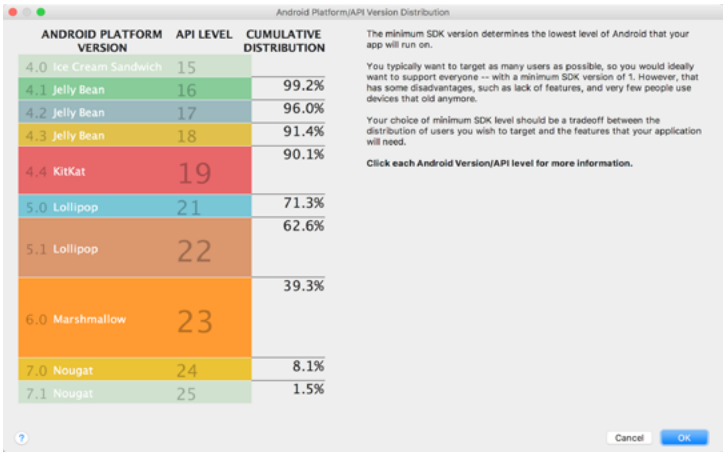



Figure 3-3

Since the project is not intended for Google TV, Android Auto or wearable devices, leave the remaining options disabled before clicking *Next*. Instant Apps will not be covered until later in this book so make sure that the *Include Android Instant App support* option is disabled.

## 3.3 Creating an Activity

The next step is to define the type of initial activity that is to be created for the application. A range of different activity types is available when developing Android applications. The *Empty*, *Master/Detail Flow*, *Google Maps* and *Navigation Drawer* options will be covered extensively in later chapters. For the purposes of this example, however, simply select the option to create a *Basic Activity*. The Basic Activity option creates a template user interface consisting of an app bar, menu, content area and a single floating action button.

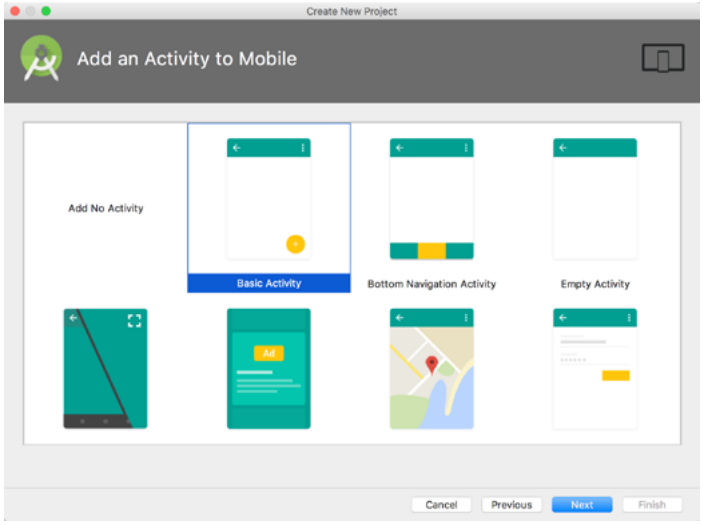



Figure 3-4

With the Basic Activity option selected, click *Next*. On the final screen (Figure 3-5) name the activity and title *AndroidSampleActivity*. The activity will consist of a single user interface screen layout which, for the purposes of this example, should be named *activity_android_sample*. Finally, enter *My Android App* into the title field as shown in Figure 3-5:

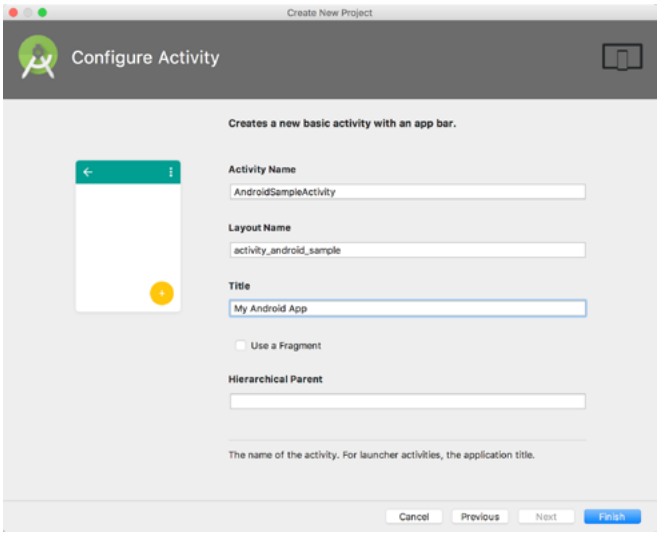



Figure 3-5

Since the AndroidSampleActivity is essentially the top level activity for the project and has no parent activity, there is no need to specify an activity for the Hierarchical parent (in other words AndroidSampleActivity does not need an "Up" button to return to another activity).

Click on *Finish* to initiate the project creation process.

## 3.4 Modifying the Example Application

At this point, Android Studio has created a minimal example application project and opened the main window.

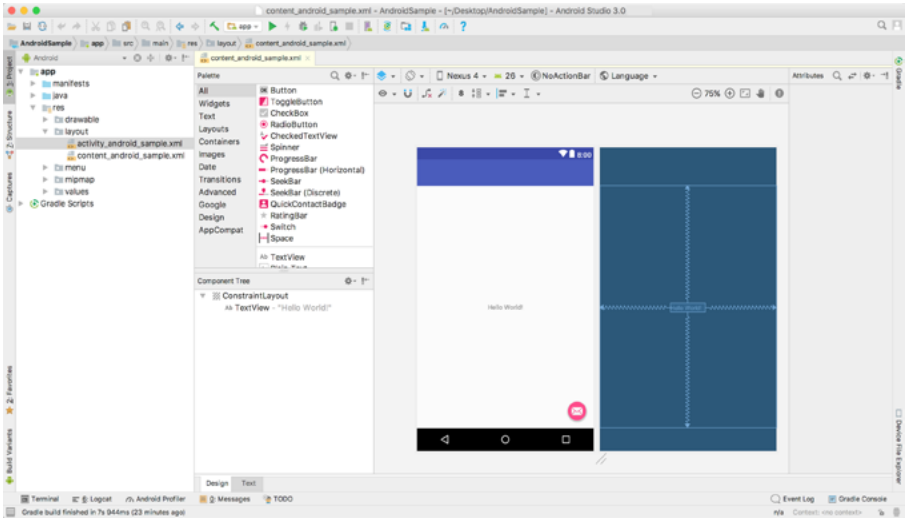


Figure 3-6

The newly created project and references to associated files are listed in the *Project* tool window located on the left-hand side of the main project window. The Project tool window has a number of modes in which information can be displayed. By default, this panel will be in *Android* mode. This setting is controlled by the menu at the top of the panel as highlighted in Figure 3-7. If the panel is not currently in Android mode, use the menu to switch mode:

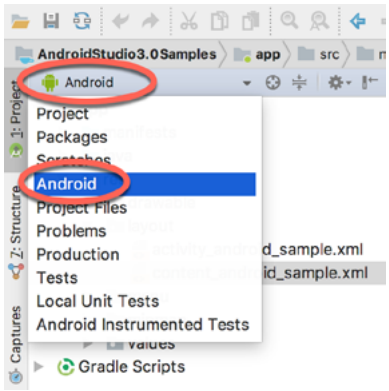



Figure 3-7

The example project created for us when we selected the option to create an activity consists of a user interface containing a label that will read "Hello World!" when the application is executed.

The next step in this tutorial is to modify the user interface of our application so that it displays a larger text view object with a different message to the one provided for us by Android Studio.

The user interface design for our activity is stored in a file named *activity_android_sample.xml* which, in turn, is located under *app -> res -> layout* in the project file hierarchy. This layout file includes the app bar (also known as an action bar) that appears across the top of the device screen (marked A in Figure 3-8) and the floating action button (the email button marked B). In addition to these items, the *activity_android_sample.xml* layout file contains a reference to a second file containing the content layout (marked C):

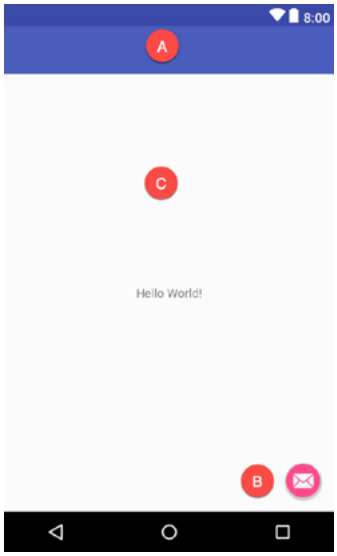



Figure 3-8

By default, the content layout is contained within a file named *content_android_sample.xml* and it is within this file that changes to the layout of the activity are made. Using the Project tool window, locate this file as illustrated in Figure 3-9:

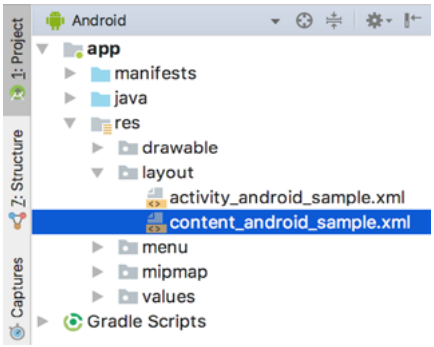



Figure 3-9

Once located, double-click on the file to load it into the user interface Layout Editor tool which will appear in the center panel of the Android Studio main window:

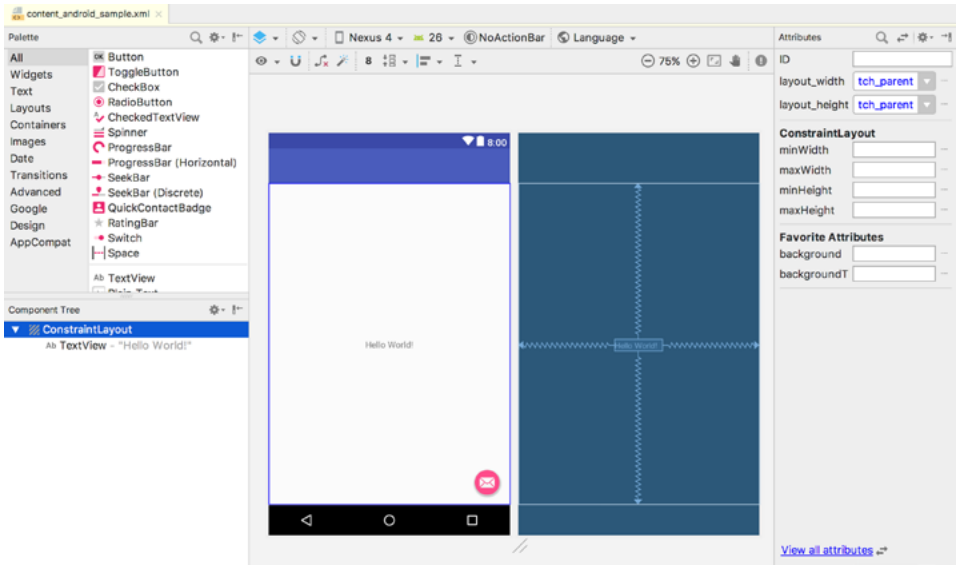



Figure 3-10

In the toolbar across the top of the Layout Editor window is a menu (currently set to *Nexus 4* in the above figure) which is reflected in the visual representation of the device within the Layout Editor panel. A wide range of other device options are available for selection by clicking on this menu.

To change the orientation of the device representation between landscape and portrait simply use the drop down menu immediately to the left of the device selection menu showing the  icon.

As can be seen in the device screen, the content layout already includes a label that displays a "Hello World!" message. Running down the left-hand side of the panel is a palette containing different categories of user interface components that may be used to construct a user interface, such as buttons, labels and text fields. It should be noted, however, that not all user interface components are obviously visible to the user. One such category

consists of *layouts*. Android supports a variety of layouts that provide different levels of control over how visual user interface components are positioned and managed on the screen. Though it is difficult to tell from looking at the visual representation of the user interface, the current design has been created using a ConstraintLayout. This can be confirmed by reviewing the information in the *Component Tree* panel which, by default, is located in the lower left-hand corner of the Layout Editor panel and is shown in Figure 3-11:

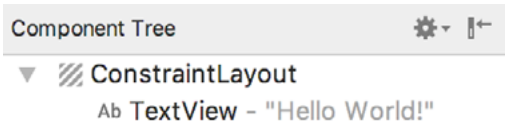



Figure 3-11

As we can see from the component tree hierarchy, the user interface layout consists of a ConstraintLayout parent with a single child in the form of a TextView object.

Before proceeding, check that the Layout Editor's Autoconnect mode is enabled. This means that as components are added to the layout, the Layout Editor will automatically add constraints to make sure the components are correctly positioned for different screen sizes and device orientations (a topic that will be covered in much greater detail in future chapters). The Autoconnect button appears in the Layout Editor toolbar and is represented by a magnet icon. When disabled the magnet appears with a diagonal line through it (Figure 3-12). If necessary, re-enable Autoconnect mode by clicking on this button.

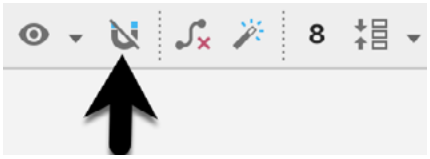


Figure 3-12

The next step in modifying the application is to delete the TextView component from the design. Begin by clicking on the TextView object within the user interface view so that it appears with a blue border around it. Once selected, press the Delete key on the keyboard to remove the object from the layout.

The Palette panel consists of two columns with the left-hand column containing a list of view component categories. The right-hand column lists the components contained within the currently selected category. In Figure 3-13, for example, the Button view is currently selected within the Widgets category:

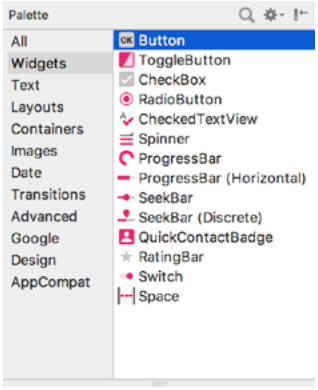



Figure 3-13

Click and drag the *Button* object from the Widgets list and drop it in the center of the user interface design when the marker lines appear indicating the center of the display:

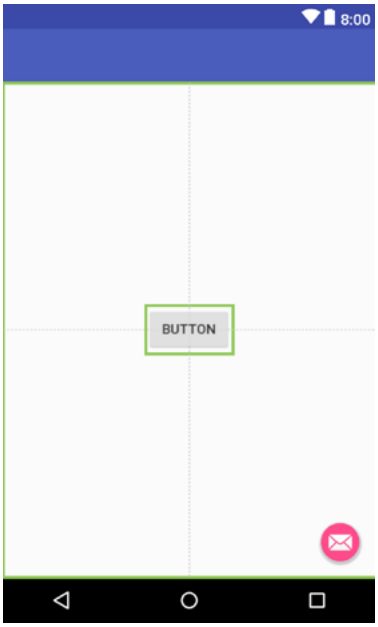



Figure 3-14

The next step is to change the text that is currently displayed by the Button component. The panel located to the right of the design area is the Attributes panel. This panel displays the attributes assigned to the currently selected component in the layout. Within this panel, locate the *text* property and change the current value from "Button" to "Demo" as shown in Figure 3-15:

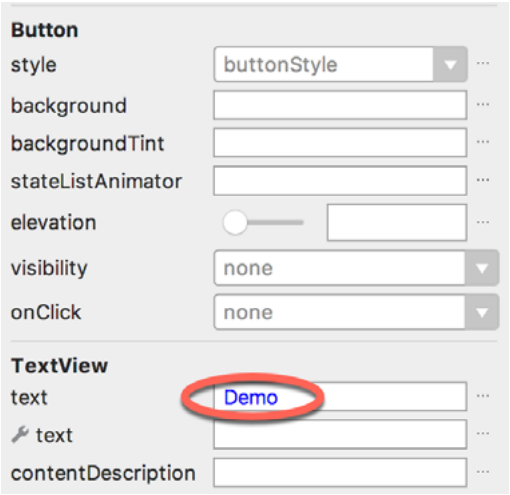



Figure 3-15

A useful shortcut to changing the text property of a component is to double-click on it in the layout. This will automatically locate the attribute in the attributes panel and select it ready for editing.

The second text property with a wrench next to it allows a text property to be set which only appears within the

Layout Editor tool but is not shown at runtime. This is useful for testing the way in which a visual component and the layout will behave with different settings without having to run the app repeatedly.

At this point it is important to explain the warning button located in the top right-hand corner of the Layout Editor tool as indicated in Figure 3-16. Obviously, this is indicating potential problems with the layout. For details on any problems, click on the button:

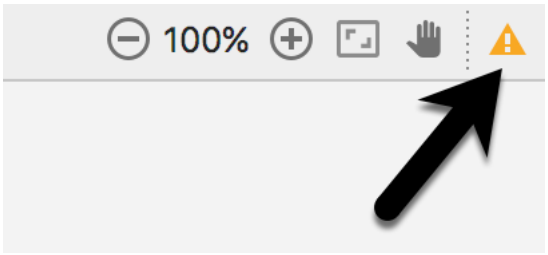



Figure 3-16

When clicked, a panel (Figure 3-17) will appear describing the nature of the problems and offering some possible corrective measures:

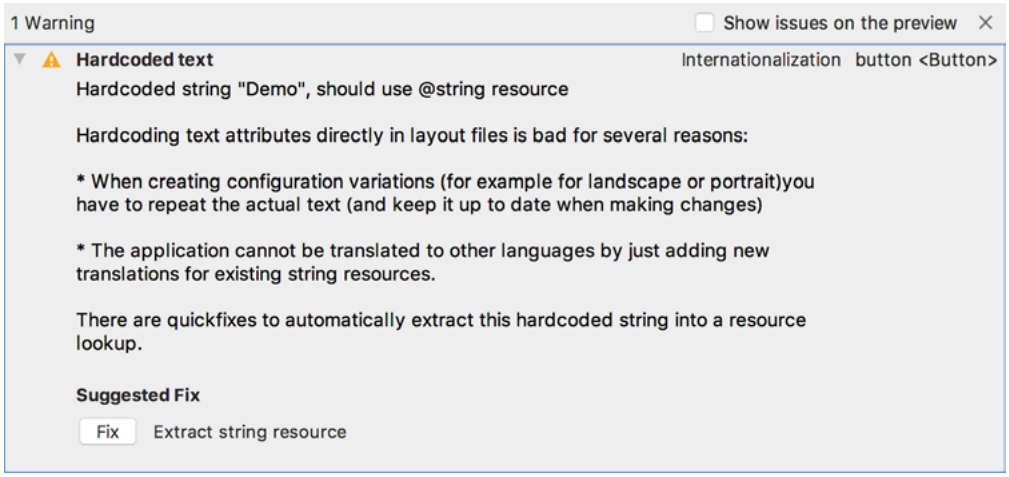



Figure 3-17

Currently, the only warning listed reads as follows:

```
Hardcoded string "Demo", should use '@string' resource
```

This I18N message is informing us that a potential issue exists with regard to the future internationalization of the project ("I18N" comes from the fact that the word "internationalization" begins with an "I", ends with an "N" and has 18 letters in between). The warning is reminding us that when developing Android applications, attributes and values such as text strings should be stored in the form of *resources* wherever possible. Doing so enables changes to the appearance of the application to be made by modifying resource files instead of changing the application source code. This can be especially valuable when translating a user interface to a different spoken language. If all of the text in a user interface is contained in a single resource file, for example, that file can be given to a translator who will then perform the translation work and return the translated file for inclusion in the application. This enables multiple languages to be targeted without the necessity for any source code changes to be made. In this instance, we are going to create a new resource named *demostring* and assign to it the string "Demo".

Click on the *Fix* button in the Issue Explanation panel to display the *Extract Resource* panel (Figure 3-18). Within this panel, change the resource name field to *demostring* and leave the resource value set to *Demo* before clicking on the OK button.

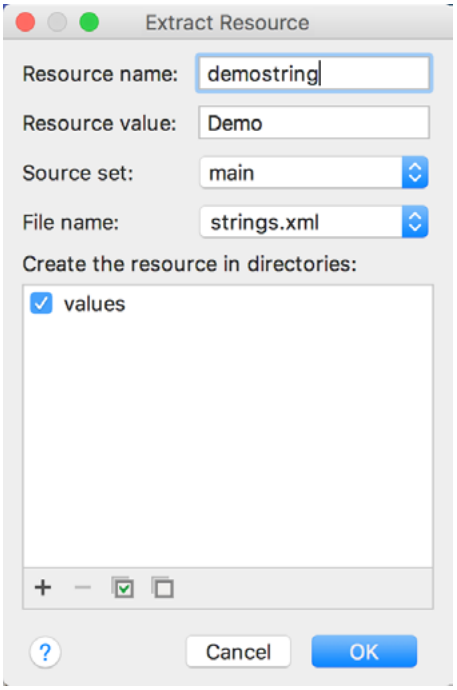



Figure 3-18

It is also worth noting that the string could also have been assigned to a resource when it was entered into the Attributes panel. This involves clicking on the button displaying three dots to the right of the property field in the Attributes panel and selecting the *Add new resource -> New String Value…* menu option from the resulting Resources dialog. In practice, however, it is often quicker to simply set values directly into the Attributes panel fields for any widgets in the layout, then work sequentially through the list in the warnings dialog to extract any necessary resources when the layout is complete.

## 3.5 Reviewing the Layout and Resource Files

Before moving on to the next chapter, we are going to look at some of the internal aspects of user interface design and resource handling. In the previous section, we made some changes to the user interface by modifying the *content_android_sample.xml* file using the Layout Editor tool. In fact, all that the Layout Editor was doing was providing a user-friendly way to edit the underlying XML content of the file. In practice, there is no reason why you cannot modify the XML directly in order to make user interface changes and, in some instances, this may actually be quicker than using the Layout Editor tool. At the bottom of the Layout Editor panel are two tabs labeled *Design* and *Text* respectively. To switch to the XML view simply select the *Text* tab as shown in Figure 3-19:

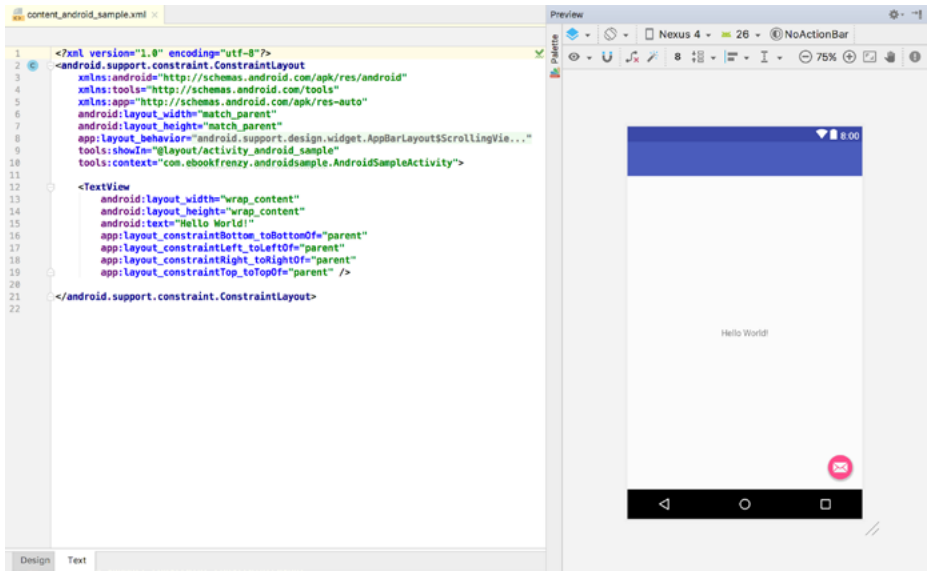



Figure 3-19

As can be seen from the structure of the XML file, the user interface consists of the ConstraintLayout component, which in turn, is the parent of the Button object. We can also see that the *text* property of the Button is set to our *demostring* resource. Although varying in complexity and content, all user interface layouts are structured in this hierarchical, XML based way.

One of the more powerful features of Android Studio can be found to the right-hand side of the XML editing panel. If the panel is not visible, display it by selecting the *Preview* button located along the right-hand edge of the Android Studio window. This is the Preview panel and shows the current visual state of the layout. As changes are made to the XML layout, these will be reflected in the preview panel. The layout may also be modified visually from within the Preview panel with the changes appearing in the XML listing. To see this in action, modify the XML layout to change the background color of the ConstraintLayout to a shade of red as follows:

```
<?xml version="1.0" encoding="utf-8"?>
<android.support.constraint.ConstraintLayout xmlns:android="http://schemas.
android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    app:layout_behavior="@string/appbar_scrolling_view_behavior"
  tools:context="com.ebookfrenzy.myapplication.AndroidSampleActivity"
    tools:showIn="@layout/activity_android_sample"
    android:background="#ff2438" >
.
.
</android.support.constraint.ConstraintLayout>
```

Note that the color of the preview changes in real-time to match the new setting in the XML file. Note also that a small red square appears in the left-hand margin (also referred to as the *gutter*) of the XML editor next to the line containing the color setting. This is a visual cue to the fact that the color red has been set on a property. Change

the color value to #a0ff28 and note that both the small square in the margin and the preview change to green.

Finally, use the Project view to locate the *app -> res -> values -> strings.xml* file and double-click on it to load it into the editor. Currently the XML should read as follows:

```
<resources>
    <string name="app_name">AndroidSample</string>
    <string name="action_settings">Settings</string>
    <string name="demostring">Demo</string>
</resources>
```

As a demonstration of resources in action, change the string value currently assigned to the *demostring* resource to "Hello" and then return to the Layout Editor tool by selecting the tab for the layout file in the editor panel. Note that the layout has picked up the new resource value for the string.

There is also a quick way to access the value of a resource referenced in an XML file. With the Layout Editor tool in Text mode, click on the "@string/demostring" property setting so that it highlights and then press Ctrl-B on the keyboard (Cmd-B on macOS). Android Studio will subsequently open the *strings.xml* file and take you to the line in that file where this resource is declared. Use this opportunity to revert the string resource back to the original "Demo" text.

Resource strings may also be edited using the Android Studio Translations Editor. To open this editor, right-click on the *app -> res -> values -> strings.xml* file and select the *Open Editor* menu option. This will display the Translation Editor in the main panel of the Android Studio window:

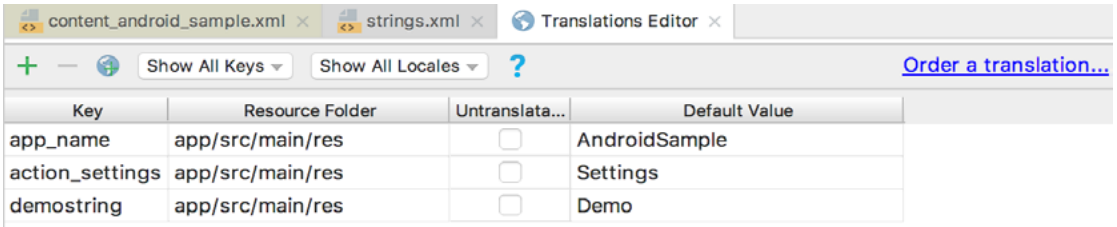



Figure 3-20

This editor allows the strings assigned to resource keys to be edited and for translations for multiple languages to be managed. The *Order a translation…* link may also be used to order a translation of the strings contained within the application to other languages. The cost of the translations will vary depending on the number of strings involved.

## 3.6 Summary

While not excessively complex, a number of steps are involved in setting up an Android development environment. Having performed those steps, it is worth working through a simple example to make sure the environment is correctly installed and configured. In this chapter, we have created a simple application and then used the Android Studio Layout Editor tool to modify the user interface layout. In doing so, we explored the importance of using resources wherever possible, particularly in the case of string values, and briefly touched on the topic of layouts. Finally, we looked at the underlying XML that is used to store the user interface designs of Android applications.

While it is useful to be able to preview a layout from within the Android Studio Layout Editor tool, there is no substitute for testing an application by compiling and running it. In a later chapter, the steps necessary to set up an emulator for testing purposes will be covered in detail. Before running the application, however, the next chapter will take a small detour to provide a guided tour of the Android Studio user interface.

Chapter 4

# 4. A Tour of the Android Studio User Interface

While it is tempting to plunge into running the example application created in the previous chapter, doing so involves using aspects of the Android Studio user interface which are best described in advance.

Android Studio is a powerful and feature rich development environment that is, to a large extent, intuitive to use. That being said, taking the time now to gain familiarity with the layout and organization of the Android Studio user interface will considerably shorten the learning curve in later chapters of the book. With this in mind, this chapter will provide an initial overview of the various areas and components that make up the Android Studio environment.

## 4.1 The Welcome Screen

The welcome screen (Figure 4-1) is displayed any time that Android Studio is running with no projects currently open (open projects can be closed at any time by selecting the *File -> Close Project* menu option). If Android Studio was previously exited while a project was still open, the tool will by-pass the welcome screen next time it is launched, automatically opening the previously active project.

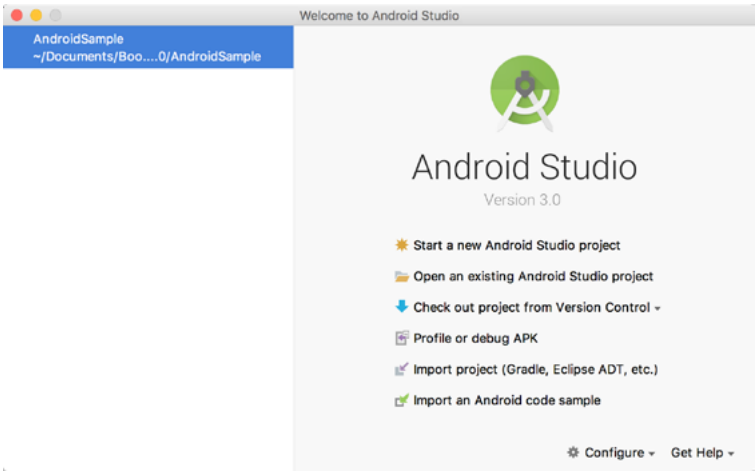



Figure 4-1

In addition to a list of recent projects, the Quick Start menu provides a range of options for performing tasks such as opening, creating and importing projects along with access to projects currently under version control. In addition, the *Configure* menu at the bottom of the window provides access to the SDK Manager along with a vast array of settings and configuration options. A review of these options will quickly reveal that there is almost no aspect of Android Studio that cannot be configured and tailored to your specific needs.

The Configure menu also includes an option to check if updates to Android Studio are available for download.

## 4.2 The Main Window

When a new project is created, or an existing one opened, the Android Studio *main window* will appear. When multiple projects are open simultaneously, each will be assigned its own main window. The precise configuration of the window will vary depending on which tools and panels were displayed the last time the project was open, but will typically resemble that of Figure 4-2.

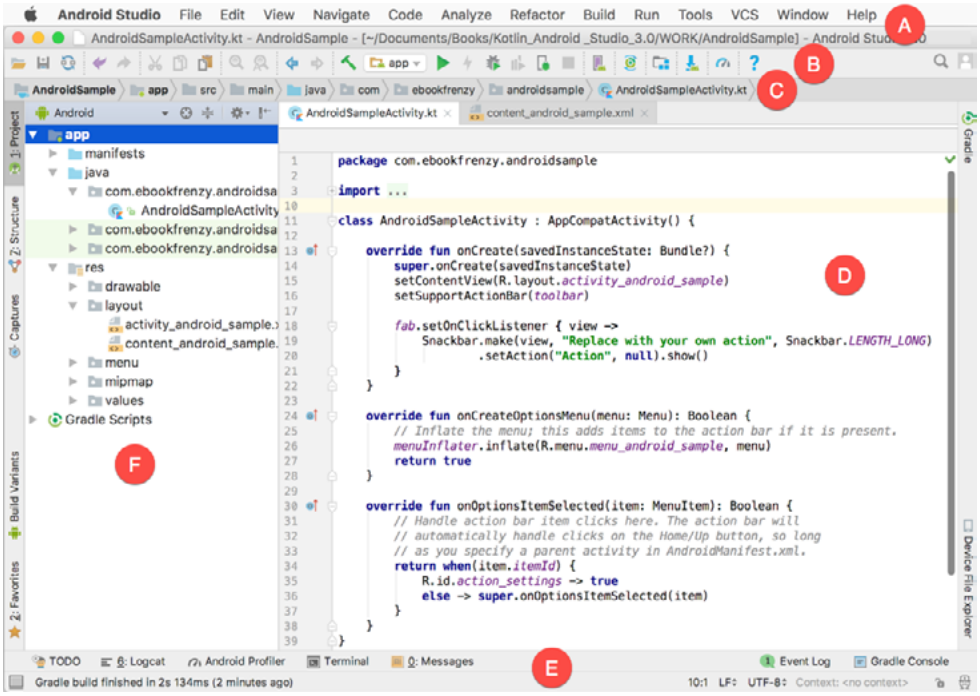



Figure 4-2

The various elements of the main window can be summarized as follows:

**A – Menu Bar** – Contains a range of menus for performing tasks within the Android Studio environment.

**B – Toolbar** – A selection of shortcuts to frequently performed actions. The toolbar buttons provide quicker access to a select group of menu bar actions. The toolbar can be customized by right-clicking on the bar and selecting the *Customize Menus and Toolbars…* menu option.

**C – Navigation Bar** – The navigation bar provides a convenient way to move around the files and folders that make up the project. Clicking on an element in the navigation bar will drop down a menu listing the subfolders and files at that location ready for selection. This provides an alternative to the Project tool window.

**D – Editor Window** – The editor window displays the content of the file on which the developer is currently working. What gets displayed in this location, however, is subject to context. When editing code, for example, the code editor will appear. When working on a user interface layout file, on the other hand, the user interface Layout Editor tool will appear. When multiple files are open, each file is represented by a tab located along the top edge of the editor as shown in Figure 4-3.

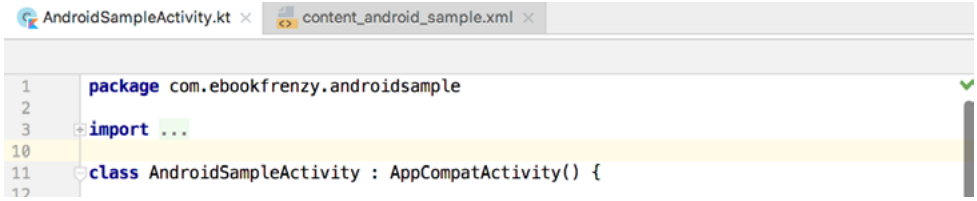



Figure 4-3

**E – Status Bar** – The status bar displays informational messages about the project and the activities of Android Studio together with the tools menu button located in the far left corner. Hovering over items in the status bar will provide a description of that field. Many fields are interactive, allowing the user to click to perform tasks or obtain more detailed status information.

**F – Project Tool Window** – The project tool window provides a hierarchical overview of the project file structure allowing navigation to specific files and folders to be performed. The toolbar can be used to display the project in a number of different ways. The default setting is the *Android* view which is the mode primarily used in the remainder of this book.

The project tool window is just one of a number of tool windows available within the Android Studio environment.

## 4.3 The Tool Windows

In addition to the project view tool window, Android Studio also includes a number of other windows which, when enabled, are displayed along the bottom and sides of the main window. The tool window quick access menu can be accessed by hovering the mouse pointer over the button located in the far left-hand corner of the status bar (Figure 4-4) without clicking the mouse button.

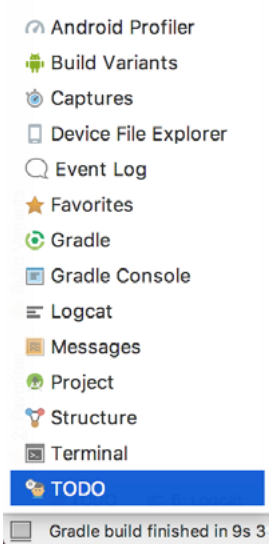



Figure 4-4

Selecting an item from the quick access menu will cause the corresponding tool window to appear within the main window.

Alternatively, a set of *tool window bars* can be displayed by clicking on the quick access menu icon in the status bar. These bars appear along the left, right and bottom edges of the main window (as indicated by the arrows in

Figure 4-5) and contain buttons for showing and hiding each of the tool windows. When the tool window bars are displayed, a second click on the button in the status bar will hide them.

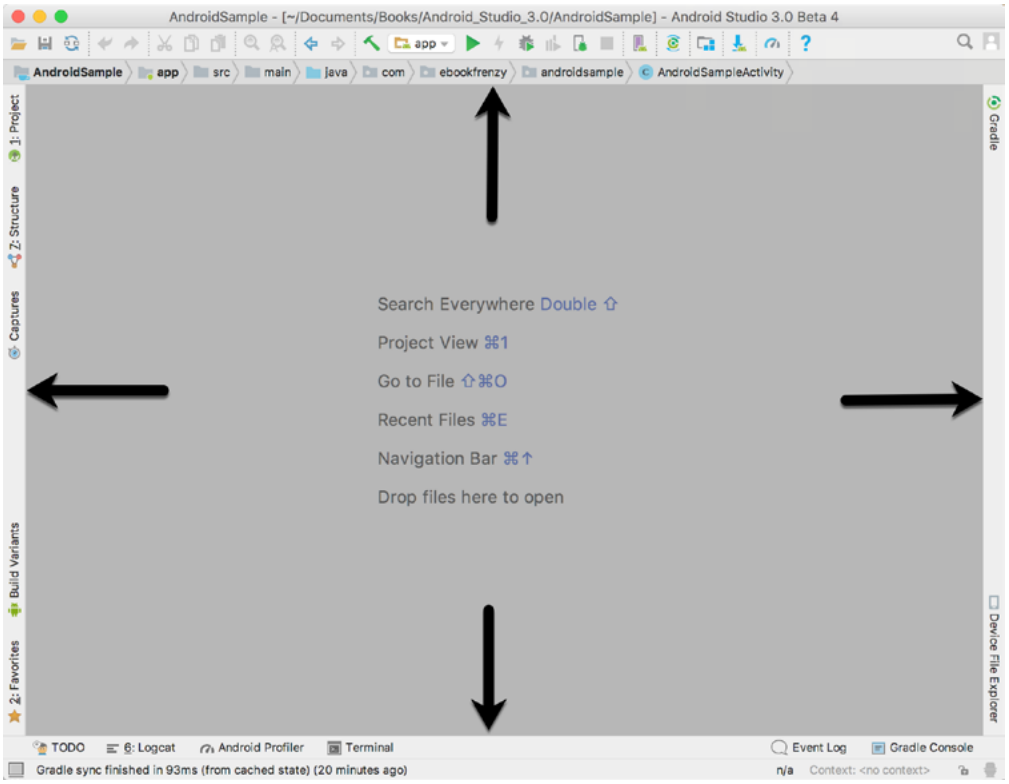



Figure 4-5

Clicking on a button will display the corresponding tool window while a second click will hide the window. Buttons prefixed with a number (for example 1: Project) indicate that the tool window may also be displayed by pressing the Alt key on the keyboard (or the Command key for macOS) together with the corresponding number.

The location of a button in a tool window bar indicates the side of the window against which the window will appear when displayed. These positions can be changed by clicking and dragging the buttons to different locations in other window tool bars.

Each tool window has its own toolbar along the top edge. The buttons within these toolbars vary from one tool to the next, though all tool windows contain a settings option, represented by the cog icon, which allows various aspects of the window to be changed. Figure 4-6 shows the settings menu for the project view tool window. Options are available, for example, to undock a window and to allow it to float outside of the boundaries of the Android Studio main window and to move and resize the tool panel.

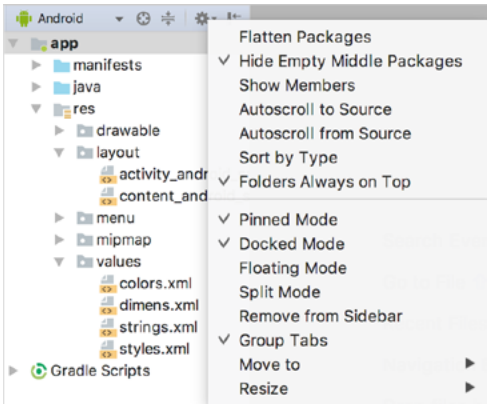



Figure 4-6

All of the windows also include a far right button on the toolbar providing an additional way to hide the tool window from view. A search of the items within a tool window can be performed simply by giving that window focus by clicking in it and then typing the search term (for example the name of a file in the Project tool window). A search box will appear in the window's tool bar and items matching the search highlighted.

Android Studio offers a wide range of tool windows, the most commonly used of which are as follows:

**Project** – The project view provides an overview of the file structure that makes up the project allowing for quick navigation between files. Generally, double-clicking on a file in the project view will cause that file to be loaded into the appropriate editing tool.

**Structure** – The structure tool provides a high level view of the structure of the source file currently displayed in the editor. This information includes a list of items such as classes, methods and variables in the file. Selecting an item from the structure list will take you to that location in the source file in the editor window.

**Captures** – The captures tool window provides access to performance data files that have been generated by the monitoring tools contained within Android Studio.

**Favorites** – A variety of project items can be added to the favorites list. Right-clicking on a file in the project view, for example, provides access to an *Add to Favorites* menu option. Similarly, a method in a source file can be added as a favorite by right-clicking on it in the Structure tool window. Anything added to a Favorites list can be accessed through this Favorites tool window.

**Build Variants** – The build variants tool window provides a quick way to configure different build targets for the current application project (for example different builds for debugging and release versions of the application, or multiple builds to target different device categories).

**TODO** – As the name suggests, this tool provides a place to review items that have yet to be completed on the project. Android Studio compiles this list by scanning the source files that make up the project to look for comments that match specified TODO patterns. These patterns can be reviewed and changed by selecting the *File -> Settings…* menu option (*Android Studio -> Preferences…* on macOS) and navigating to the *TODO* page listed under *Editor*.

**Messages** – The messages tool window records output from the Gradle build system (Gradle is the underlying system used by Android Studio for building the various parts of projects into runnable applications) and can be useful for identifying the causes of build problems when compiling application projects.

**Logcat** – The Logcat tool window provides access to the monitoring log output from a running application in

addition to options for taking screenshots and videos of the application and stopping and restarting a process.

**Terminal** – Provides access to a terminal window on the system on which Android Studio is running. On Windows systems this is the Command Prompt interface, while on Linux and macOS systems this takes the form of a Terminal prompt.

**Run** – The run tool window becomes available when an application is currently running and provides a view of the results of the run together with options to stop or restart a running process. If an application is failing to install and run on a device or emulator, this window will typically provide diagnostic information relating to the problem.

**Event Log** – The event log window displays messages relating to events and activities performed within Android Studio. The successful build of a project, for example, or the fact that an application is now running will be reported within this tool window.

**Gradle Console** – The Gradle console is used to display all output from the Gradle system as projects are built from within Android Studio. This will include information about the success or otherwise of the build process together with details of any errors or warnings.

**Gradle** – The Gradle tool window provides a view onto the Gradle tasks that make up the project build configuration. The window lists the tasks that are involved in compiling the various elements of the project into an executable application. Right-click on a top level Gradle task and select the *Open Gradle Config* menu option to load the Gradle build file for the current project into the editor. Gradle will be covered in greater detail later in this book.

**Android Profiler** – The Android Profiler tool window provides realtime monitoring and analysis tools for identifying performance issues within running apps, including CPU, memory and network usage.

**Device File Explorer** – The Device File Explorer tool window provides direct access to the filesystem of the currently connected Android device or emulator allowing the filesystem to be browsed and files copied to the local filesystem.

## 4.4 Android Studio Keyboard Shortcuts

Android Studio includes an abundance of keyboard shortcuts designed to save time when performing common tasks. A full keyboard shortcut keymap listing can be viewed and printed from within the Android Studio project window by selecting the *Help -> Keymap Reference* menu option.

## 4.5 Switcher and Recent Files Navigation

Another useful mechanism for navigating within the Android Studio main window involves the use of the *Switcher*. Accessed via the *Ctrl-Tab* keyboard shortcut, the switcher appears as a panel listing both the tool windows and currently open files (Figure 4-7).

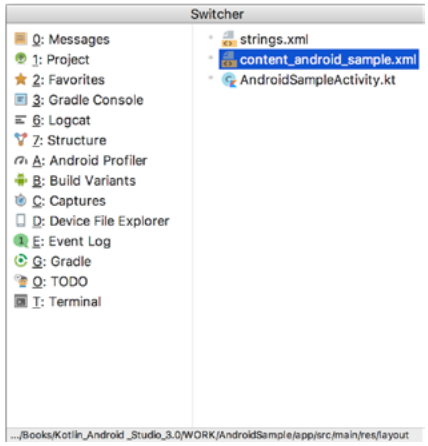



Figure 4-7

Once displayed, the switcher will remain visible for as long as the Ctrl key remains depressed. Repeatedly tapping the Tab key while holding down the Ctrl key will cycle through the various selection options, while releasing the Ctrl key causes the currently highlighted item to be selected and displayed within the main window.

In addition to the switcher, navigation to recently opened files is provided by the Recent Files panel (Figure 4-8). This can be accessed using the Ctrl-E keyboard shortcut (Cmd-E on macOS). Once displayed, either the mouse pointer can be used to select an option or, alternatively, the keyboard arrow keys used to scroll through the file name and tool window options. Pressing the Enter key will select the currently highlighted item.

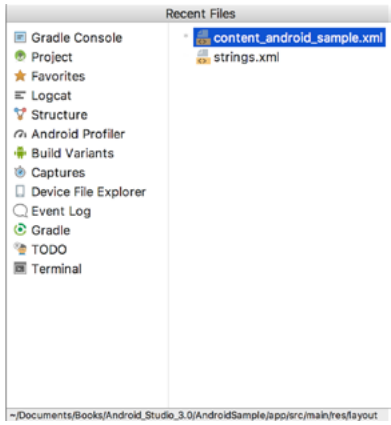



Figure 4-8

## 4.6 Changing the Android Studio Theme

The overall theme of the Android Studio environment may be changed either from the welcome screen using the *Configure -> Settings* option, or via the *File -> Settings…* menu option (*Android Studio -> Preferences…* on macOS) of the main window.

Once the settings dialog is displayed, select the *Appearance* option in the left-hand panel and then change the setting of the *Theme* menu before clicking on the *Apply* button. The themes available will depend on the platform but usually include options such as IntelliJ, Windows, Default and Darcula. Figure 4-9 shows an example of the main window with the Darcula theme selected:

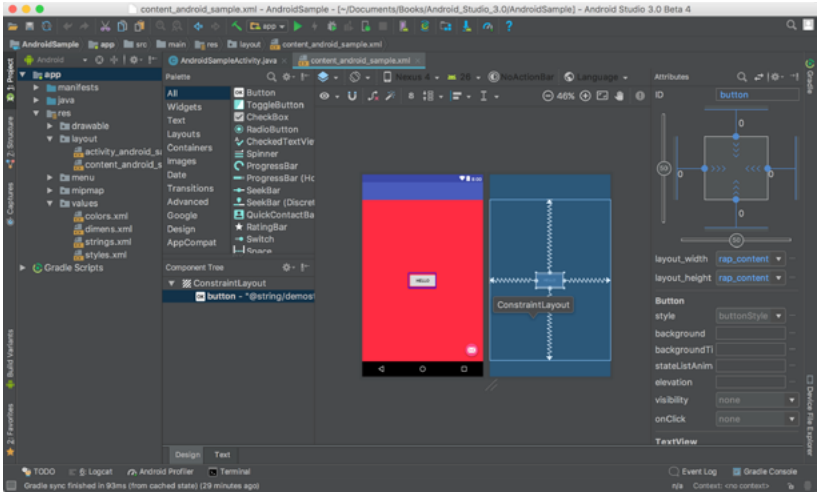


Figure 4-9

## 4.7 Summary

The primary elements of the Android Studio environment consist of the welcome screen and main window. Each open project is assigned its own main window which, in turn, consists of a menu bar, toolbar, editing and design area, status bar and a collection of tool windows. Tool windows appear on the sides and bottom edges of the main window and can be accessed either using the quick access menu located in the status bar, or via the optional tool window bars.

There are very few actions within Android Studio which cannot be triggered via a keyboard shortcut. A keymap of default keyboard shortcuts can be accessed at any time from within the Android Studio main window.

Chapter 5

# 5. Creating an Android Virtual Device (AVD) in Android Studio

In the course of developing Android apps in Android Studio it will be necessary to compile and run an application multiple times. An Android application may be tested by installing and running it either on a physical device or in an *Android Virtual Device (AVD)* emulator environment. Before an AVD can be used, it must first be created and configured to match the specifications of a particular device model. The goal of this chapter, therefore, is to work through the steps involved in creating such a virtual device using the Nexus 5X phone as a reference example.

## 5.1 About Android Virtual Devices

AVDs are essentially emulators that allow Android applications to be tested without the necessity to install the application on a physical Android based device. An AVD may be configured to emulate a variety of hardware features including options such as screen size, memory capacity and the presence or otherwise of features such as a camera, GPS navigation support or an accelerometer. As part of the standard Android Studio installation, a number of emulator templates are installed allowing AVDs to be configured for a range of different devices. Additional templates may be loaded or custom configurations created to match any physical Android device by specifying properties such as processor type, memory capacity and the size and pixel density of the screen. Check the online developer documentation for your device to find out if emulator definitions are available for download and installation into the AVD environment.

When launched, an AVD will appear as a window containing an emulated Android device environment. Figure 5-1, for example, shows an AVD session configured to emulate the Google Nexus 5X model.

New AVDs are created and managed using the Android Virtual Device Manager, which may be used either in command-line mode or with a more user-friendly graphical user interface.


Figure 5-1

## 5.2 Creating a New AVD

In order to test the behavior of an application in the absence of a physical device, it will be necessary to create an AVD for a specific Android device configuration.

To create a new AVD, the first step is to launch the AVD Manager. This can be achieved from within the Android Studio environment by selecting the *Tools -> Android -> AVD Manager* menu option from within the main window.

Once launched, the tool will appear as outlined in Figure 5-2 if existing AVD instances have been created:

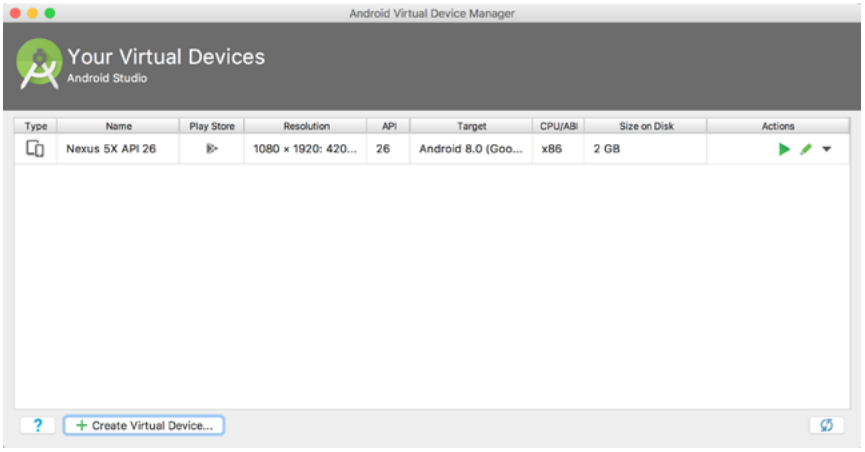



Figure 5-2

To add an additional AVD, begin by clicking on the *Create Virtual Device* button in order to invoke the *Virtual Device Configuration* dialog:

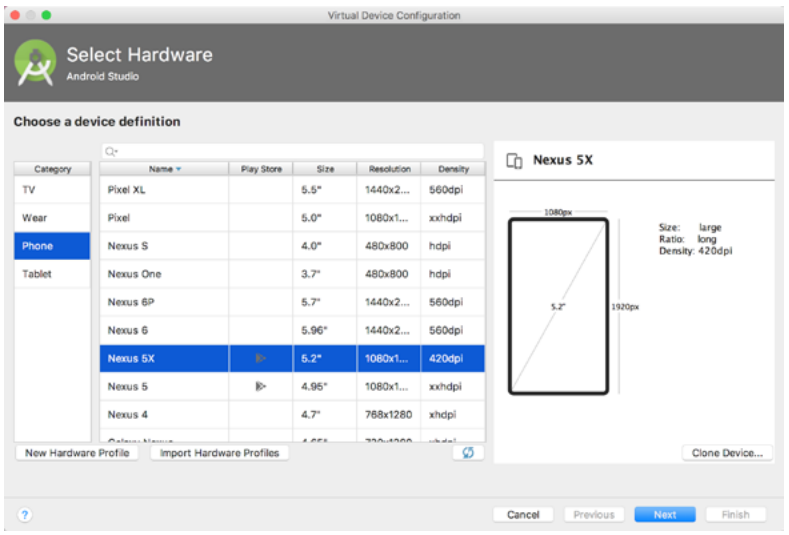



Figure 5-3

Within the dialog, perform the following steps to create a Nexus 5X compatible emulator:

1. From the *Category* panel, select the *Phone* option to display the list of available Android tablet AVD

templates.

2. Select the *Nexus 5X* device option and click *Next*.

3. On the System Image screen, select the latest version of Android (at time of writing this is Oreo, API level 26, Android 8.0 with Google Play) for the *x86* ABI. Note that if the system image has not yet been installed a *Download* link will be provided next to the Release Name. Click this link to download and install the system image before selecting it. If the image you need is not listed, click on the *x86 images* and *Other images* tabs to view alternative lists.

4. Click *Next* to proceed and enter a descriptive name (for example *Nexus 5X API 26*) into the name field or simply accept the default name.

5. Click *Finish* to create the AVD.

6. With the AVD created, the AVD Manager may now be closed. If future modifications to the AVD are necessary, simply re-open the AVD Manager, select the AVD from the list and click on the pencil icon in the *Actions* column of the device row in the AVD Manager.

## 5.3 Starting the Emulator

To perform a test run of the newly created AVD emulator, simply select the emulator from the AVD Manager and click on the launch button (the green triangle in the Actions column). The emulator will appear in a new window and begin the startup process. The amount of time it takes for the emulator to start will depend on the configuration of both the AVD and the system on which it is running. In the event that the startup time on your system is considerable, do not hesitate to leave the emulator running. The system will detect that it is already running and attach to it when applications are launched, thereby saving considerable amounts of startup time.

The emulator probably defaulted to appearing in portrait orientation. It is useful to be aware that this and other default options can be changed. Within the AVD Manager, select the new Nexus 5X entry and click on the pencil icon in the *Actions* column of the device row. In the configuration screen locate the *Startup and orientation* section and change the orientation setting. Exit and restart the emulator session to see this change take effect. More details on the emulator are covered in the next chapter (*"Using and Configuring the Android Studio AVD Emulator"*).

To save time in the next section of this chapter, leave the emulator running before proceeding.

## 5.4 Running the Application in the AVD

With an AVD emulator configured, the example AndroidSample application created in the earlier chapter now can be compiled and run. With the AndroidSample project loaded into Android Studio, simply click on the run button represented by a green triangle located in the Android Studio toolbar as shown in Figure 5-4 below, select the *Run -> Run 'app'* menu option or use the Ctrl-R keyboard shortcut:

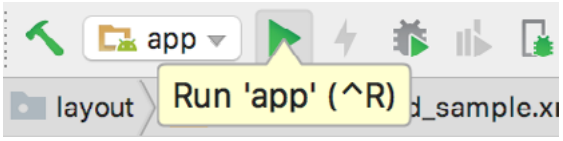



Figure 5-4

By default, Android Studio will respond to the run request by displaying the *Select Deployment Target* dialog. This provides the option to execute the application on an AVD instance that is already running, or to launch a new AVD session specifically for this application. Figure 5-5 lists the previously created Nexus 5X AVD as a running device as a result of the steps performed in the preceding section. With this device selected in the

dialog, click on *OK* to install and run the application on the emulator.

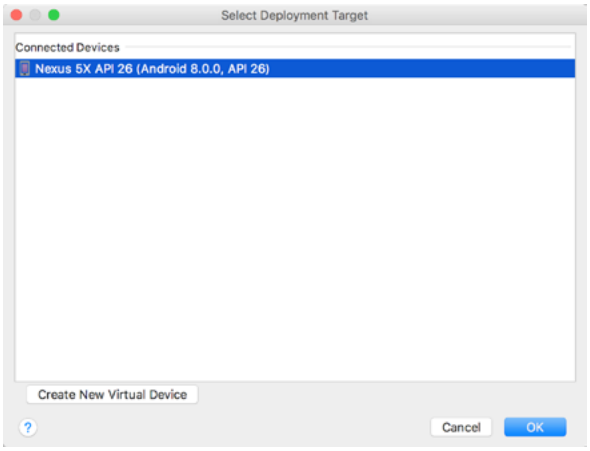



Figure 5-5

Once the application is installed and running, the user interface for the AndroidSampleActivity class will appear within the emulator:

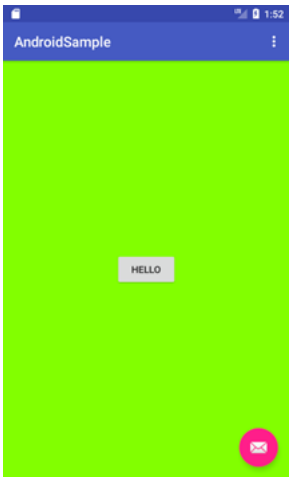



Figure 5-6

In the event that the activity does not automatically launch, check to see if the launch icon has appeared among the apps on the emulator. If it has, simply click on it to launch the application. Once the run process begins, the Run and Logcat tool windows will become available. The Run tool window will display diagnostic information as the application package is installed and launched. Figure 5-7 shows the Run tool window output from a successful application launch:

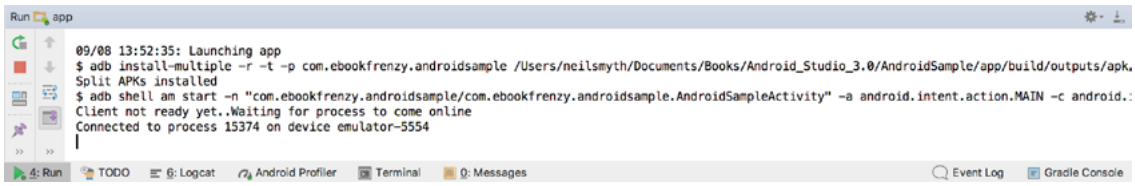



Figure 5-7

If problems are encountered during the launch process, the Run tool window will provide information that will hopefully help to isolate the cause of the problem.

Assuming that the application loads into the emulator and runs as expected, we have safely verified that the Android development environment is correctly installed and configured.

## 5.5 Run/Debug Configurations

A particular project can be configured such that a specific device or emulator is used automatically each time it is run from within Android Studio. This avoids the necessity to make a selection from the device chooser each time the application is executed. To review and modify the Run/Debug configuration, click on the button to the left of the run button in the Android Studio toolbar and select the *Edit Configurations…* option from the resulting menu:

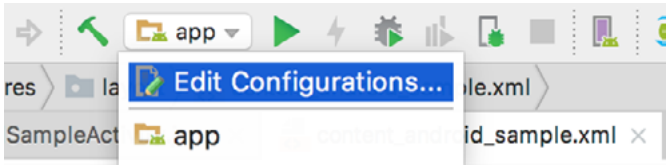



Figure 5-8

In the *Run/Debug Configurations* dialog, the application may be configured to always use a preferred emulator by selecting *Emulator* from the *Target* menu located in the *Deployment Target Options* section and selecting the emulator from the drop down menu. Figure 5-9, for example, shows the AndroidSample application configured to run by default on the previously created Nexus 5X emulator:

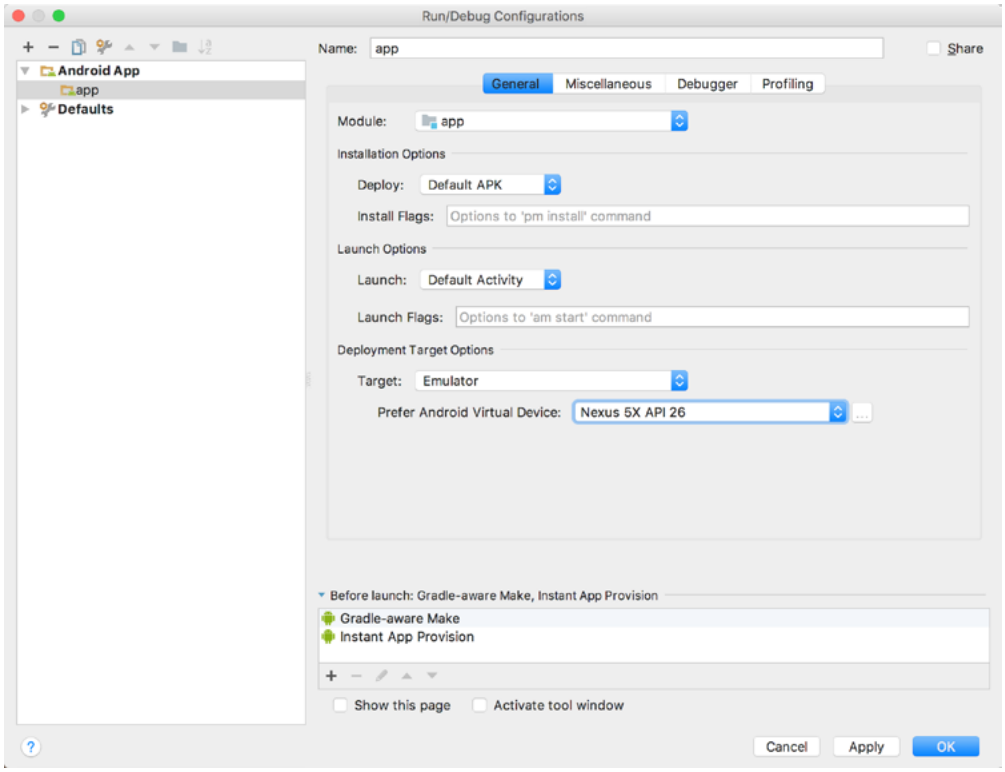



Figure 5-9

Be sure to switch the Target menu setting back to "Open Select Deployment Target Dialog" mode before moving on to the next chapter of the book.

## 5.6 Stopping a Running Application

To stop a running application, simply click on the stop button located in the main toolbar as shown in Figure 5-10:

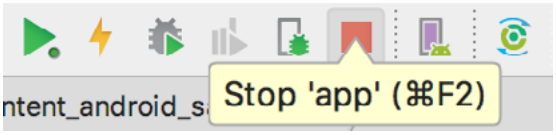



Figure 5-10

An app may also be terminated using the Logcat tool window. Begin by displaying the *Logcat* tool window either using the window bar button, or via the quick access menu (invoked by moving the mouse pointer over the button in the left-hand corner of the status bar as shown in Figure 5-11).

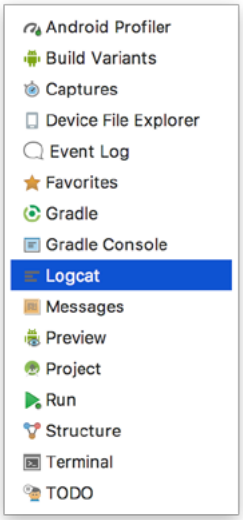



Figure 5-11

Once the Logcat tool window appears, select the *androidsample* app menu highlighted in Figure 5-12 below:

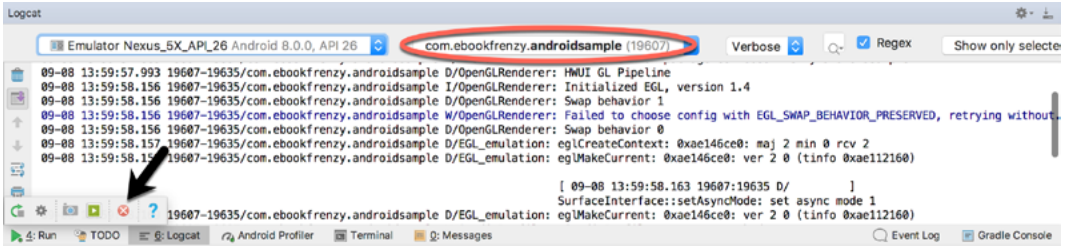



Figure 5-12

With the process selected, stop it by clicking on the red *Terminate Application* button in the toolbar to the left of the process list indicated by the arrow in the above figure.

An alternative to using the Android tool window is to open the Android Device Monitor. This can be launched via the *Tools -> Android -> Android Device Monitor* menu option. Once launched, the process may be selected from the list (Figure 5-13) and terminated by clicking on the red *Stop* button located in the toolbar above the list.

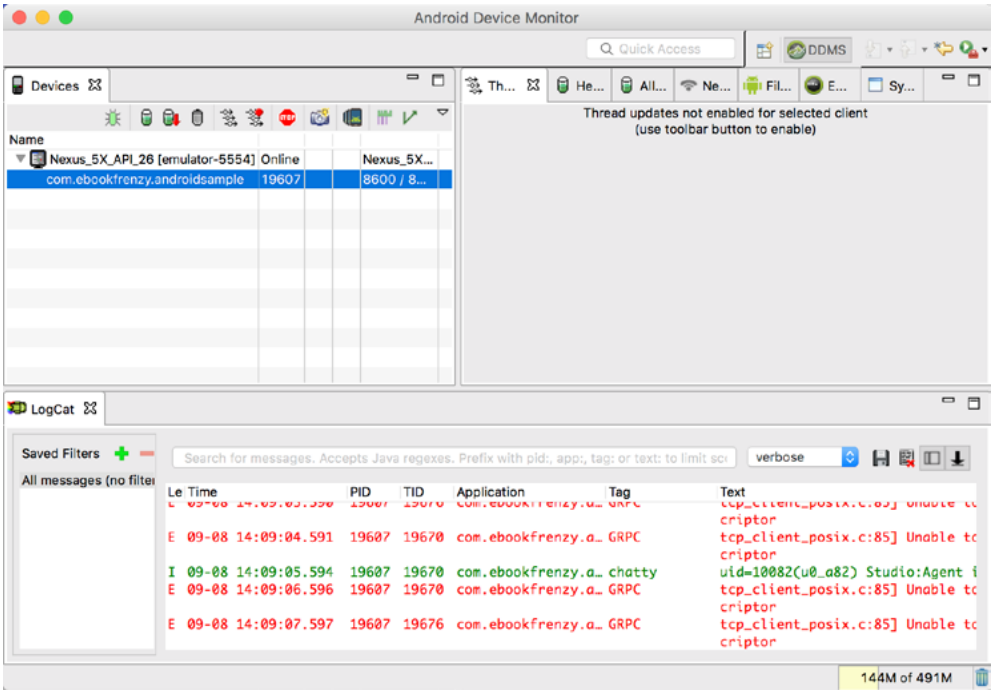



Figure 5-13

## 5.7 AVD Command-line Creation

As previously discussed, in addition to the graphical user interface it is also possible to create a new AVD directly from the command-line. This is achieved using the *avdmanager* tool in conjunction with some command-line options. Once initiated, the tool will prompt for additional information before creating the new AVD.

Assuming that the system has been configured such that the Android SDK *tools* directory is included in the PATH environment variable, a list of available targets for the new AVD may be obtained by issuing the following command in a terminal or command window:

```
avdmanager list targets
```

The resulting output from the above command will contain a list of Android SDK versions that are available on the system. For example:

```
Available Android targets:
----------
id: 1 or "android-25"
     Name: Android API 25
     Type: Platform
     API level: 25
     Revision: 3
----------
id: 2 or "android-26"
```

```
    Name: Android API 26
    Type: Platform
    API level: 26
    Revision: 1
```

The avdmanager tool also allows new AVD instances to be created from the command line. For example, to create a new AVD named *Nexus9* using the target ID for the Android API level 26 device using the x86 ABI, the following command may be used:

```
avdmanager create avd -n Nexus9 -k "system-images;android-26;google_apis;x86"
```

The android tool will create the new AVD to the specifications required for a basic Android 8 device, also providing the option to create a custom configuration to match the specification of a specific device if required. Once a new AVD has been created from the command line, it may not show up in the Android Device Manager tool until the *Refresh* button is clicked.

In addition to the creation of new AVDs, a number of other tasks may be performed from the command line. For example, a list of currently available AVDs may be obtained using the *list avd* command line arguments:

```
avdmanager list avd


Available Android Virtual Devices:
Name: Nexus_5X_API_26
  Device: Nexus 5X (Google)
    Path: /Users/neilsmyth/.android/avd/Nexus_5X_API_26.avd
  Target: Google Play (Google Inc.)
          Based on: Android 8.0 (Oreo) Tag/ABI: google_apis_playstore/x86
    Skin: nexus_5x
  Sdcard: 100M
```

Similarly, to delete an existing AVD, simply use the *delete* option as follows:

```
avdmanager delete avd –n <avd name>
```

## 5.8 Android Virtual Device Configuration Files

By default, the files associated with an AVD are stored in the *.android/avd* sub-directory of the user's home directory, the structure of which is as follows (where <*avd name*> is replaced by the name assigned to the AVD):

```
<avd name>.avd/config.ini
<avd name>.avd/userdata.img
<avd name>.ini
```

The *config.ini* file contains the device configuration settings such as display dimensions and memory specified during the AVD creation process. These settings may be changed directly within the configuration file and will be adopted by the AVD when it is next invoked.

The <*avd name*>*.ini* file contains a reference to the target Android SDK and the path to the AVD files. Note that a change to the *image.sysdir* value in the *config.ini* file will also need to be reflected in the *target* value of this file.

## 5.9 Moving and Renaming an Android Virtual Device

The current name or the location of the AVD files may be altered from the command line using the *avdmanager* tool's *move avd* argument. For example, to rename an AVD named Nexus9 to Nexus9B, the following command may be executed:

```
avdmanager move avd -n Nexus9 -r Nexus9B
```

To physically relocate the files associated with the AVD, the following command syntax should be used:

```
avdmanager move avd -n <avd name> -p <path to new location>
```

For example, to move an AVD from its current file system location to /tmp/Nexus9Test:

```
avdmanager move avd -n Nexus9 -p /tmp/Nexus9Test
```

Note that the destination directory must not already exist prior to executing the command to move an AVD.

## 5.10 Summary

A typical application development process follows a cycle of coding, compiling and running in a test environment. Android applications may be tested on either a physical Android device or using an Android Virtual Device (AVD) emulator. AVDs are created and managed using the Android AVD Manager tool which may be used either as a command line tool or using a graphical user interface. When creating an AVD to simulate a specific Android device model it is important that the virtual device be configured with a hardware specification that matches that of the physical device.

Chapter 6

# 6. Using and Configuring the Android Studio AVD Emulator

The Android Virtual Device (AVD) emulator environment bundled with Android Studio 1.x was an uncharacteristically weak point in an otherwise reputable application development environment. Regarded by many developers as slow, inflexible and unreliable, the emulator was long overdue for an overhaul. Fortunately, Android Studio 2 introduced an enhanced emulator environment providing significant improvements in terms of configuration flexibility and overall performance and further enhancements have been made for Android Studio 3.

Before the next chapter explores testing on physical Android devices, this chapter will take some time to provide an overview of the Android Studio AVD emulator and highlight many of the configuration features that are available to customize the environment.

## 6.1 The Emulator Environment

When launched, the emulator displays an initial splash screen during the loading process. Once loaded, the main emulator window appears containing a representation of the chosen device type (in the case of Figure 6-1 this is a Nexus 5X device):


Figure 6-1

Positioned along the right-hand edge of the window is the toolbar providing quick access to the emulator controls and configuration options.

## 6.2 The Emulator Toolbar Options

The emulator toolbar (Figure 6-2) provides access to a range of options relating to the appearance and behavior of the emulator environment.

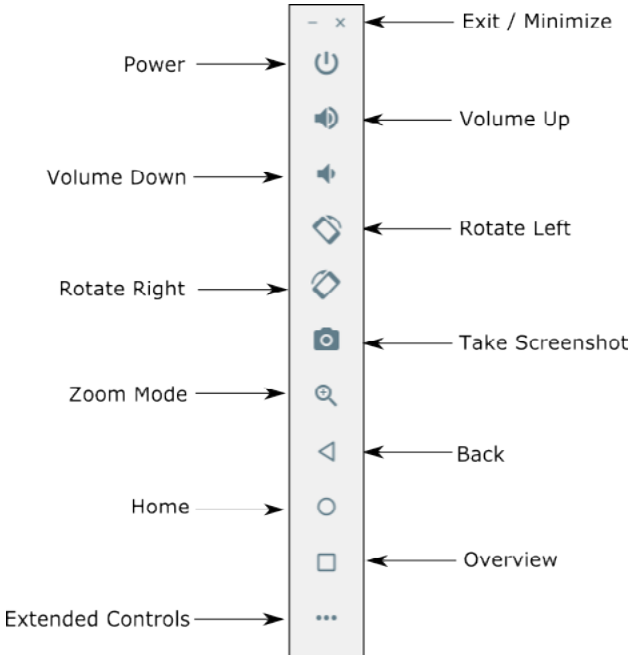



Figure 6-2

Each button in the toolbar has associated with it a keyboard accelerator which can be identified either by hovering the mouse pointer over the button and waiting for the tooltip to appear, or via the help option of the extended controls panel.

Though many of the options contained within the toolbar are self-explanatory, each option will be covered for the sake of completeness:

- **Exit / Minimize** – The uppermost 'x' button in the toolbar exits the emulator session when selected while the '-' option minimizes the entire window.
- **Power** – The Power button simulates the hardware power button on a physical Android device. Clicking and releasing this button will lock the device and turn off the screen. Clicking and holding this button will initiate the device "Power off" request sequence.
- **Volume Up / Down** – Two buttons that control the audio volume of playback within the simulator environment.
- **Rotate Left/Right** – Rotates the emulated device between portrait and landscape orientations.
- **Screenshot** – Takes a screenshot of the content currently displayed on the device screen. The captured image is stored at the location specified in the Settings screen of the extended controls panel as outlined later in this chapter.
- **Zoom Mode** – This button toggles in and out of zoom mode, details of which will be covered later in this chapter.
- **Back** – Simulates selection of the standard Android "Back" button. As with the Home and Overview buttons outlined below, the same results can be achieved by selecting the actual buttons on the emulator screen.
- **Home** – Simulates selection of the standard Android "Home" button.

- **Overview** – Simulates selection of the standard Android "Overview" button which displays the currently running apps on the device.
- **Extended Controls** – Displays the extended controls panel, allowing for the configuration of options such as simulated location and telephony activity, battery strength, cellular network type and fingerprint identification.

## 6.3 Working in Zoom Mode

The zoom button located in the emulator toolbar switches in and out of zoom mode. When zoom mode is active the toolbar button is depressed and the mouse pointer appears as a magnifying glass when hovering over the device screen. Clicking the left mouse button will cause the display to zoom in relative to the selected point on the screen, with repeated clicking increasing the zoom level. Conversely, clicking the right mouse button decreases the zoom level. Toggling the zoom button off reverts the display to the default size.

Clicking and dragging while in zoom mode will define a rectangular area into which the view will zoom when the mouse button is released.

While in zoom mode the visible area of the screen may be panned using the horizontal and vertical scrollbars located within the emulator window.

## 6.4 Resizing the Emulator Window

The size of the emulator window (and the corresponding representation of the device) can be changed at any time by clicking and dragging on any of the corners or sides of the window.

## 6.5 Extended Control Options

The extended controls toolbar button displays the panel illustrated in Figure 6-3. By default, the location settings will be displayed. Selecting a different category from the left-hand panel will display the corresponding group of controls:

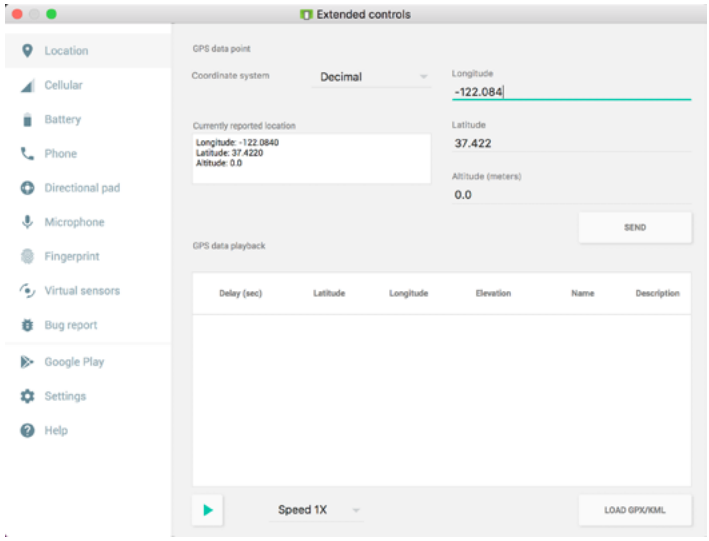



Figure 6-3

### 6.5.1 Location

The location controls allow simulated location information to be sent to the emulator in the form of decimal or sexigesimal coordinates. Location information can take the form of a single location, or a sequence of points representing movement of the device, the latter being provided via a file in either GPS Exchange (GPX) or

Keyhole Markup Language (KML) format.

A single location is transmitted to the emulator when the *Send* button is clicked. The transmission of GPS data points begins once the "play" button located beneath the data table is selected. The speed at which the GPS data points are fed to the emulator can be controlled using the speed menu adjacent to the play button.

### 6.5.2 Cellular

The type of cellular connection being simulated can be changed within the cellular settings screen. Options are available to simulate different network types (CSM, EDGE, HSDPA etc) in addition to a range of voice and data scenarios such as roaming and denied access.

### 6.5.3 Battery

A variety of battery state and charging conditions can be simulated on this panel of the extended controls screen, including battery charge level, battery health and whether the AC charger is currently connected.

### 6.5.4 Phone

The phone extended controls provide two very simple but useful simulations within the emulator. The first option allows for the simulation of an incoming call from a designated phone number. This can be of particular use when testing the way in which an app handles high level interrupts of this nature.

The second option allows the receipt of text messages to be simulated within the emulator session. As in the real world, these messages appear within the Message app and trigger the standard notifications within the emulator.

### 6.5.5 Directional Pad

A directional pad (D-Pad) is an additional set of controls either built into an Android device or connected externally (such as a game controller) that provides directional controls (left, right, up, down). The directional pad settings allow D-Pad interaction to be simulated within the emulator.

### 6.5.6 Microphone

The microphone settings allow the microphone to be enabled and virtual headset and microphone connections to be simulated. A button is also provided to launch the Voice Assistant on the emulator.

### 6.5.7 Fingerprint

Many Android devices are now supplied with built-in fingerprint detection hardware. The AVD emulator makes it possible to test fingerprint authentication without the need to test apps on a physical device containing a fingerprint sensor. Details on how to configure fingerprint testing within the emulator will be covered in detail later in this chapter.

### 6.5.8 Virtual Sensors

The virtual sensors option allows the accelerometer and magnetometer to be simulated to emulate the effects of the physical motion of a device such as rotation, movement and tilting through yaw, pitch and roll settings.

### 6.5.9 Settings

The settings panel provides a small group of configuration options. Use this panel to choose a darker theme for the toolbar and extended controls panel, specify a file system location into which screenshots are to be saved, configure OpenGL support levels, and to configure the emulator window to appear on top of other windows on the desktop.

### 6.5.10 Help

The Help screen contains three sub-panels containing a list of keyboard shortcuts, links to access the emulator online documentation, file bugs and send feedback, and emulator version information.

## 6.6 Drag and Drop Support

An Android application is packaged into an APK file when it is built. When Android Studio built and ran the AndroidSample app created earlier in this book, for example, the application was compiled and packaged into an APK file. That APK file was then transferred to the emulator and launched.

The Android Studio emulator also supports installation of apps by dragging and dropping the corresponding APK file onto the emulator window. To experience this in action, start the emulator, open Settings and select the *Apps & notifications* option followed by the *App Info* option on the subsequent screen. Within the list of installed apps, locate and select the AndroidSample app and, in the app detail screen, uninstall the app from the emulator.

Open the file system navigation tool for your operating system (e.g. Windows Explorer for Windows or Finder for macOS) and navigate to the folder containing the AndroidSample project. Within this folder locate the *app/build/outputs/apk/debug* subfolder. This folder should contain an APK file named *app-debug.apk*. Drag this file and drop it onto the emulator window. The dialog shown in (Figure 6-4) will subsequently appear as the APK file is installed.

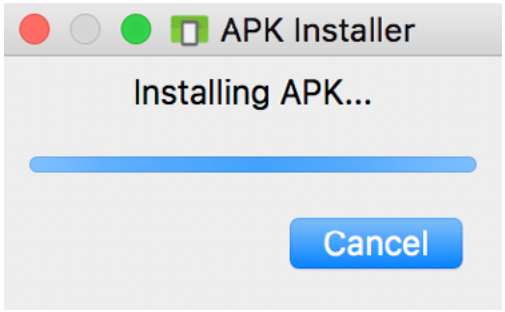



Figure 6-4

Once the APK file installation has completed, locate the app on the device and click on it to launch it.

In addition to APK files, any other type of file such as image, video or data files can be installed onto the emulator using this drag and drop feature. Such files are added to the SD card storage area of the emulator where they may subsequently be accessed from within app code.

## 6.7 Configuring Fingerprint Emulation

The emulator allows up to 10 simulated fingerprints to be configured and used to test fingerprint authentication within Android apps. To configure simulated fingerprints begin by launching the emulator, opening the Settings app and selecting the *Security & Location* option.

Within the Security settings screen, select the *Use fingerprint* option. On the resulting information screen click on the *Next* button to proceed to the Fingerprint setup screen. Before fingerprint security can be enabled a backup screen unlocking method (such as a PIN number) must be configured. Click on the *Fingerprint + PIN* button and, when prompted, choose not to require the PIN on device startup. Enter and confirm a suitable PIN number and complete the PIN entry process by accepting the default notifications option.

Proceed through the remaining screens until the Settings app requests a fingerprint on the sensor. At this point display the extended controls dialog, select the *Fingerprint* category in the left-hand panel and make sure that *Finger 1* is selected in the main settings panel:

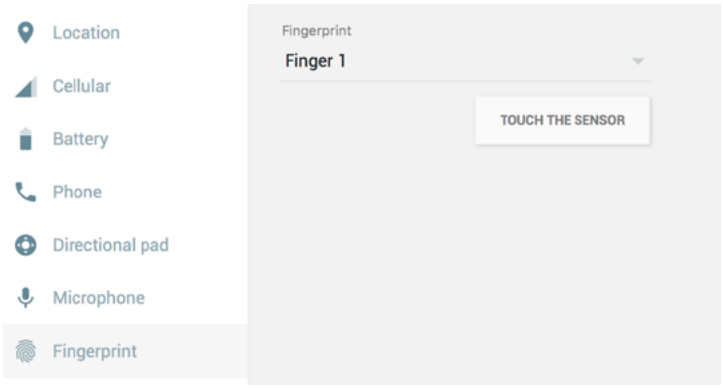



Figure 6-5

Click on the *Touch the Sensor* button to simulate Finger 1 touching the fingerprint sensor. The emulator will report the successful addition of the fingerprint:

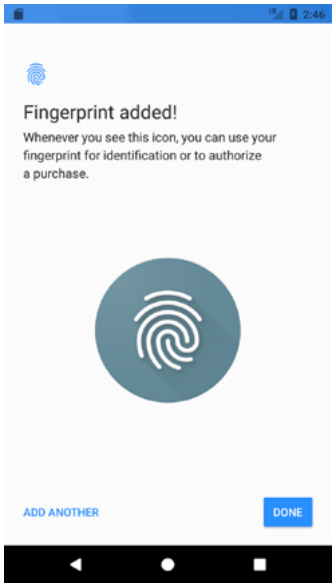



Figure 6-6

To add additional fingerprints click on the *Add Another* button and select another finger from the extended controls panel menu before clicking on the *Touch the Sensor* button once again. The topic of building fingerprint authentication into an Android app is covered in detail in the chapter entitled *"An Android Fingerprint Authentication Tutorial"*.

## 6.8 Summary

Android Studio 3 contains a new and improved Android Virtual Device emulator environment designed to make it easier to test applications without the need to run on a physical Android device. This chapter has provided a brief tour of the emulator and highlighted key features that are available to configure and customize the environment to simulate different testing conditions

Chapter 7

# 7. Testing Android Studio Apps on a Physical Android Device

While much can be achieved by testing applications using an Android Virtual Device (AVD), there is no substitute for performing real world application testing on a physical Android device and there are a number of Android features that are only available on physical Android devices.

Communication with both AVD instances and connected Android devices is handled by the *Android Debug Bridge (ADB)*. In this chapter we will work through the steps to configure the adb environment to enable application testing on a physical Android device with macOS, Windows and Linux based systems.

## 7.1 An Overview of the Android Debug Bridge (ADB)

The primary purpose of the ADB is to facilitate interaction between a development system, in this case Android Studio, and both AVD emulators and physical Android devices for the purposes of running and debugging applications.

The ADB consists of a client, a server process running in the background on the development system and a daemon background process running in either AVDs or real Android devices such as phones and tablets.

The ADB client can take a variety of forms. For example, a client is provided in the form of a command-line tool named *adb* located in the Android SDK *platform-tools* sub-directory. Similarly, Android Studio also has a built-in client.

A variety of tasks may be performed using the *adb* command-line tool. For example, a listing of currently active virtual or physical devices may be obtained using the *devices* command-line argument. The following command output indicates the presence of an AVD on the system but no physical devices:

```
$ adb devices
List of devices attached
emulator-5554   device
```

## 7.2 Enabling ADB on Android based Devices

Before ADB can connect to an Android device, that device must first be configured to allow the connection. On phone and tablet devices running Android 6.0 or later, the steps to achieve this are as follows:

1. Open the Settings app on the device and select the *About tablet* or *About phone* option.
2. On the *About* screen, scroll down to the *Build number* field (Figure 7-1) and tap on it seven times until a message appears indicating that developer mode has been enabled.

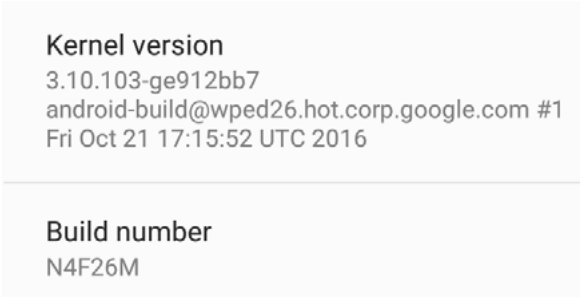



Figure 7-1

3. Return to the main Settings screen and note the appearance of a new option titled Developer options. Select this option and locate the setting on the developer screen entitled USB debugging. Enable the switch next to this item as illustrated in Figure 7-2:


Figure 7-2

4. Swipe downward from the top of the screen to display the notifications panel (Figure 7-3) and note that the device is currently connected for debugging.

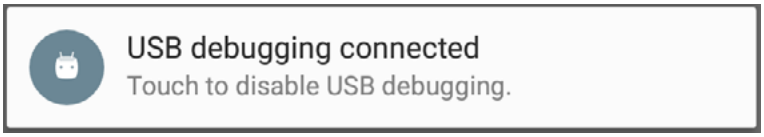



Figure 7-3

At this point, the device is now configured to accept debugging connections from adb on the development system. All that remains is to configure the development system to detect the device when it is attached. While this is a relatively straightforward process, the steps involved differ depending on whether the development system is running Windows, macOS or Linux. Note that the following steps assume that the Android SDK *platform-tools* directory is included in the operating system PATH environment variable as described in the chapter entitled *"Setting up an Android Studio Development Environment"*.

## 7.2.1 macOS ADB Configuration

In order to configure the ADB environment on a macOS system, connect the device to the computer system using a USB cable, open a terminal window and execute the following command to restart the adb server:

```
$ adb kill-server
$ adb start-server
* daemon not running. starting it now on port 5037 *
* daemon started successfully *
```

Once the server is successfully running, execute the following command to verify that the device has been detected:

```
$ adb devices
List of devices attached
```

```
74CE000600000001        offline
```

If the device is listed as *offline*, go to the Android device and check for the presence of the dialog shown in Figure 7-4 seeking permission to *Allow USB debugging*. Enable the checkbox next to the option that reads *Always allow from this computer*, before clicking on *OK*. Repeating the *adb devices* command should now list the device as being available:

```
List of devices attached
015d41d4454bf80c        device
```

In the event that the device is not listed, try logging out and then back in to the macOS desktop and, if the problem persists, rebooting the system.

### 7.2.2 Windows ADB Configuration

The first step in configuring a Windows based development system to connect to an Android device using ADB is to install the appropriate USB drivers on the system. The USB drivers to install will depend on the model of Android Device. If you have a Google Nexus device, then it will be necessary to install and configure the Google USB Driver package on your Windows system. Detailed steps to achieve this are outlined on the following web page:

*http://developer.android.com/sdk/win-usb.html*

For Android devices not supported by the Google USB driver, it will be necessary to download the drivers provided by the device manufacturer. A listing of drivers together with download and installation information can be obtained online at:

*http://developer.android.com/tools/extras/oem-usb.html*

With the drivers installed and the device now being recognized as the correct device type, open a Command Prompt window and execute the following command:

```
adb devices
```

This command should output information about the connected device similar to the following:

```
List of devices attached
HT4CTJT01906        offline
```

If the device is listed as *offline* or *unauthorized*, go to the device display and check for the dialog shown in Figure 7-4 seeking permission to *Allow USB debugging*.

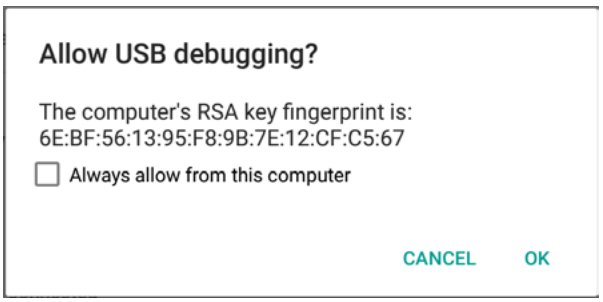



Figure 7-4

Enable the checkbox next to the option that reads *Always allow from this computer*, before clicking on *OK*. Repeating the *adb devices* command should now list the device as being ready:

```
List of devices attached
```

```
HT4CTJT01906    device
```

In the event that the device is not listed, execute the following commands to restart the ADB server:

```
adb kill-server
adb start-server
```

If the device is still not listed, try executing the following command:

```
android update adb
```

Note that it may also be necessary to reboot the system.

### 7.2.3 Linux adb Configuration

For the purposes of this chapter, we will once again use Ubuntu Linux as a reference example in terms of configuring adb on Linux to connect to a physical Android device for application testing.

Physical device testing on Ubuntu Linux requires the installation of a package named *android-tools-adb* which, in turn, requires that the Android Studio user be a member of the *plugdev* group. This is the default for user accounts on most Ubuntu versions and can be verified by running the *id* command. If plugdev group is not listed, run the following command to add your account to the group:

```
sudo usermod -aG plugdev $LOGNAME
```

After the group membership requirement has been met, the *android-tools-adb* package can be installed by executing the following command:

```
sudo apt-get install android-tools-adb
```

Once the above changes have been made, reboot the Ubuntu system. Once the system has restarted, open a Terminal window, start the adb server and check the list of attached devices:

```
$ adb start-server
* daemon not running. starting it now on port 5037 *
* daemon started successfully *
$ adb devices
List of devices attached
015d41d4454bf80c        offline
```

If the device is listed as *offline* or *unauthorized*, go to the Android device and check for the dialog shown in Figure 7-4 seeking permission to *Allow USB debugging*.

## 7.3 Testing the adb Connection

Assuming that the adb configuration has been successful on your chosen development platform, the next step is to try running the test application created in the chapter entitled *"Creating an Example Android App in Android Studio"* on the device.

Launch Android Studio, open the AndroidSample project and, once the project has loaded, click on the run button located in the Android Studio toolbar (Figure 7-5).

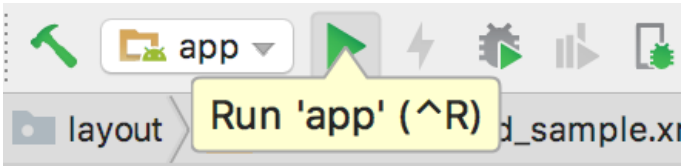



Figure 7-5

Assuming that the project has not previously been configured to run automatically in an emulator environment, the deployment target selection dialog will appear with the connected Android device listed as a currently running device. Figure 7-6, for example, lists a Nexus 9 device as a suitable target for installing and executing the application.

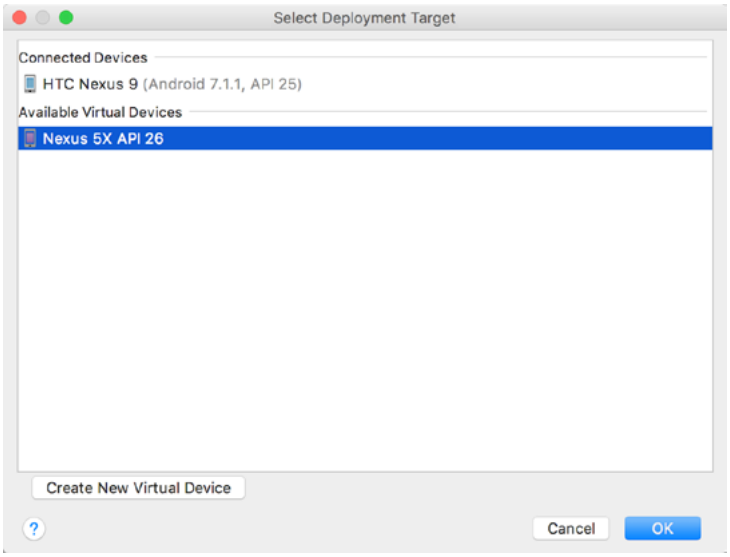



Figure 7-6

To make this the default device for testing, enable the *Use same device for future launches* option. With the device selected, click on the *OK* button to install and run the application on the device. As with the emulator environment, diagnostic output relating to the installation and launch of the application on the device will be logged in the Run tool window.

## 7.4 Summary

While the Android Virtual Device emulator provides an excellent testing environment, it is important to keep in mind that there is no real substitute for making sure an application functions correctly on a physical Android device. This, after all, is where the application will be used in the real world.

By default, however, the Android Studio environment is not configured to detect Android devices as a target testing device. It is necessary, therefore, to perform some steps in order to be able to load applications directly onto an Android device from within the Android Studio development environment. The exact steps to achieve this goal differ depending on the development platform being used. In this chapter, we have covered those steps for Linux, macOS and Windows based platforms.

Chapter 8

# 8. The Basics of the Android Studio Code Editor

Developing applications for Android involves a considerable amount of programming work which, by definition, involves typing, reviewing and modifying lines of code. It should come as no surprise that the majority of a developer's time spent using Android Studio will typically involve editing code within the editor window.

The modern code editor needs to go far beyond the original basics of typing, deleting, cutting and pasting. Today the usefulness of a code editor is generally gauged by factors such as the amount by which it reduces the typing required by the programmer, ease of navigation through large source code files and the editor's ability to detect and highlight programming errors in real-time as the code is being written. As will become evident in this chapter, these are just a few of the areas in which the Android Studio editor excels.

While not an exhaustive overview of the features of the Android Studio editor, this chapter aims to provide a guide to the key features of the tool. Experienced programmers will find that some of these features are common to most code editors available today, while a number are unique to this particular editing environment.

## 8.1 The Android Studio Editor

The Android Studio editor appears in the center of the main window when a Java, Kotlin, XML or other text based file is selected for editing. Figure 8-1, for example, shows a typical editor session with a Kotlin source code file loaded:

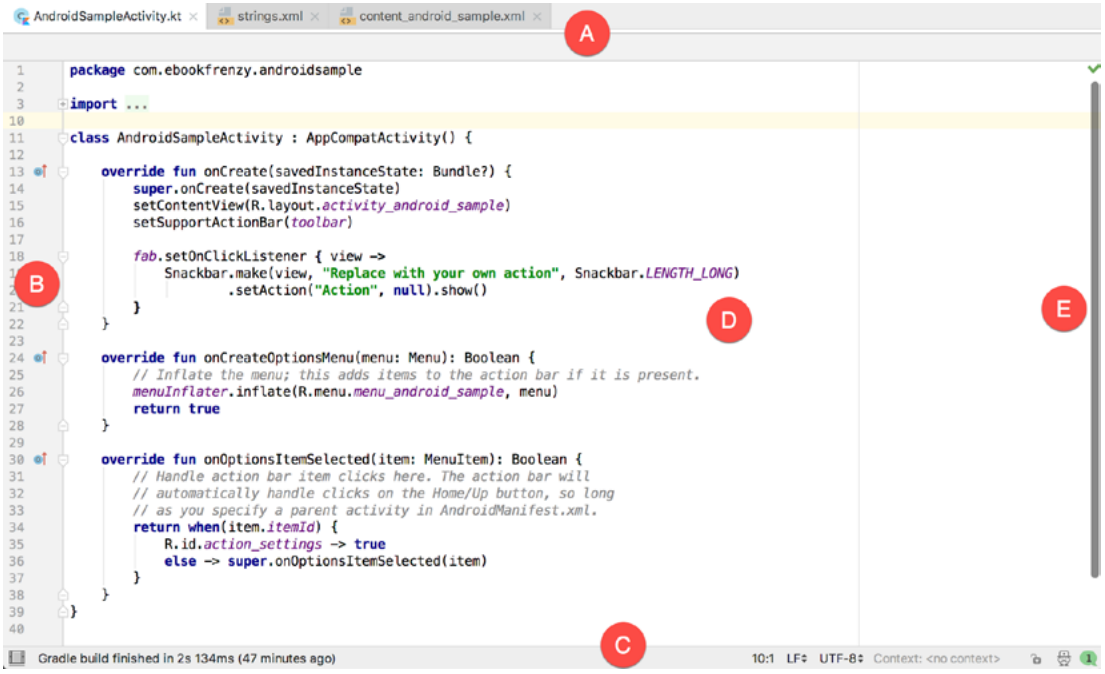



Figure 8-1

The elements that comprise the editor window can be summarized as follows:

**A – Document Tabs** – Android Studio is capable of holding multiple files open for editing at any one time. As each file is opened, it is assigned a document tab displaying the file name in the tab bar located along the top edge of the editor window. A small dropdown menu will appear in the far right-hand corner of the tab bar when there is insufficient room to display all of the tabs. Clicking on this menu will drop down a list of additional open files. A wavy red line underneath a file name in a tab indicates that the code in the file contains one or more errors that need to be addressed before the project can be compiled and run.

Switching between files is simply a matter of clicking on the corresponding tab or using the *Alt-Left* and *Alt-Right* keyboard shortcuts. Navigation between files may also be performed using the Switcher mechanism (accessible via the *Ctrl-Tab* keyboard shortcut).

To detach an editor panel from the Android Studio main window so that it appears in a separate window, click on the tab and drag it to an area on the desktop outside of the main window. To return the editor to the main window, click on the file tab in the separated editor window and drag and drop it onto the original editor tab bar in the main window.

**B – The Editor Gutter Area** - The gutter area is used by the editor to display informational icons and controls. Some typical items, among others, which appear in this gutter area are debugging breakpoint markers, controls to fold and unfold blocks of code, bookmarks, change markers and line numbers. Line numbers are switched on by default but may be disabled by right-clicking in the gutter and selecting the *Show Line Numbers* menu option.

**C – The Status Bar** – Though the status bar is actually part of the main window, as opposed to the editor, it does contain some information about the currently active editing session. This information includes the current position of the cursor in terms of lines and characters and the encoding format of the file (UTF-8, ASCII etc.). Clicking on these values in the status bar allows the corresponding setting to be changed. Clicking on the line number, for example, displays the *Go to Line* dialog.

**D – The Editor Area** – This is the main area where the code is displayed, entered and edited by the user. Later sections of this chapter will cover the key features of the editing area in detail.

**E – The Validation and Marker Sidebar** – Android Studio incorporates a feature referred to as "on-the-fly code analysis". What this essentially means is that as you are typing code, the editor is analyzing the code to check for warnings and syntax errors. The indicator at the top of the validation sidebar will change from a green check mark (no warnings or errors detected) to a yellow square (warnings detected) or red alert icon (errors have been detected). Clicking on this indicator will display a popup containing a summary of the issues found with the code in the editor as illustrated in Figure 8-2:


Figure 8-2

The sidebar also displays markers at the locations where issues have been detected using the same color coding. Hovering the mouse pointer over a marker when the line of code is visible in the editor area will display a popup

containing a description of the issue (Figure 8-3):

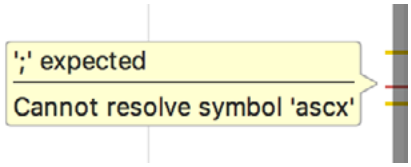



Figure 8-3

Hovering the mouse pointer over a marker for a line of code which is currently scrolled out of the viewing area of the editor will display a "lens" overlay containing the block of code where the problem is located (Figure 8-4) allowing it to be viewed without the necessity to scroll to that location in the editor:

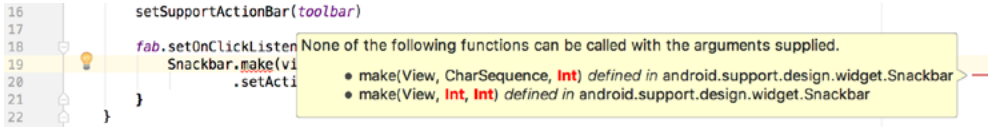



Figure 8-4

It is also worth noting that the lens overlay is not limited to warnings and errors in the sidebar. Hovering over any part of the sidebar will result in a lens appearing containing the code present at that location within the source file.

Having provided an overview of the elements that comprise the Android Studio editor, the remainder of this chapter will explore the key features of the editing environment in more detail.

## 8.2 Splitting the Editor Window

By default, the editor will display a single panel showing the content of the currently selected file. A particularly useful feature when working simultaneously with multiple source code files is the ability to split the editor into multiple panes. To split the editor, right-click on a file tab within the editor window and select either the *Split Vertically* or *Split Horizontally* menu option. Figure 8-5, for example, shows the splitter in action with the editor split into three panels:

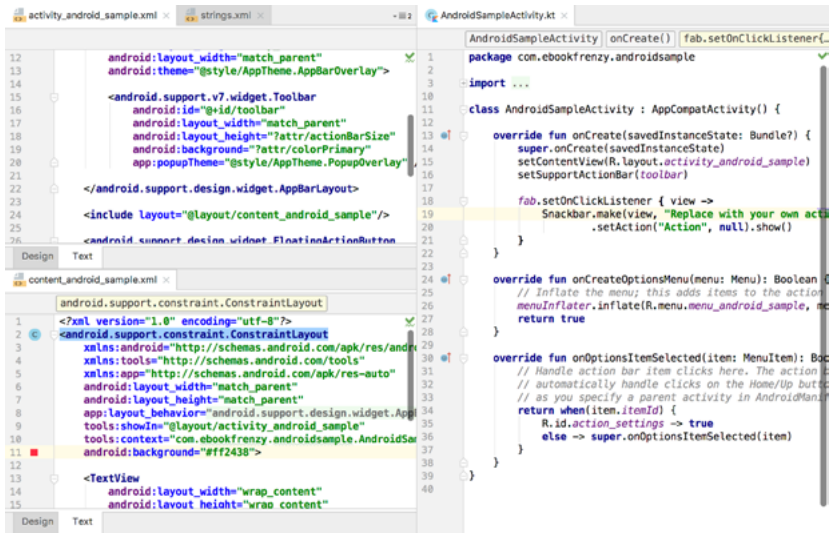



Figure 8-5

The orientation of a split panel may be changed at any time by right-clicking on the corresponding tab and selecting the *Change Splitter Orientation* menu option. Repeat these steps to unsplit a single panel, this time selecting the *Unsplit* option from the menu. All of the split panels may be removed by right-clicking on any tab and selecting the *Unsplit All* menu option.

Window splitting may be used to display different files, or to provide multiple windows onto the same file, allowing different areas of the same file to be viewed and edited concurrently.

## 8.3 Code Completion

The Android Studio editor has a considerable amount of built-in knowledge of Kotlin programming syntax and the classes and methods that make up the Android SDK, as well as knowledge of your own code base. As code is typed, the editor scans what is being typed and, where appropriate, makes suggestions with regard to what might be needed to complete a statement or reference. When a completion suggestion is detected by the editor, a panel will appear containing a list of suggestions. In Figure 8-6, for example, the editor is suggesting possibilities for the beginning of a String declaration:

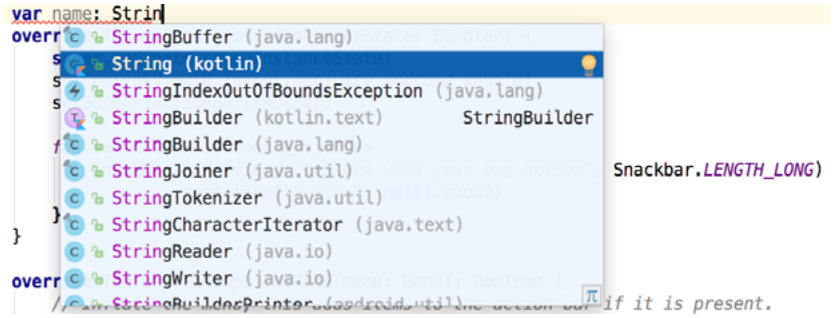



Figure 8-6

If none of the auto completion suggestions are correct, simply keep typing and the editor will continue to refine the suggestions where appropriate. To accept the top most suggestion, simply press the Enter or Tab key on the keyboard. To select a different suggestion, use the arrow keys to move up and down the list, once again using the Enter or Tab key to select the highlighted item.

Completion suggestions can be manually invoked using the *Ctrl-Space* keyboard sequence. This can be useful when changing a word or declaration in the editor. When the cursor is positioned over a word in the editor, that word will automatically highlight. Pressing *Ctrl-Space* will display a list of alternate suggestions. To replace the current word with the currently highlighted item in the suggestion list, simply press the Tab key.

In addition to the real-time auto completion feature, the Android Studio editor also offers a system referred to as *Smart Completion*. Smart completion is invoked using the *Shift-Ctrl-Space* keyboard sequence and, when selected, will provide more detailed suggestions based on the current context of the code. Pressing the *Shift-Ctrl-Space* shortcut sequence a second time will provide more suggestions from a wider range of possibilities.

Code completion can be a matter of personal preference for many programmers. In recognition of this fact, Android Studio provides a high level of control over the auto completion settings. These can be viewed and modified by selecting the *File -> Settings…* menu option (or *Android Studio -> Preferences…* on macOS) and choosing *Editor -> General -> Code Completion* from the settings panel as shown in Figure 8-7:

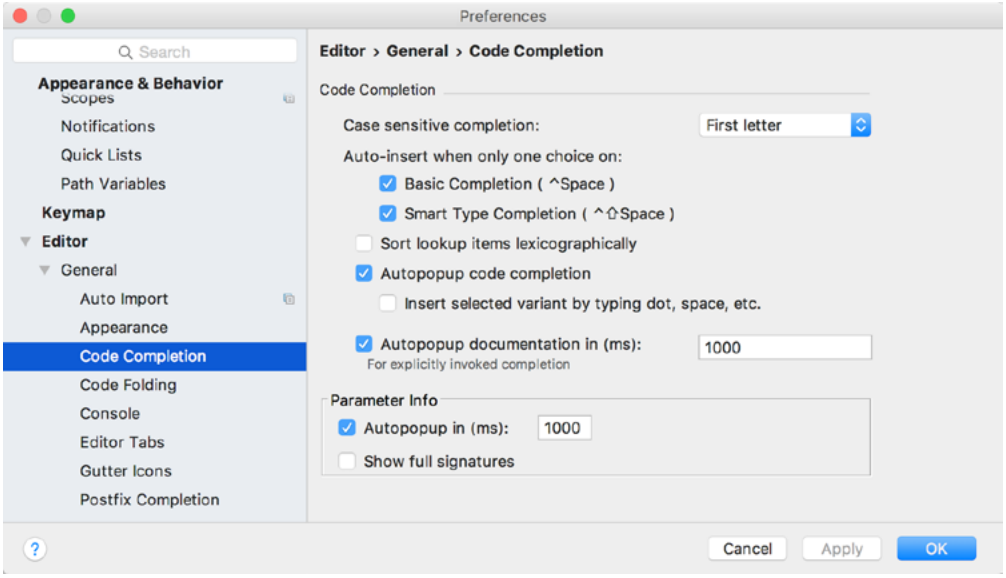



Figure 8-7

## 8.4 Statement Completion

Another form of auto completion provided by the Android Studio editor is statement completion. This can be used to automatically fill out the parentheses and braces for items such as methods and loop statements. Statement completion is invoked using the *Shift-Ctrl-Enter* (*Shift-Cmd-Enter* on macOS) keyboard sequence. Consider for example the following code:

```
myMethod()
```

Having typed this code into the editor, triggering statement completion will cause the editor to automatically add the braces to the method:

```
myMethod() {


}
```

## 8.5 Parameter Information

It is also possible to ask the editor to provide information about the argument parameters accepted by a method. With the cursor positioned between the brackets of a method call, the *Ctrl-P* (*Cmd-P* on macOS) keyboard sequence will display the parameters known to be accepted by that method, with the most likely suggestion highlighted in bold:

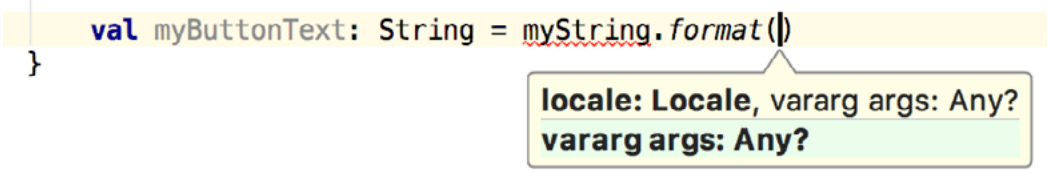



Figure 8-8

## 8.6 Parameter Name Hints

The code editor may be configured to display parameter name hints within method calls. Figure 8-9, for example, highlights the parameter name hints within the calls to the *make()* and *setAction()* methods of the *Snackbar* class:

```
FloatingActionButton fab = (FloatingActionButton) findViewById(R.id.fab);
fab.setOnClickListener((view) → {
        Snackbar.make(view, text: "Replace with your own action", Snackbar.LENGTH_LONG)
                .setAction( text: "Action",  listener: null).show();
});
```

Figure 8-9

The settings for this mode may be configured by selecting the *File -> Settings* (*Android Studio -> Preferences* on macOS) menu option followed by *Editor -> Appearance* in the left-hand panel. On the Appearance screen, enable or disable the *Show parameter name hints* option. To adjust the hint settings, click on the *Configure...* button, select the programming language and make any necessary adjustments.

## 8.7 Code Generation

In addition to completing code as it is typed the editor can, under certain conditions, also generate code for you. The list of available code generation options shown in Figure 8-10 can be accessed using the *Alt-Insert* (*Cmd-N* on macOS) keyboard shortcut when the cursor is at the location in the file where the code is to be generated.

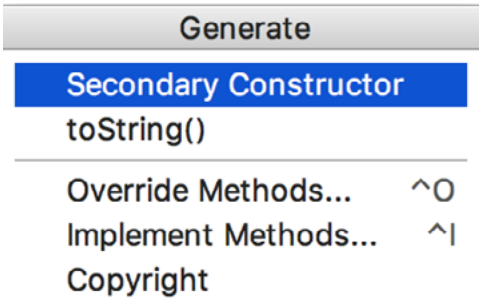



Figure 8-10

For the purposes of an example, consider a situation where we want to be notified when an Activity in our project is about to be destroyed by the operating system. As will be outlined in a later chapter of this book, this can be achieved by overriding the *onStop()* lifecycle method of the Activity superclass. To have Android Studio generate a stub method for this, simply select the *Override Methods…* option from the code generation list and select the *onStop()* method from the resulting list of available methods:

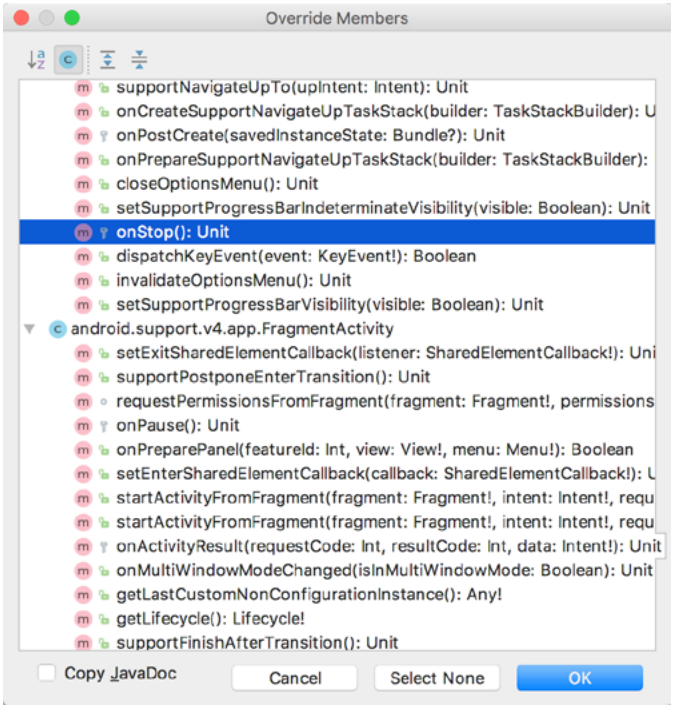



Figure 8-11

Having selected the method to override, clicking on *OK* will generate the stub method at the current cursor location in the Kotlin source file as follows:

```
override fun onStop() {
    super.onStop()
}
```

## 8.8 Code Folding

Once a source code file reaches a certain size, even the most carefully formatted and well organized code can become overwhelming and difficult to navigate. Android Studio takes the view that it is not always necessary to have the content of every code block visible at all times. Code navigation can be made easier through the use of the *code folding* feature of the Android Studio editor. Code folding is controlled using markers appearing in the editor gutter at the beginning and end of each block of code in a source file. Figure 8-12, for example, highlights the start and end markers for a method declaration which is not currently folded:

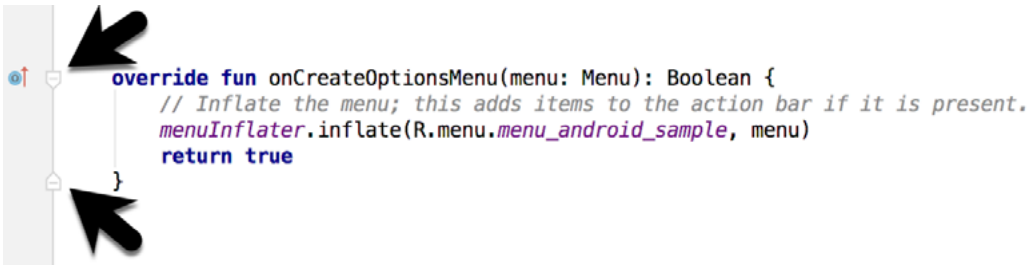



Figure 8-12

Clicking on either of these markers will fold the statement such that only the signature line is visible as shown

in Figure 8-13:

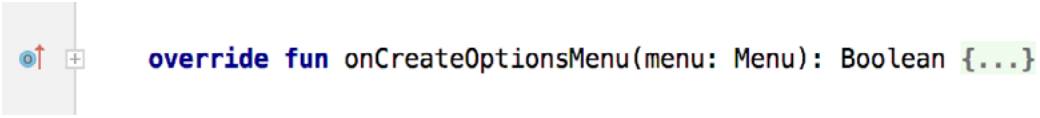



Figure 8-13

To unfold a collapsed section of code, simply click on the '+' marker in the editor gutter. To see the hidden code without unfolding it, hover the mouse pointer over the "{…}" indicator as shown in Figure 8-14. The editor will then display the lens overlay containing the folded code block:

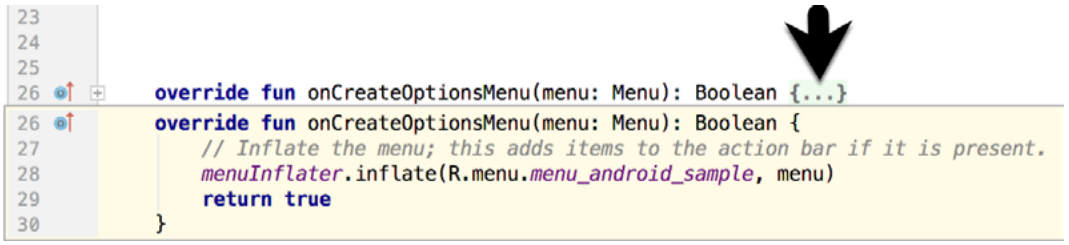



Figure 8-14

All of the code blocks in a file may be folded or unfolded using the *Ctrl-Shift-Plus* and *Ctrl-Shift-Minus* keyboard sequences.

By default, the Android Studio editor will automatically fold some code when a source file is opened. To configure the conditions under which this happens, select *File -> Settings…* (*Android Studio -> Preferences…* on macOS) and choose the *Editor -> General -> Code Folding* entry in the resulting settings panel (Figure 8-15):

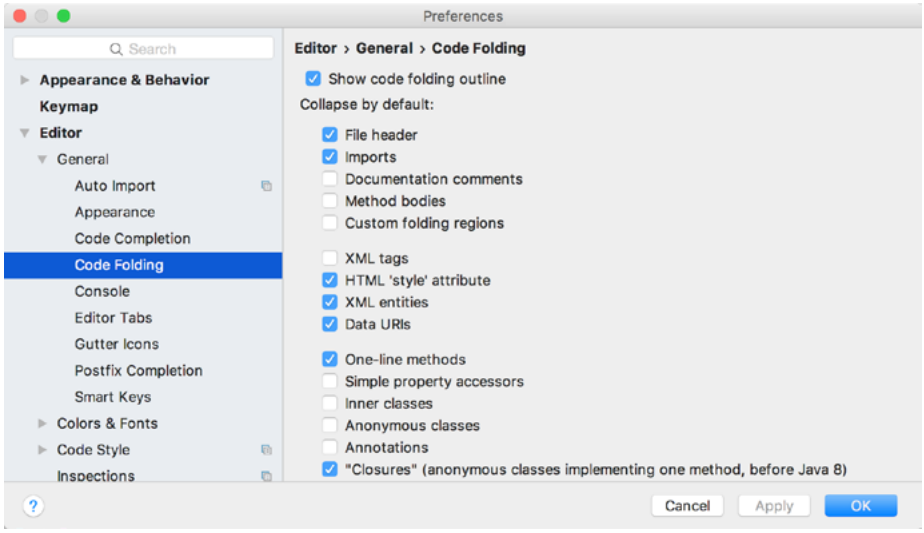



Figure 8-15

## 8.9 Quick Documentation Lookup

Context sensitive Kotlin and Android documentation can be accessed by placing the cursor over the declaration for which documentation is required and pressing the *Ctrl-Q* keyboard shortcut (*Ctrl-J* on macOS). This will display a popup containing the relevant reference documentation for the item. Figure 8-16, for example, shows

the documentation for the Android Snackbar class.


Figure 8-16

Once displayed, the documentation popup can be moved around the screen as needed. Clicking on the push pin icon located in the right-hand corner of the popup title bar will ensure that the popup remains visible once focus moves back to the editor, leaving the documentation visible as a reference while typing code.

## 8.10 Code Reformatting

In general, the Android Studio editor will automatically format code in terms of indenting, spacing and nesting of statements and code blocks as they are added. In situations where lines of code need to be reformatted (a common occurrence, for example, when cutting and pasting sample code from a web site), the editor provides a source code reformatting feature which, when selected, will automatically reformat code to match the prevailing code style.

To reformat source code, press the *Ctrl-Alt-L* (*Cmd-Alt-L* on macOS) keyboard shortcut sequence. To display the *Reformat Code* dialog (Figure 8-17) use the *Ctrl-Alt-Shift-L* (*Cmd-Alt-Shift-L* on macOS). This dialog provides the option to reformat only the currently selected code, the entire source file currently active in the editor or only code that has changed as the result of a source code control update.

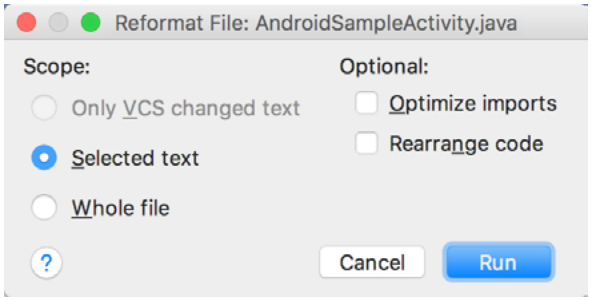



Figure 8-17

The full range of code style preferences can be changed from within the project settings dialog. Select the *File -> Settings* menu option (*Android Studio -> Preferences…* on macOS) and choose *Code Style* in the left-hand panel to access a list of supported programming and markup languages. Selecting a language will provide access to a vast array of formatting style options, all of which may be modified from the Android Studio default to match your preferred code style. To configure the settings for the *Rearrange code* option in the above dialog, for example, unfold the *Code Style* section, select Kotlin and, from the Kotlin settings, select the *Arrangement* tab.

## 8.11 Finding Sample Code

The Android Studio editor provides a way to access sample code relating to the currently highlighted entry within the code listing. This feature can be useful for learning how a particular Android class or method is used. To find sample code, highlight a method or class name in the editor, right-click on it and select the *Find Sample*

*Code* menu option. The Find Sample Code panel (Figure 8-18) will appear beneath the editor with a list of matching samples. Selecting a sample from the list will load the corresponding code into the right-hand panel:

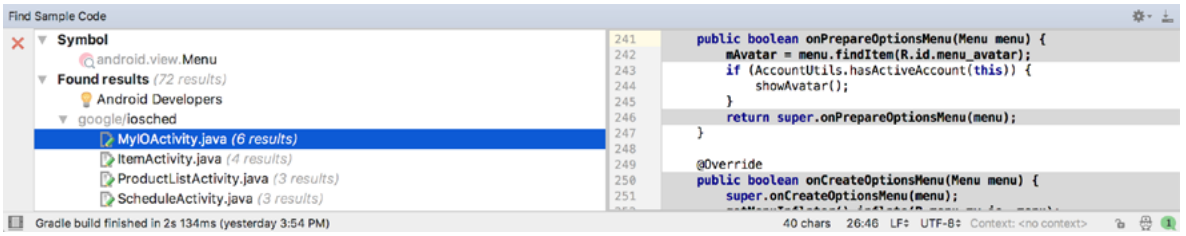



Figure 8-18

## 8.12 Summary

The Android Studio editor goes to great length to reduce the amount of typing needed to write code and to make that code easier to read and navigate. In this chapter we have covered a number of the key editor features including code completion, code generation, editor window splitting, code folding, reformatting and documentation lookup.

Chapter 9

# 9. An Overview of the Android Architecture

So far in this book, steps have been taken to set up an environment suitable for the development of Android applications using Android Studio. An initial step has also been taken into the process of application development through the creation of a simple Android Studio application project.

Before delving further into the practical matters of Android application development, however, it is important to gain an understanding of some of the more abstract concepts of both the Android SDK and Android development in general. Gaining a clear understanding of these concepts now will provide a sound foundation on which to build further knowledge.

Starting with an overview of the Android architecture in this chapter, and continuing in the next few chapters of this book, the goal is to provide a detailed overview of the fundamentals of Android development.

## 9.1 The Android Software Stack

Android is structured in the form of a software stack comprising applications, an operating system, run-time environment, middleware, services and libraries. This architecture can, perhaps, best be represented visually as outlined in Figure 9-1. Each layer of the stack, and the corresponding elements within each layer, are tightly integrated and carefully tuned to provide the optimal application development and execution environment for mobile devices. The remainder of this chapter will work through the different layers of the Android stack, starting at the bottom with the Linux Kernel.

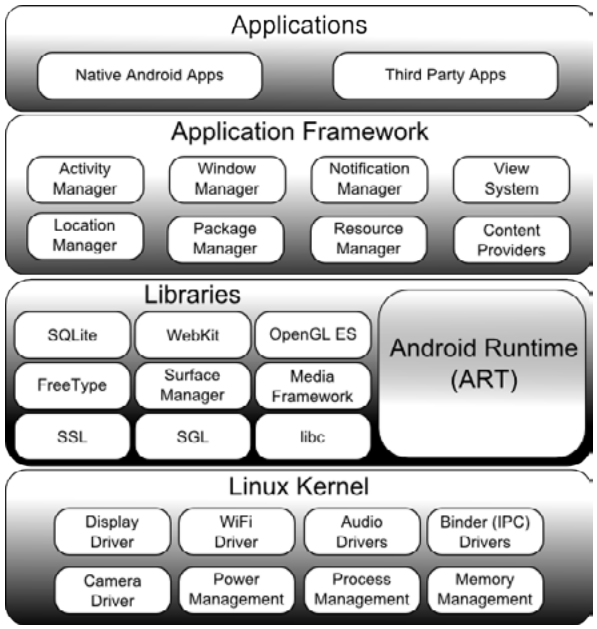



Figure 9-1

## 9.2 The Linux Kernel

Positioned at the bottom of the Android software stack, the Linux Kernel provides a level of abstraction between the device hardware and the upper layers of the Android software stack. Based on Linux version 2.6, the kernel provides preemptive multitasking, low-level core system services such as memory, process and power management in addition to providing a network stack and device drivers for hardware such as the device display, Wi-Fi and audio.

The original Linux kernel was developed in 1991 by Linus Torvalds and was combined with a set of tools, utilities and compilers developed by Richard Stallman at the Free Software Foundation to create a full operating system referred to as GNU/Linux. Various Linux distributions have been derived from these basic underpinnings such as Ubuntu and Red Hat Enterprise Linux.

It is important to note, however, that Android uses only the Linux kernel. That said, it is worth noting that the Linux kernel was originally developed for use in traditional computers in the form of desktops and servers. In fact, Linux is now most widely deployed in mission critical enterprise server environments. It is a testament to both the power of today's mobile devices and the efficiency and performance of the Linux kernel that we find this software at the heart of the Android software stack.

## 9.3 Android Runtime – ART

When an Android app is built within Android Studio it is compiled into an intermediate bytecode format (referred to as DEX format). When the application is subsequently loaded onto the device, the Android Runtime (ART) uses a process referred to as Ahead-of-Time (AOT) compilation to translate the bytecode down to the native instructions required by the device processor. This format is known as Executable and Linkable Format (ELF).

Each time the application is subsequently launched, the ELF executable version is run, resulting in faster application performance and improved battery life.

This contrasts with the Just-in-Time (JIT) compilation approach used in older Android implementations whereby the bytecode was translated within a virtual machine (VM) each time the application was launched.

## 9.4 Android Libraries

In addition to a set of standard Java development libraries (providing support for such general purpose tasks as string handling, networking and file manipulation), the Android development environment also includes the Android Libraries. These are a set of Java-based libraries that are specific to Android development. Examples of libraries in this category include the application framework libraries in addition to those that facilitate user interface building, graphics drawing and database access.

A summary of some key core Android libraries available to the Android developer is as follows:

- **android.app** – Provides access to the application model and is the cornerstone of all Android applications.
- **android.content** – Facilitates content access, publishing and messaging between applications and application components.
- **android.database** – Used to access data published by content providers and includes SQLite database management classes.
- **android.graphics** – A low-level 2D graphics drawing API including colors, points, filters, rectangles and canvases.
- **android.hardware** – Presents an API providing access to hardware such as the accelerometer and light sensor.

- **android.opengl** – A Java interface to the OpenGL ES 3D graphics rendering API.
- **android.os** – Provides applications with access to standard operating system services including messages, system services and inter-process communication.
- **android.media** – Provides classes to enable playback of audio and video.
- **android.net** – A set of APIs providing access to the network stack. Includes *android.net.wifi*, which provides access to the device's wireless stack.
- **android.print** – Includes a set of classes that enable content to be sent to configured printers from within Android applications.
- **android.provider** – A set of convenience classes that provide access to standard Android content provider databases such as those maintained by the calendar and contact applications.
- **android.text** – Used to render and manipulate text on a device display.
- **android.util** – A set of utility classes for performing tasks such as string and number conversion, XML handling and date and time manipulation.
- **android.view** – The fundamental building blocks of application user interfaces.
- **android.widget** - A rich collection of pre-built user interface components such as buttons, labels, list views, layout managers, radio buttons etc.
- **android.webkit** – A set of classes intended to allow web-browsing capabilities to be built into applications.

Having covered the Java-based libraries in the Android runtime, it is now time to turn our attention to the C/C++ based libraries contained in this layer of the Android software stack.

### 9.4.1 C/C++ Libraries

The Android runtime core libraries outlined in the preceding section are Java-based and provide the primary APIs for developers writing Android applications. It is important to note, however, that the core libraries do not perform much of the actual work and are, in fact, essentially Java "wrappers" around a set of C/C++ based libraries. When making calls, for example, to the *android.opengl* library to draw 3D graphics on the device display, the library actually ultimately makes calls to the *OpenGL ES* C++ library which, in turn, works with the underlying Linux kernel to perform the drawing tasks.

C/C++ libraries are included to fulfill a wide and diverse range of functions including 2D and 3D graphics drawing, Secure Sockets Layer (SSL) communication, SQLite database management, audio and video playback, bitmap and vector font rendering, display subsystem and graphic layer management and an implementation of the standard C system library (libc).

In practice, the typical Android application developer will access these libraries solely through the Java based Android core library APIs. In the event that direct access to these libraries is needed, this can be achieved using the Android Native Development Kit (NDK), the purpose of which is to call the native methods of non-Java or Kotlin programming languages (such as C and C++) from within Java code using the Java Native Interface (JNI).

## 9.5 Application Framework

The Application Framework is a set of services that collectively form the environment in which Android applications run and are managed. This framework implements the concept that Android applications are constructed from reusable, interchangeable and replaceable components. This concept is taken a step further in that an application is also able to *publish* its capabilities along with any corresponding data so that they can be

found and reused by other applications.

The Android framework includes the following key services:

- **Activity Manager** – Controls all aspects of the application lifecycle and activity stack.
- **Content Providers** – Allows applications to publish and share data with other applications.
- **Resource Manager** – Provides access to non-code embedded resources such as strings, color settings and user interface layouts.
- **Notifications Manager** – Allows applications to display alerts and notifications to the user.
- **View System** – An extensible set of views used to create application user interfaces.
- **Package Manager** – The system by which applications are able to find out information about other applications currently installed on the device.
- **Telephony Manager** – Provides information to the application about the telephony services available on the device such as status and subscriber information.
- **Location Manager** – Provides access to the location services allowing an application to receive updates about location changes.

## 9.6 Applications

Located at the top of the Android software stack are the applications. These comprise both the native applications provided with the particular Android implementation (for example web browser and email applications) and the third party applications installed by the user after purchasing the device.

## 9.7 Summary

A good Android development knowledge foundation requires an understanding of the overall architecture of Android. Android is implemented in the form of a software stack architecture consisting of a Linux kernel, a runtime environment and corresponding libraries, an application framework and a set of applications. Applications are predominantly written in Java or Kotlin and compiled down to bytecode format within the Android Studio build environment. When the application is subsequently installed on a device, this bytecode is compiled down by the Android Runtime (ART) to the native format used by the CPU. The key goals of the Android architecture are performance and efficiency, both in application execution and in the implementation of reuse in application design.

Chapter 10

# 10. The Anatomy of an Android Application

Regardless of your prior programming experiences, be it Windows, macOS, Linux or even iOS based, the chances are good that Android development is quite unlike anything you have encountered before.

The objective of this chapter, therefore, is to provide an understanding of the high-level concepts behind the architecture of Android applications. In doing so, we will explore in detail both the various components that can be used to construct an application and the mechanisms that allow these to work together to create a cohesive application.

## 10.1 Android Activities

Those familiar with object-oriented programming languages such as Java, Kotlin, C++ or C# will be familiar with the concept of encapsulating elements of application functionality into classes that are then instantiated as objects and manipulated to create an application. Since Android applications are written in Java and Kotlin, this is still very much the case. Android, however, also takes the concept of re-usable components to a higher level.

Android applications are created by bringing together one or more components known as *Activities*. An activity is a single, standalone module of application functionality that usually correlates directly to a single user interface screen and its corresponding functionality. An appointments application might, for example, have an activity screen that displays appointments set up for the current day. The application might also utilize a second activity consisting of a screen where new appointments may be entered by the user.

Activities are intended as fully reusable and interchangeable building blocks that can be shared amongst different applications. An existing email application, for example, might contain an activity specifically for composing and sending an email message. A developer might be writing an application that also has a requirement to send an email message. Rather than develop an email composition activity specifically for the new application, the developer can simply use the activity from the existing email application.

Activities are created as subclasses of the Android *Activity* class and must be implemented so as to be entirely independent of other activities in the application. In other words, a shared activity cannot rely on being called at a known point in a program flow (since other applications may make use of the activity in unanticipated ways) and one activity cannot directly call methods or access instance data of another activity. This, instead, is achieved using *Intents* and *Content Providers*.

By default, an activity cannot return results to the activity from which it was invoked. If this functionality is required, the activity must be specifically started as a *sub-activity* of the originating activity.

## 10.2 Android Intents

Intents are the mechanism by which one activity is able to launch another and implement the flow through the activities that make up an application. Intents consist of a description of the operation to be performed and, optionally, the data on which it is to be performed.

Intents can be *explicit*, in that they request the launch of a specific activity by referencing the activity by class name, or *implicit* by stating either the type of action to be performed or providing data of a specific type on

which the action is to be performed. In the case of implicit intents, the Android runtime will select the activity to launch that most closely matches the criteria specified by the Intent using a process referred to as *Intent Resolution*.

## 10.3 Broadcast Intents

Another type of Intent, the *Broadcast Intent*, is a system wide intent that is sent out to all applications that have registered an "interested" *Broadcast Receiver*. The Android system, for example, will typically send out Broadcast Intents to indicate changes in device status such as the completion of system start up, connection of an external power source to the device or the screen being turned on or off.

A Broadcast Intent can be *normal* (asynchronous) in that it is sent to all interested Broadcast Receivers at more or less the same time, or *ordered* in that it is sent to one receiver at a time where it can be processed and then either aborted or allowed to be passed to the next Broadcast Receiver.

## 10.4 Broadcast Receivers

Broadcast Receivers are the mechanism by which applications are able to respond to Broadcast Intents. A Broadcast Receiver must be registered by an application and configured with an *Intent Filter* to indicate the types of broadcast in which it is interested. When a matching intent is broadcast, the receiver will be invoked by the Android runtime regardless of whether the application that registered the receiver is currently running. The receiver then has 5 seconds in which to complete any tasks required of it (such as launching a Service, making data updates or issuing a notification to the user) before returning. Broadcast Receivers operate in the background and do not have a user interface.

## 10.5 Android Services

Android Services are processes that run in the background and do not have a user interface. They can be started and subsequently managed from activities, Broadcast Receivers or other Services. Android Services are ideal for situations where an application needs to continue performing tasks but does not necessarily need a user interface to be visible to the user. Although Services lack a user interface, they can still notify the user of events using notifications and *toasts* (small notification messages that appear on the screen without interrupting the currently visible activity) and are also able to issue Intents.

Services are given a higher priority by the Android runtime than many other processes and will only be terminated as a last resort by the system in order to free up resources. In the event that the runtime does need to kill a Service, however, it will be automatically restarted as soon as adequate resources once again become available. A Service can reduce the risk of termination by declaring itself as needing to run in the *foreground*. This is achieved by making a call to *startForeground()*. This is only recommended for situations where termination would be detrimental to the user experience (for example, if the user is listening to audio being streamed by the Service).

Example situations where a Service might be a practical solution include, as previously mentioned, the streaming of audio that should continue when the application is no longer active, or a stock market tracking application that needs to notify the user when a share hits a specified price.

## 10.6 Content Providers

Content Providers implement a mechanism for the sharing of data between applications. Any application can provide other applications with access to its underlying data through the implementation of a Content Provider including the ability to add, remove and query the data (subject to permissions). Access to the data is provided via a Universal Resource Identifier (URI) defined by the Content Provider. Data can be shared in the form of a file or an entire SQLite database.

The native Android applications include a number of standard Content Providers allowing applications to access

data such as contacts and media files.

The Content Providers currently available on an Android system may be located using a *Content Resolver*.

## 10.7 The Application Manifest

The glue that pulls together the various elements that comprise an application is the Application Manifest file. It is within this XML based file that the application outlines the activities, services, broadcast receivers, data providers and permissions that make up the complete application.

## 10.8 Application Resources

In addition to the manifest file and the Dex files that contain the byte code, an Android application package will also typically contain a collection of *resource files*. These files contain resources such as the strings, images, fonts and colors that appear in the user interface together with the XML representation of the user interface layouts. By default, these files are stored in the */res* sub-directory of the application project's hierarchy.

## 10.9 Application Context

When an application is compiled, a class named *R* is created that contains references to the application resources. The application manifest file and these resources combine to create what is known as the *Application Context*. This context, represented by the Android *Context* class, may be used in the application code to gain access to the application resources at runtime. In addition, a wide range of methods may be called on an application's context to gather information and make changes to the application's environment at runtime.

## 10.10 Summary

A number of different elements can be brought together in order to create an Android application. In this chapter, we have provided a high-level overview of Activities, Services, Intents and Broadcast Receivers together with an overview of the manifest file and application resources.

Maximum reuse and interoperability are promoted through the creation of individual, standalone modules of functionality in the form of activities and intents, while data sharing between applications is achieved by the implementation of content providers.

While activities are focused on areas where the user interacts with the application (an activity essentially equating to a single user interface screen), background processing is typically handled by Services and Broadcast Receivers.

The components that make up the application are outlined for the Android runtime system in a manifest file which, combined with the application's resources, represents the application's context.

Much has been covered in this chapter that is most likely new to the average developer. Rest assured, however, that extensive exploration and practical use of these concepts will be made in subsequent chapters to ensure a solid knowledge foundation on which to build your own applications.

Chapter 11

# 11. An Introduction to Kotlin

Android development is performed primarily using Android Studio which is, in turn, based on the IntelliJ IDEA development environment created by a company named JetBrains. Prior to the release of Android Studio 3.0, all Android apps were written using Android Studio and the Java programming language (with some occasional C++ code when needed).

With the introduction of Android Studio 3.0, however, developers now have the option of creating Android apps using another programming language called Kotlin. Although detailed coverage of all features of this language is beyond the scope of this book (entire books can and have been written covering solely Kotlin), the objective of this and the following six chapters is to provide enough information to begin programming in Kotlin and quickly get up to speed developing Android apps using this programming language.

## 11.1 What is Kotlin?

Named after an island located in the Baltic Sea, Kotlin is a programming language created by JetBrains and follows Java in the tradition of naming programming languages after islands. Kotlin code is intended to be easier to understand and write and also safer than many other programming languages. The language, compiler and related tools are all open source and available for free under the Apache 2 license.

The primary goals of the Kotlin language are to make code both concise and safe. Code is generally considered concise when it can be easily read and understood. Conciseness also plays a role when writing code, allowing code to be written more quickly and with greater efficiency. In terms of safety, Kotlin includes a number of features that improve the chances that potential problems will be identified when the code is being written instead of causing runtime crashes.

A third objective in the design and implementation of Kotlin involves interoperability with Java.

## 11.2 Kotlin and Java

Originally introduced by Sun Microsystems in 1995 Java is still by far the most popular programming language in use today. Until the introduction of Kotlin, it is quite likely that every Android app available on the market was written in Java. Since acquiring the Android operating system, Google has invested heavily in tuning and optimizing compilation and runtime environments for running Java-based code on Android devices.

Rather than try to re-invent the wheel, Kotlin is design to both integrate with and work alongside Java. When Kotlin code is compiled it generates the same bytecode as that generated by the Java compiler enabling projects to be built using a combination of Java and Kotlin code. This compatibility also allows existing Java frameworks and libraries to be used seamlessly from within Kotlin code and also for Kotlin code to be called from within Java.

Kotlin's creators also acknowledged that while there were ways to improve on existing languages, there are many features of Java that did not need to be changed. Consequently, those familiar with programming in Java will find many of these skills to be transferable to Kotlin-based development. Programmers with Swift programming experience will also find much that is familiar when learning Kotlin.

## 11.3 Converting from Java to Kotlin

Given the high level of interoperability between Kotlin and Java it is not essential to convert existing Java code to Kotlin since these two languages will comfortably co-exist within the same project. That being said, Java code

can be converted to Kotlin from within Android Studio using a built-in Java to Kotlin converter. To convert an entire Java source file to Kotlin, load the file into the Android Studio code editor and select the *Code -> Convert Java File to Kotlin File* menu option. Alternatively, blocks of Java code may be converted to Kotlin by cutting the code and pasting it into an existing Kotlin file within the Android Studio code editor. Note when performing Java to Kotlin conversions that the Java code will not always convert to the best possible Kotlin code and that time should be taken to review and tidy up the code after conversion.

## 11.4 Kotlin and Android Studio

Support for Kotlin is provided within Android Studio via the Kotlin Plug-in which is integrated by default into Android Studio 3.0.

## 11.5 Experimenting with Kotlin

When learning a new programming language, it is often useful to be able to enter and execute snippets of code. One of the best ways to do this with Kotlin is to use the online playground (Figure 11-1) located at http://try.kotl.in. In addition to providing an environment in which Kotlin code may be quickly entered and executed, the online playground also includes a set of examples demonstrating key Kotlin features in action.

The panel on the left-hand side (marked A in Figure 11-1) contains a list of coding examples together with any examples you create. Code is typed into the main panel (B) and executed by clicking the Run button (C). Any output from the code execution appears in the console panel (D). Arguments may be passed through to the main function by entering them into the field marked E.

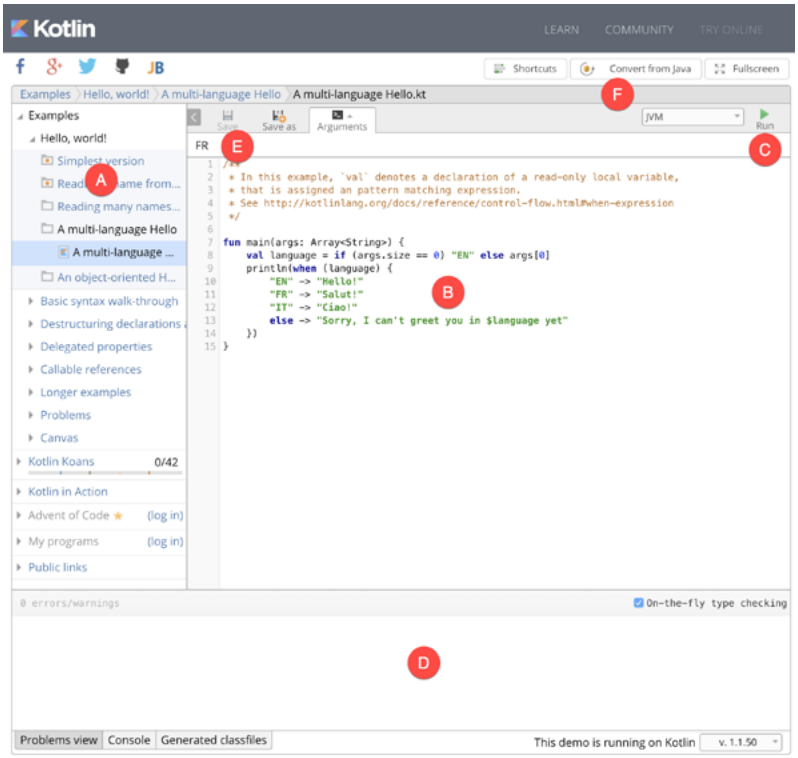



Figure 11-1

Try out some Kotlin code by opening a browser window, navigating to the online playground and entering the following into the main code panel:

```
fun main(args: Array<String>) {

    println("Welcome to Kotlin")

    for (i in 1..8) {
        println("i = $i")
    }
}
```

After entering the code, click on the Run button and note the output in the console panel:

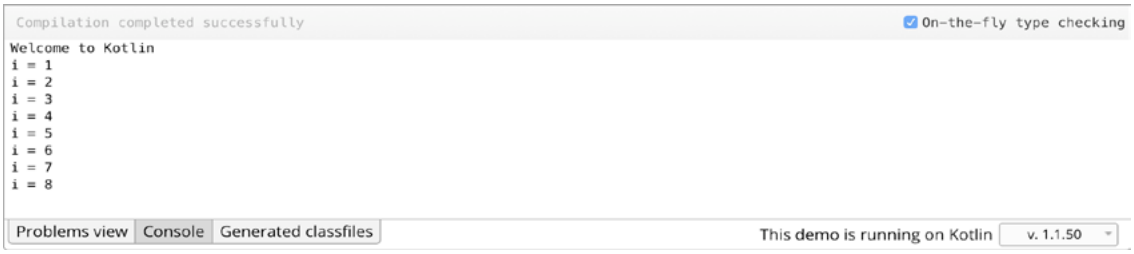



Figure 11-2

The online playground may also be used to find the Kotlin equivalent for fragments of Java code. Simply enter (or cut and paste) the Java code into the main panel and click on the Convert from Java button (marked E).

## 11.6 Semi-colons in Kotlin

Unlike programming languages such as Java and C++, Kotlin does not require semi-colons at the end of each statement or expression line. The following, therefore, is valid Kotlin code:

```
val mynumber = 10
println(mynumber)
```

Semi-colons are only required when multiple statements appear on the same line:

```
val mynumber = 10; println(mynumber)
```

## 11.7 Summary

For the first time since the Android operating system was introduced, developers now have an alternative to writing apps in Java code. Kotlin is a programming language developed by JetBrains, the company that created the development environment on which Android Studio is based. Kotlin is intended to make code safer and easier to understand and write. Kotlin is also highly compatible with Java, allowing Java and Kotlin code to co-exist within the same projects. This interoperability ensures that most of the standard Java and Java-based Android libraries and frameworks are available for use when developing using Kotlin.

Kotlin support for Android Studio is provided via a plug-in bundled with Android Studio 3.0 or later. This plug-in also provides a converter to translate Java code to Kotlin.

When learning Kotlin, the online playground provides a useful environment for quickly trying out Kotlin code.