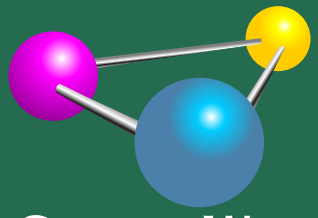
Version 6.3

Supports Through Android 5.0!

The Busy Coder's Guide to Android Development

Mark L. Murphy



CommonsWare

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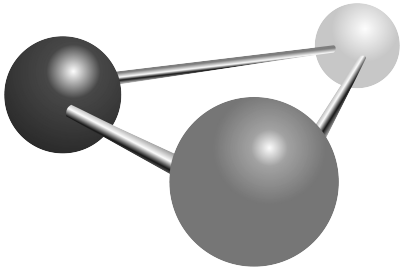

COMMONSWARE

The Busy Coder's Guide to Android Development
by Mark L. Murphy

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Table of Contents

Headings formatted in ***bold-italic*** have changed since the last version.

Preface

Welcome to the Book!

Thanks!

Thanks for your interest in developing applications for Android! Android has grown from nothing to arguably the world's most popular smartphone OS in a few short years. Whether you are developing applications for the public, for your business or organization, or are just experimenting on your own, I think you will find Android to be an exciting and challenging area for exploration.

And, most of all, thanks for your interest in this book! I sincerely hope you find it useful and at least occasionally entertaining.

The Book's Structure

As you may have noticed, this is a rather large book.

To make the equivalent of 2,800+ pages of material manageable, the chapters are divided into the *core* chapters and a series of *trails*.

The core chapters represent many key concepts that Android developers need to understand in order to build an app. While an occasional "nice to have" topic will drift into the core — to help illustrate a point, for example — the core chapters generally are fairly essential.

The core chapters are designed to be read in sequence and will interleave both traditional technical book prose with tutorial chapters, to give you hands-on experience with the concepts being discussed. Most of the tutorials can be skipped,

though the first two — covering setting up your SDK environment and creating a project – everybody should read.

The bulk of the chapters are divided into trails, covering some particular general topic, from data storage to advanced UI effects to performance measurement and tuning. Each trail will have several chapters. However, those chapters, and the trails themselves, are not necessarily designed to be read in any order. Each chapter in the trails will point out prerequisite chapters or concepts that you will want to have covered in advance. Hence, these chapters are mostly reference material, for when you specifically want to learn something about a specific topic.

The core chapters will link to chapters in the trails, to show you where you can find material related to the chapter you just read. So between the book's table of contents, this preface, the search tool in your digital book reader, and the cross-chapter links, you should have plenty of ways of finding the material you want to read.

You are welcome to read the entire book front-to-back if you wish. The trails will appear after the core chapters. Those trails will be in a reasonably logical order, though you may have to hop around a bit to cover all of the prerequisites.

The Trails

Here is a list of all of the trails and the chapters that pertain to those trails, in order of appearance (except for those appearing in the list multiple times, where they span major categories):

Code Organization and Gradle

- Working with Library Projects
- Gradle and Legacy Projects
- Gradle and Tasks
- Gradle and the New Project Structure
- Gradle and Dependencies
- Manifest Merger Rules
- Signing Your App
- Distribution
- Advanced Gradle for Android Tips

Testing

- JUnit and Android
- MonkeyRunner and the Test Monkey
- Testing with UIAutomator

Advanced UI

- Introducing GridLayout
- Dialogs and DialogFragments
- Advanced ListViews
- Action Bar Navigation
- Action Modes and Context Menus
- Other Advanced Action Bar Techniques
- AppCompat: The Official Action Bar Backport
- ActionBarSherlock
- Implementing a Navigation Drawer
- Advanced Uses of WebView
- The Input Method Framework
- Fonts
- Rich Text
- Animators
- Legacy Animations
- Custom Drawables
- Mapping with Maps V2
- Crafting Your Own Views
- Custom Dialogs and Preferences
- Progress Indicators
- Advanced Notifications
- More Fun with Pagers
- Focus Management and Accessibility
- Miscellaneous UI Tricks
- Event Bus Alternatives

Home Screen Effects

- Home Screen App Widgets
- Adapter-Based App Widgets

Data Storage and Retrieval

- Content Provider Theory
- Content Provider Implementation Patterns
- The Loader Framework
- The ContactsContract Provider
- The CalendarContract Provider
- The MediaStore Provider
- Consuming Documents
- Providing Documents
- Encrypted Storage
- Packaging and Distributing Data
- Advanced Database Techniques
- Miscellaneous Network Capabilities

Media

- Audio Playback
- Audio Recording
- Video Playback
- Using the Camera via 3rd-Party Apps
- Working Directly with the Camera
- The MediaStore Provider
- Media Routes
- Supporting External Displays
- Google Cast and ChromeCast
- The “10 Foot UI”
- Creating a MediaRouteProvider

Security

- SSL
- Encrypted Storage
- Advanced Permissions
- Restricted Profiles and UserManager
- Tapjacking
- Miscellaneous Security Techniques

Hardware and System Services

- Accessing Location-Based Services
- The Fused Location Provider
- Working with the Clipboard
- Telephony
- Working With SMS
- NFC
- Device Administration
- PowerManager and WakeLocks
- JobScheduler
- Push Notifications with GCM
- Basic Use of Sensors
- Printing and Document Generation
- Other System Settings and Services
- Dealing with Different Hardware

Integration and Introspection

- Responding to URLs
- Plugin Patterns
- PackageManager Tricks
- Searching with SearchManager
- Remote Services and the Binding Pattern
- Advanced Manifest Tips
- Miscellaneous Integration Tips
- Reusable Components

Scripting Languages

- The Role of Scripting Languages
- The Scripting Layer for Android
- JVM Scripting Languages

Other Tools

- Advanced Emulator Capabilities
- Using Lint
- Using Hierarchy View
- Using DDMS

- Finding CPU Bottlenecks
- Finding Memory Leaks with MAT

Tuning Android Applications

- Issues with Speed
- Finding CPU Bottlenecks
- NDK
- Improving CPU Performance in Java
- Finding and Eliminating Jank
- Issues with Bandwidth
- Focus On: TrafficStats
- Measuring Bandwidth Consumption
- Being Smarter About Bandwidth
- Issues with Application Heap
- Finding Memory Leaks with MAT
- Issues with System RAM
- Issues with Battery Life
- Other Power Measurement Options
- Sources of Power Drain
- Addressing Application Size Issues

Alternatives for App Development

- The Role of Alternative Environments
- HTML5
- PhoneGap
- Other Alternative Environments

Miscellaneous Topics

- Anti-Patterns

Widget Catalog

- AdapterViewFlipper
- CalendarView
- DatePicker
- ExpandableListView
- SeekBar

About the Updates

This book is updated frequently, typically every 6–8 weeks.

Each release has notations to show what is new or changed compared with the immediately preceding release:

- The Table of Contents shows sections with changes in bold-italic font
- Those sections have changebars on the right to denote specific paragraphs that are new or modified

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- A Stack Overflow "bump" service, to get additional attention for a question that you have posted there that does not have an adequate answer.
- 80% off of live webinars hosted by Mark Murphy, the author of this book, on Android application development topics.

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Find a problem in one of our books? Let us know!

Be the first to report a unique concrete problem in the current digital edition, and we will extend your Warescription by six months as a bounty for helping us deliver a better product.

By "concrete" problem, we mean things like:

1. Typographical errors
2. Sample applications that do not work as advertised, in the environment described in the book

3. Factual errors that cannot be open to interpretation

By "unique", we mean ones not yet reported. Be sure to check the book's errata page, though, to see if your issue has already been reported. One coupon is given per email containing valid bug reports.

We appreciate hearing about "softer" issues as well, such as:

1. Places where you think we are in error, but where we feel our interpretation is reasonable
2. Places where you think we could add sample applications, or expand upon the existing material
3. Samples that do not work due to "shifting sands" of the underlying environment (e.g., changed APIs with new releases of an SDK)

However, those "softer" issues do not qualify for the formal bounty program.

Questions about the bug bounty, or problems you wish to report for bounty consideration, should be sent to bounty@commonsware.com.

Source Code and Its License

The source code samples shown in this book are available for download from the book's GitHub repository. All of the Android projects are licensed under the Apache 2.0 License, in case you have the desire to reuse any of it.

If you wish to use the source code from the GitHub repository, please follow the instructions on that repository's home page for details of how to use the projects in various development environments, notably Eclipse and Android Studio.

If you are using Eclipse, please do **NOT** import all of the projects from the repo into your main workspace. There are *hundreds* of these projects, and they may cause your Eclipse environment to become very slow, particularly when starting it up. Instead, import only those specific projects that you want to work with "live" as opposed to simply reading about them in the book.

Copying source code directly from the book, in the PDF editions, works best with Adobe Reader, though it may also work with other PDF viewers. Some PDF viewers, for reasons that remain unclear, foul up copying the source code to the clipboard when it is selected.

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Acknowledgments

I would like to thank the Android team, not only for putting out a good product, but for invaluable assistance on the Android Google Groups and Stack Overflow.

I would also like to thank the thousands of readers of past editions of this book, for their feedback, bug reports, and overall support.

Of course, thanks are also out to the overall Android ecosystem, particularly those developers contributing their skills to publish libraries, write blog posts, answer support questions, and otherwise contribute to the strength of Android.

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Core Chapters

Key Android Concepts

No doubt, you are in a hurry to get started with Android application development. After all, you are reading this book, aimed at busy coders.

However, before we dive into getting tools set up and starting in on actual programming, it is important that we "get on the same page" with respect to several high-level Android concepts. This will simplify further discussions later in the book.

Android Applications

This book is focused on writing Android applications. An application is something that a user might install from the Play Store or otherwise download to their device. That application should have some user interface, and it might have other code designed to work in the background (multi-tasking).

This book is not focused on modifications to the Android firmware, such as writing device drivers. For that, you will need to seek other resources.

This book assumes that you have some hands-on experience with Android devices, and therefore you are familiar with buttons like HOME and BACK, the built-in Settings application, the concept of a home screen and launcher, and so forth. If you have never used an Android device, you are strongly encouraged to get one (e.g., a used one on eBay, Craigslist, etc.) and spend some time with it before starting in on learning Android application development.

Programming Language

The vast majority of Android applications are written exclusively in Java. Hence, that is what this book will spend most of its time on and will demonstrate with a seemingly infinite number of examples.

However, there are other options:

- You can write parts of the app in C/C++, for performance gains, porting over existing code bases, etc.
- You can write an entire app in C/C++, mostly for games using OpenGL for 3D animations
- You can write the guts of an app in HTML, CSS, and JavaScript, using tools to package that material into an Android application that can be distributed through the Play Store and similar venues
- And so on

Coverage of these non-Java alternatives will be found in the trails of this book, as the bulk of this book is focused on Java.

The author assumes that you know Java at this point. If you do not, you will need to learn Java before you go much further. You do not need to know *everything* about Java, as Java is vast. Rather, focus on:

- Language fundamentals (flow control, etc.)
- Classes and objects
- Methods and data members
- Public, private, and protected
- Static and instance scope
- Exceptions
- Threads
- Collections
- Generics
- File I/O
- Reflection
- Interfaces

The links are to Wikibooks material on those topics, though there are countless other Java resources for you to consider.

Components

When you first learned Java — whether that was yesterday or back when dinosaurs roamed the Earth — you probably started off with something like this:

```
class SillyApp {
    public static void main(String[] args) {
        System.out.println("Hello World!");
    }
}
```

In other words, the entry point into your application was a `public static void` method named `main()` that took a `String` array of arguments. From there, you were responsible for doing whatever was necessary.

However, there are other patterns used elsewhere in Java. For example, you do not usually write a `main()` method when writing a Java servlet. Instead, you extend a particular class supplied by a framework (e.g., `HttpServlet`) to create a component, then write some metadata that enumerates your components and tell the framework when and how to use them (e.g., `WEB.XML`).

Android apps are closer in spirit to the servlet approach. You will not write a `public static void main()` method. Instead, you will create subclasses of some Android-supplied base classes that define various application components. In addition, you will create some metadata that tells Android about those subclasses.

There are four types of components, all of which will be covered extensively in this book:

Activities

The building block of the user interface is the *activity*. You can think of an activity as being the Android analogue for the window or dialog in a desktop application, or the page in a classic Web app. It represents a chunk of your user interface and, in some cases, a discrete entry point into your app (i.e., a way for other apps to link to your app).

Normally, an activity will take up most of the screen, leaving space for some "chrome" bits like the clock, signal strength indicators, and so forth.

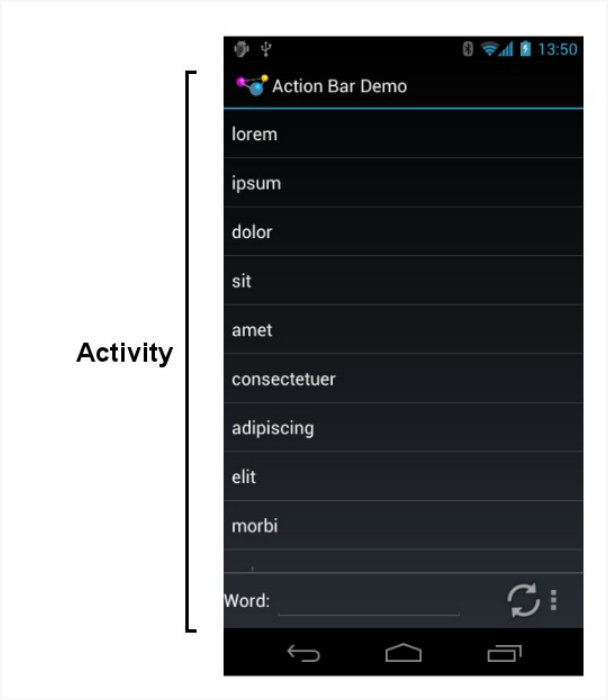

Figure 1: Activity on the screen

Services

Activities are short-lived and can be shut down at any time, such as when the user presses the BACK button. *Services*, on the other hand, are designed to keep running, if needed, independent of any activity, for a moderate period of time. You might use a service for checking for updates to an RSS feed, or to play back music even if the controlling activity is no longer operating. You will also use services for scheduled tasks (akin to Linux or OS X "cron jobs") and for exposing custom APIs to other applications on the device, though the latter is a relatively advanced capability.

Content Providers

Content providers provide a level of abstraction for any data stored on the device that is accessible by multiple applications. The Android development model encourages you to make your own data available to other applications, as well as your own — building a content provider lets you do that, while maintaining a degree of control over how your data gets accessed.

Broadcast Receivers

The system, or applications, will send out *broadcasts* from time to time, for everything from the battery getting low, to when the screen turns off, to when connectivity changes from WiFi to mobile data. A broadcast receiver can arrange to listen for these broadcasts and respond accordingly.

Widgets, Containers, Resources, and Fragments

Most of the focus on Android application development is on the UI layer and activities. Most Android activities use what is known as "the widget framework" for rendering their user interface, though you are welcome to use the 2D (`Canvas`) and 3D (OpenGL) APIs as well for more specialized GUIs.

In Android terms, a *widget* is the "micro" unit of user interface. Fields, buttons, labels, lists, and so on are all widgets. Your activity's UI, therefore, is made up of one or more of these widgets. For example, here we see label (`TextView`), field (`EditText`), and push-button (`Button`) widgets:

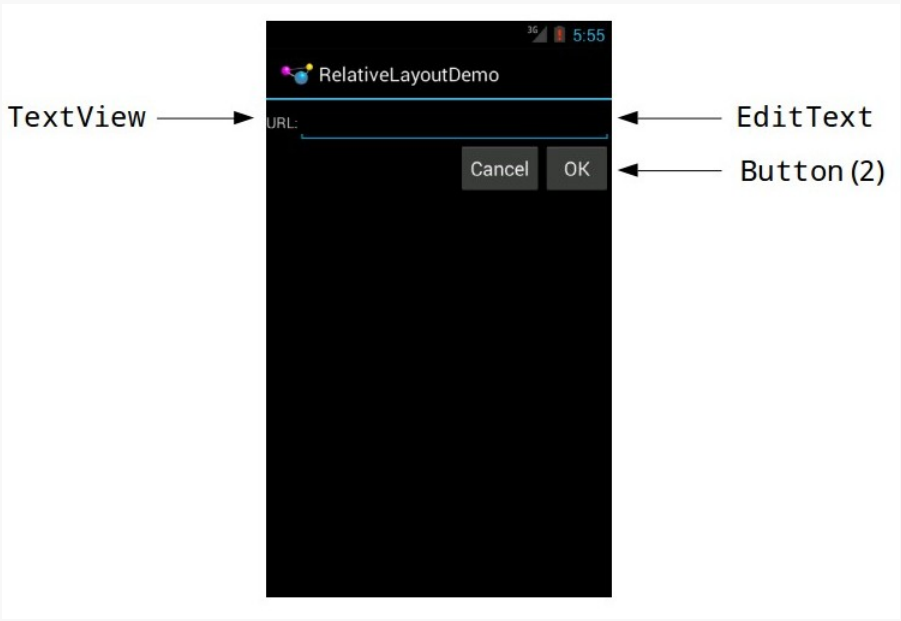

Figure 2: Activity with widgets

If you have more than one widget — which is fairly typical — you will need to tell Android how those widgets are organized on the screen. To do that, you will use

various container classes referred to as *layout managers*. These will let you put things in rows, columns, or more complex arrangements as needed.

To describe how the containers and widgets are connected, you will typically create a *layout resource file*. *Resources* in Android refer to things like images, strings, and other material that your application uses but is not in the form of some programming language source code. UI layouts are another type of resource. You will create these layouts either using a structured tool, such as an IDE's drag-and-drop GUI builder, or by hand in XML form.

Sometimes, your UI will work across all sorts of devices: phones, tablets, televisions, etc. Sometimes, your UI will need to be tailored for different environments. You will be able to put resources into *resource sets* that indicate under what circumstances those resources can be used (e.g., use these for normal-sized screens, but use those for larger screens).

Sometimes, supporting larger screens means you will want to "snap together" parts of your smaller-screen UI. For example, Gmail on a tablet will show your list of labels, the list of conversations in a selected label, and the list of messages in a selected conversation, all in one activity. However, Gmail on a phone cannot do that, as there is not enough screen space, so it shows each of those (labels, conversations, messages) in separate activities. Android supplies a construct called the *fragment* to help make it easier for you to implement these sorts of effects.

We will be examining all of these concepts, in much greater detail, as we get deeper into the book.

Apps and Packages

Given a bucket of source code and a basket of resources, the Android build tools will give you an application as a result. The application comes in the form of an *APK file*. It is that APK file that you will upload to the Play Store or distribute by other means.

Each Android application has a package name. A package name must fulfill three requirements:

1. It must be a valid Java package name, as some Java source code will be generated by the Android build tools in this package
2. No two applications can exist on a device at the same time with the same package

3. No two applications can be uploaded to the Play Store having the same package

Note that sometimes you will see reference to an "application ID" — this is the role of the package name from the second and third items in the list.

When you create your Android project — the repository of that source code and those resources — you will declare what package name is to be used for your app. Typically, you will pick a package name following the Java package name "reverse domain name" convention (e.g., `com.commonsware.android.foo`). That way, the domain name system ensures that your package name prefix (`com.commonsware`) is unique, and it is up to you to ensure that the rest of the package name distinguishes one of your apps from any other.

Android Devices

There are well in excess of one billion Android devices in use today, representing thousands of different models from dozens of different manufacturers. Android itself has evolved since Android 1.0 in 2008. Between different device types and different Android versions, many a media pundit has lobbed the term "fragmentation" at Android, suggesting that creating apps that run on all these different environments is impossible.

In reality, it is not that bad. Some apps will have substantial trouble, but most apps will work just fine if you follow the guidance presented in this book and in other resources.

Types

Android devices come in all shapes, sizes, and colors. However, there are four dominant "form factors":

- the phone
- the tablet
- the television (TV)
- the wearable (smart watches, Google Glass, etc.)

You will often hear developers and pundits refer to these form factors, and this book will do so from time to time as well. However, it is important that you understand that Android has no built-in concept of a device being a "phone" or a "tablet" or a

"TV". Rather, Android distinguishes devices based on capabilities and features. So, you will not see an `isPhone()` method anywhere, though you can ask Android:

- what is the screen size?
- does the device have telephony capability?
- etc.

Similarly, as you build your applications, rather than thinking of those four form factors, focus on what capabilities and features you need. Not only will this help you line up better with how Android wants you to build your apps, but it will make it easier for you to adapt to other form factors that will come about such as:

- airplane seat-back entertainment centers
- in-car navigation and entertainment devices
- and so on

The Emulator

While there are over a billion Android devices representing thousands of models, probably you do not have one of each model. You may only have a single piece of Android hardware. And if you do not even have that, you most certainly will want to acquire one before trying to publish an Android app.

To help fill in the gaps between the devices you have and the devices that are possible, the Android developer tools ship an *emulator*. The emulator behaves like a piece of Android hardware, but it is a program you run on your development machine. You can use this emulator to emulate many different devices, with different screen sizes and Android OS versions, by creating one or more Android virtual devices, or *AVDs*.

In an upcoming chapter, we will discuss how you install the Android developer tools and how you will be able to create these AVDs and run the emulator.

OS Versions and API Levels

Android has come a long way since the early beta releases from late 2007. Each new Android OS version adds more capabilities to the platform and more things that developers can do to exploit those capabilities.

Moreover, the core Android development team tries very hard to ensure forwards and backwards compatibility. An app you write today should work unchanged on

future versions of Android (forwards compatibility), albeit perhaps missing some features or working in some sort of "compatibility mode". And there are well-trod paths for how to create apps that will work both on the latest and on previous versions of Android (backwards compatibility).

To help us keep track of all the different OS versions that matter to us as developers, Android has *API levels*. A new API level is defined when an Android version ships that contains changes that affect developers. When you create an emulator AVD to test your app, you will indicate what API level that emulator should emulate. When you distribute your app, you will indicate the oldest API level your app supports, so the app is not installed on older devices.

At the time of this writing, the API levels of significance to most Android developers are:

- API Level 10 (Android 2.3.3)
- API Level 15 (Android 4.0.3)
- API Level 16 (Android 4.1)
- API Level 17 (Android 4.2)
- API Level 18 (Android 4.3)
- API Level 19 (Android 4.4)

Here, "of significance" refers to API levels that have a reasonable number of Android devices — 5% or more, as reported by the "Platform Versions" dashboard chart.

The latest API level for most form factors is 21, representing Android 5.0. There is an API Level 20, which is the version of Android running on the first-generation Android Wear devices. Unless you are specifically developing apps for Wear, you will not be worrying much about API Level 20.

Dalvik

In terms of Android, Dalvik is a virtual machine (VM). Virtual machines are used by many programming languages, such as Java, Perl, and Smalltalk. The Dalvik VM is designed to work much like a Java VM, but optimized for embedded Linux environments.

So, what really goes on when somebody writes an Android application is:

1. Developers write Java-syntax source code, leveraging class libraries published by the Android project and third parties.

2. Developers compile the source code into Java VM bytecode, using the `javac` compiler that comes with the Java SDK.
3. Developers translate the Java VM bytecode into Dalvik VM bytecode, which is packaged with other files into a ZIP archive with the `.apk` extension (the APK file).
4. An Android device or emulator runs the APK file, causing the bytecode to be executed by an instance of a Dalvik VM.

From your standpoint, most of this is hidden by the build tools. You pour Java source code into the top, and the APK file comes out the bottom.

However, there will be places from time to time where the differences between the Dalvik VM and the traditional Java VM will affect application developers, and this book will point out some of them where relevant.

Note that Android is moving to a new runtime environment, called ART. However, the "Dalvik" term will still be used for the bytecode that is generated as part of building an APK.

Processes and Threads

When your application runs, it will do so in its own process. This is not significantly different than any other traditional operating system. Part of Dalvik's magic is making it possible for many processes to be running many Android applications at one time without consuming ridiculous amounts of RAM.

Android will also set up a batch of threads for running your app. The thread that your code will be executed upon, most of the time, is variously called the "main application thread" or the "UI thread". You do not have to set it up, but, as we will see later in the book, you will need to pay attention to what you do and do not do on that thread. You are welcome to fork your own threads to do work, and that is fairly common, though in some places Android handles that for you behind the scenes.

Don't Be Scared

Yes, this chapter threw a lot of terms at you. We will be going into greater detail on all of them in this book. However, Android is like a jigsaw puzzle with lots of interlocking pieces. To be able to describe one concept in detail, we will need to at least reference some of the others. Hence, this chapter was meant to expose you to terms, in hopes that they will sound vaguely familiar as we dive into the details.

Choosing Your Development Toolchain

Before you go much further in your Android endeavors (or, possibly, endeavours, depending upon your preferred spelling), you will need to determine what toolchain you will use to build your Android applications.

Android Studio

The next-generation Google-backed Android IDE is Android Studio. Based off of IntelliJ IDEA, Android Studio is the new foundation of Google's efforts to give Android developers top-notch development tools. While it only reached a version 1.0 status in December 2014, Android Studio had been in use for ~18 months prior to that in various early-access and beta stages. While it still has bugs, it is certainly stable enough for app development.

The next chapter contains a section with instructions on how to set up Android Studio.

Eclipse

Eclipse is also a popular IDE, particularly for Java development. Eclipse was Google's original IDE for Android development, by means of the Android Developer Tools (ADT) add-in, which gives the core of Eclipse awareness of Android. The ADT add-in, in essence, takes regular Eclipse operations and extends them to work with Android projects.

Note, though, that Google has discontinued maintenance of ADT. The Eclipse Foundation is setting up the "Andmore" project to try to continue work on allowing Eclipse to build Android apps. This book does not cover the Andmore project at this time, and developers are **strongly** encouraged to not use the ADT-enabled Eclipse from Google.

For historical reasons, the next chapter contains a section with instructions on how to set up Eclipse for Android development, as part of getting an overall Android development environment established. Similarly, there will be Eclipse instructions in the tutorials and notes about using Eclipse elsewhere in the book. These will be removed from a future edition of the book, or perhaps migrated over to Andmore.

IntelliJ IDEA

While Android Studio is based off of IntelliJ IDEA, you can still use the original IntelliJ IDEA for Android app development. A large subset of the Android Studio capabilities are available in the Android plugin for IDEA. Plus, the commercial IDEA Ultimate Edition will go beyond Android Studio in many areas outside of Android development.

Command-Line Builds via Gradle for Android

And, of course, you do not need to use an IDE at all. While this may sound sacrilegious to some, IDEs are not the only way to build applications. Much of what is accomplished via the ADT can be accomplished through command-line equivalents, meaning a shell and an editor is all you truly need. For example, the author of this book did not use an IDE for Android development until 2011.

The recommended way to build Android apps outside of an IDE is by means of Gradle. Google has published a Gradle plugin that teaches Gradle how to build Android apps. Android Studio itself uses Gradle for its builds, so a single build configuration (e.g., `build.gradle` files) can be used both from an IDE and from a build automation tool like a continuous integration server.

An upcoming chapter gets into more about what Gradle (and the Gradle for Android plugin) are all about.

Yet Other Alternatives

Other IDEs have their equivalents of the ADT, albeit with minimal assistance from Google. For example, NetBeans has support via the NBAndroid add-on, and reportedly this has advanced substantially in the past few years.

You will also hear reference to using Apache Ant for doing command-line builds of Android apps. This has largely been supplanted by Gradle for Android at this time, and support for Apache Ant will end soon. Newcomers to Android are encouraged to not invest time in new work with Apache Ant for Android development projects.

IDEs… And This Book

You are welcome to use Android Studio or Eclipse as you work through this book. You are welcome to use another IDE if you wish. You are even welcome to skip the IDE outright and just use an editor.

This book is focused primarily on demonstrating Android capabilities and the APIs for exploiting those capabilities. Hence, the sample code will work with any IDE. However, this book will cover some Android Studio- and Eclipse-specific instructions, since they are the predominant answers today.

The tutorials will have instructions for both Android Studio and Eclipse.

What We Are Not Covering

In the beginning (a.k.a., 2007), we were lucky to have any means of creating an Android app.

Nowadays, there seems to be no end to the means by which we can create an Android app.

There are a few of these “means”, though, that are specifically out of scope for this book.

App Inventor

You may also have heard of a tool named App Inventor and wonder where it fits in with all of this.

App Inventor was originally created by an education group within Google, as a means of teaching students how to think about programming constructs (branches, loops, etc.) and create interesting output (Android apps) without classic programming in Java or other syntax-based languages. App Inventor is purely drag-and-drop, both of widgets *and application logic*, the latter by means of "blocks" that snap together to form logic chains.

App Inventor was donated by Google to MIT, which has recently re-opened it to the public.

However, App Inventor is a closed system — at the present time, it does not somehow generate Java code that you can later augment. That limits you to whatever App Inventor is natively capable of doing, which, while impressive in its own right, offers a small portion of the total Android SDK capabilities.

App Generators

There are a seemingly infinite number of "app generators" available as online services. These are designed mostly for creating apps for specific vertical markets, such as apps for restaurants or apps for grocers. The resulting apps are mostly "brochure-ware", with few capabilities beyond a mobile Web site, yet still requiring the user to find, download, and install the app. Few of these generators provide the source code to the generated app, to allow the apps to be customized beyond what the generator generates.

Tutorial #1 - Installing the Tools

Now, let us get you set up with the pieces and parts necessary to build an Android app.

NOTE: The instructions presented here are accurate as of the time of this writing. However, the tools change rapidly, and so these instructions may be out of date by the time you read this. Please refer to the Android Developers Web site for current instructions, using this as a base guideline of what to expect.

Step #1 - Checking Your Hardware Requirements

Compiling and building an Android application, on its own, is not especially hardware-intensive, except for very large projects. However, there are two commonly-used tools that demand more from your development machine: your IDE and the Android emulator. Of the two, the emulator poses the bigger problem.

The more RAM you have, the better. 8GB or higher is a very good idea if you intend to use an IDE and the emulator together.

A faster CPU is also a good idea. However, the Android emulator only utilizes a single core from your development machine. Hence, it is the single-core speed that matters. The best CPU to use is one that can leverage multiple cores to give what amounts to a faster single core, such as Intel's Core i7 with Turbo Boost. For an emulator simulating a larger-screened device (e.g., tablet, television), a Core i7 that can "boost" up to 3.4GHz makes development much more pleasant. Conversely, a CPU like a Core 2 Duo with a 2.5GHz clock speed results in a tablet emulator that is nearly unusable.

Step #2 - Setting Up Java and 32-Bit Linux Support

When you write Android applications, you typically write them in Java source code. That Java source code is then turned into the stuff that Android actually runs (Dalvik bytecode in an APK file).

You need to obtain and install the official Sun/Oracle Java SE SDK (JDK). You can obtain this from the Oracle Java Web site for Windows and Linux, and presumably from Apple for OS X. The plain JDK (sans any "bundles") should suffice. Follow the instructions supplied by Oracle or Apple for installing it on your machine. At the time of this writing, Android supports Java 6 and Java 7, though Java 7 is required for certain scenarios and therefore is recommended. Java 8 works, though you may have to do additional work to configure your IDE to have Java 8 emit Java 7-compatible bytecode.

Android also supports the OpenJDK, particularly on Linux environments.

What Android does *not* support are any other Java compilers, including the GNU Compiler for Java (GCJ).

If your development OS is Linux, make sure that you can run 32-bit Linux binaries. This may or may not already be enabled in your Linux distro. For example, on Ubuntu 14.10, you may need to run the following to get the 32-bit binary support installed that is needed by the Android build tools:

```
sudo apt-get install lib32z1 lib32ncurses5 lib32bz2-1.0 lib32stdc++6
```

Step #3 - Install the Developer Tools

As noted in the previous chapter, there are a few developer tools that you can choose from.

There are three major options that this book covers:

1. Use Android Studio
2. Use Eclipse, as a fresh install via the ADT Bundle
3. Use Eclipse, adding in the ADT plugin to an existing Eclipse installation

A fourth option would be to skip either IDE and just use the Android SDK and Gradle for Android directly. This would only be appropriate for fairly expert

developers, and so the tutorials do not walk you through this path. This book has several chapters on Gradle, but those chapters are presently designed for developers already experienced in working with Android apps. For the purposes of learning Android, you are better served working with one of the supported IDEs initially. Later on, if you wish to drop the IDE and use Gradle for Android directly, you are welcome to do so.

Options #2 and #3 are close to being mutually exclusive. And, as noted earlier in the book, Eclipse support has been officially dropped by Google and, therefore, you **really** should consider using Android Studio over Eclipse today. Otherwise, you are welcome to choose one or more of these options. The installation instructions for each are described in the sections that follow.

Option #1 - Android Studio

Visit the Android Studio download page, download the ZIP file for your platform, and unZIP it to some likely spot on your hard drive. Windows users who choose to download the self-installing EXE can just run that file.

Android Studio can then be run from the `studio` batch file or shell script from your Android Studio installation's `bin/` directory.

Option #2 - Android ADT Bundle

The Android ADT Bundle contains:

- The Android SDK, which gives you all the tools you need to create and test Android applications. It comes in two parts: the base tools, plus version-specific SDKs and related add-ons.
- A copy of Eclipse, with the Android Developer Tools (ADT) plug-in pre-installed.

From the Android Developer site's SDK area, choose the ADT Bundle ZIP file that is appropriate for your development machine and unZIP it in some likely location.

Option #3 - Install the ADT for Eclipse

To use Eclipse, you will need to install the base Android SDK, then configure Eclipse.

Install the Android SDK

The Android developer tools can be found on the Android Developers Web site.

You will want to click on "Using an Existing IDE" (even if you have not yet installed Eclipse) and download the ZIP or TGZ file presented to you, unpacking it in some likely spot — there is no specific path that is required. Windows users also have the option of running a self-installing EXE file.

Configure Eclipse

If you have not yet installed Eclipse, you will need to do that first. Eclipse can be downloaded from the Eclipse Web site. The "Eclipse IDE for Java Developers" package will work fine. Note that the Android tools require Eclipse 3.7 (Indigo) or newer at the time of this writing.

If you already had Eclipse installed, it is a good idea for you to go in and check your compiler compliance level (Preferences > Java > Compiler). That should be set to 1.6. Notably, this allows the use of `@Override` annotations to indicate methods that are implementing a Java interface, rather than truly overriding a superclass method. This annotation is very common in Java code in Android projects (including many of the samples in this book).

Next, you need to install the Android Developer Tools (ADT) plug-in. To do this, go to Help | Install New Software... in the Eclipse main menu. Then, click the Add button to add a new source of plug-ins. Give it some name (e.g., Android) and supply the following URL: `https://dl-ssl.google.com/android/eclipse/`. That should trigger Eclipse to download the roster of plug-ins available from that site:

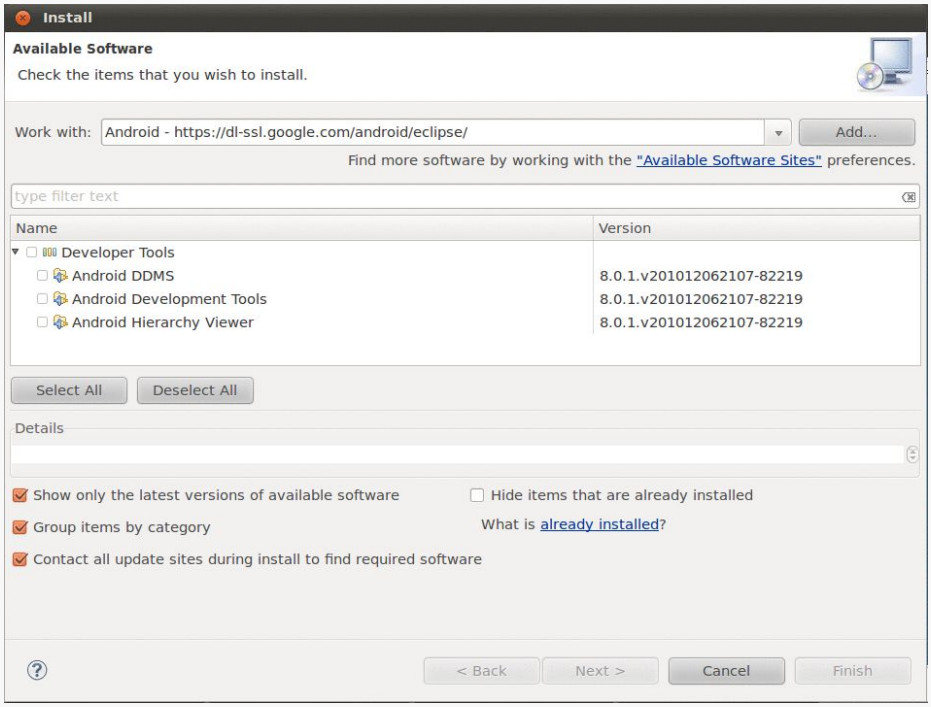

Figure 3: Eclipse ADT plug-in installation

Check the checkbox to the left of "Developer Tools" and click the Next button. Follow the rest of the wizard to review the tools to be downloaded and their respective license agreements. When the Finish button is enabled, click it, and Eclipse will download and install the plug-ins. When done, Eclipse will ask to restart — please let it.

Then, you need to teach ADT where your Android SDK installation is from the preceding section. This should occur on your next restart of Eclipse, via a "welcome wizard". Otherwise, to do this, choose Window | Preferences from the Eclipse main menu (or the equivalent Preferences option for OS X). Click on the Android entry in the list on the left:

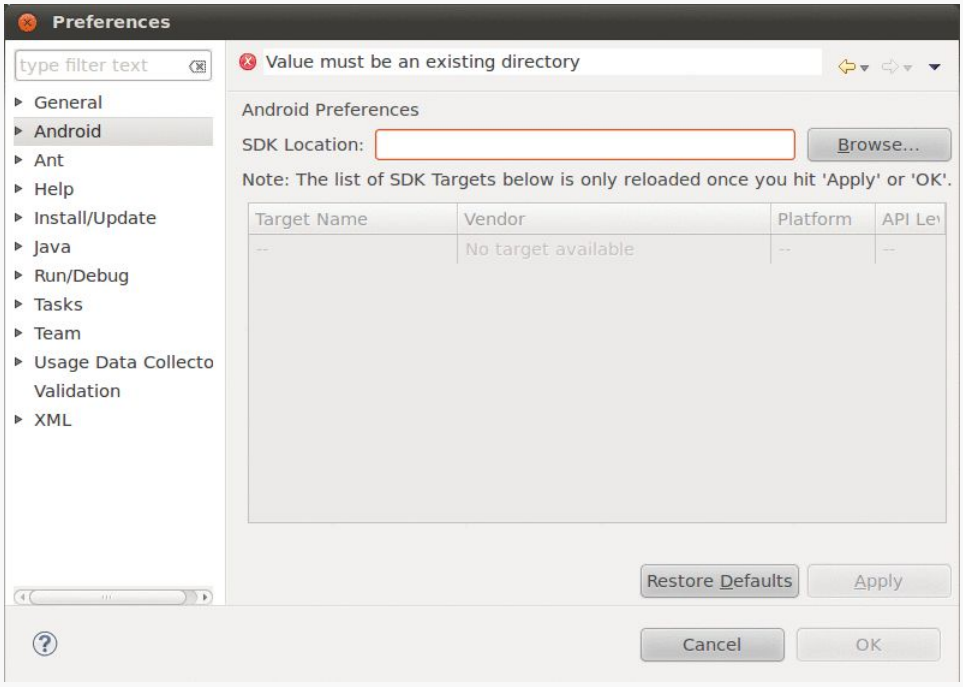

Figure 4: Eclipse ADT Configuration

Then, click the Browse... button to find the directory where you installed the SDK. After choosing it, click Apply on the Preferences window, and you should see the Android SDK versions you installed previously. Then, click OK, and the ADT will be ready for use.

Step #4 - Install the SDKs and Add-Ons

Next, we need to review what pieces of the Android SDK we have already and perhaps install some new items. To do that, you need to access the SDK Manager.

Android Studio First Run and SDK Manager Launch

When you first run Android Studio, you may be asked if you want to import settings from some other prior installation of Android Studio:

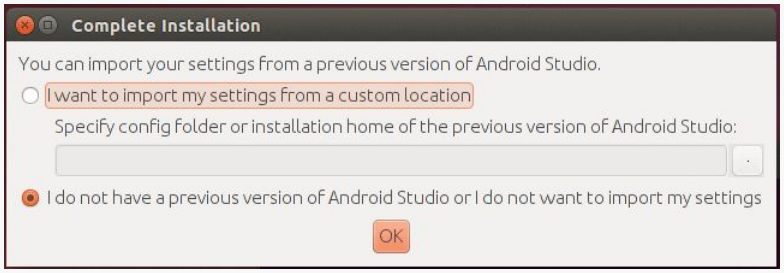

Figure 5: Android Studio First-Run Settings Migration Dialog

For most users, particularly those using Android Studio for the first time, the "I do not have..." option is the correct choice to make.

Then, after a short splash screen, you will be taken to the Android Studio Setup Wizard:

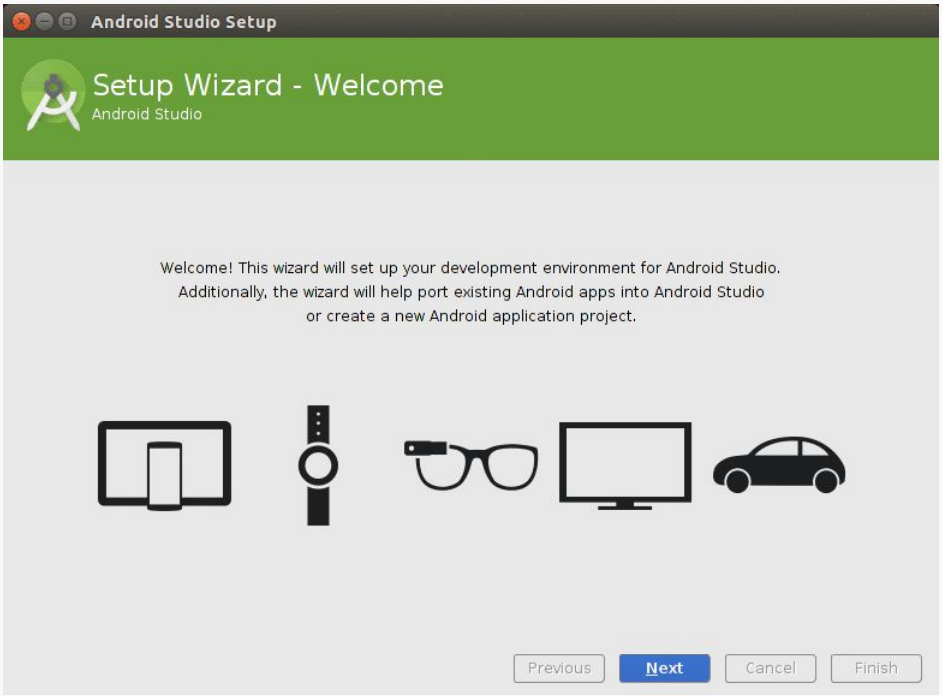

Figure 6: Android Studio Setup Wizard, First Page

Just click "Next" to advance to the second page of the wizard:

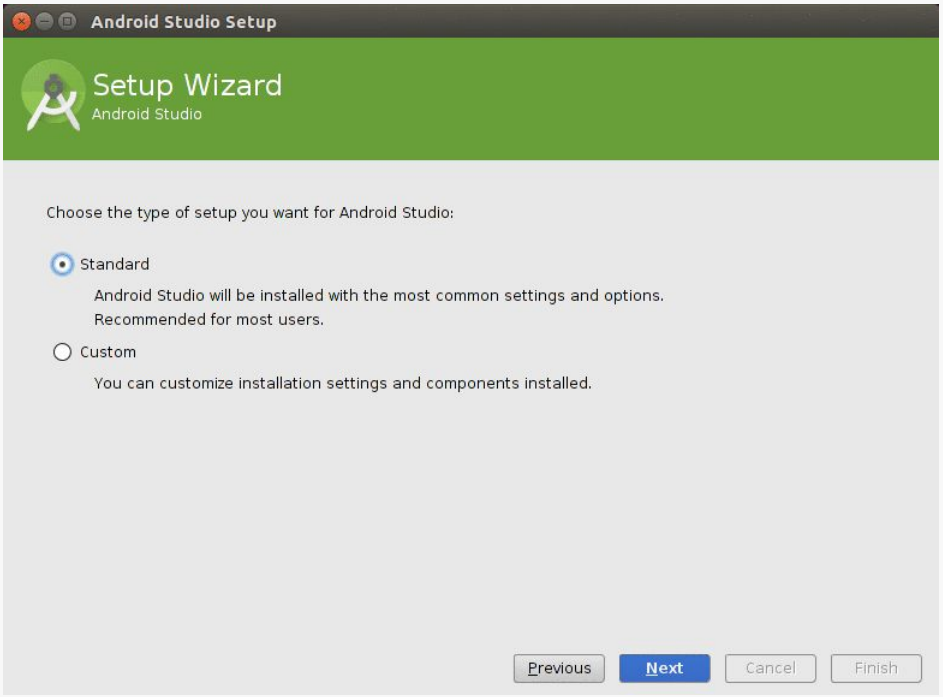

Figure 7: Android Studio Setup Wizard, Second Page

Here, you have a choice between "Standard" and "Custom" setup modes. "Custom" simply allows you to indicate what should be set up:

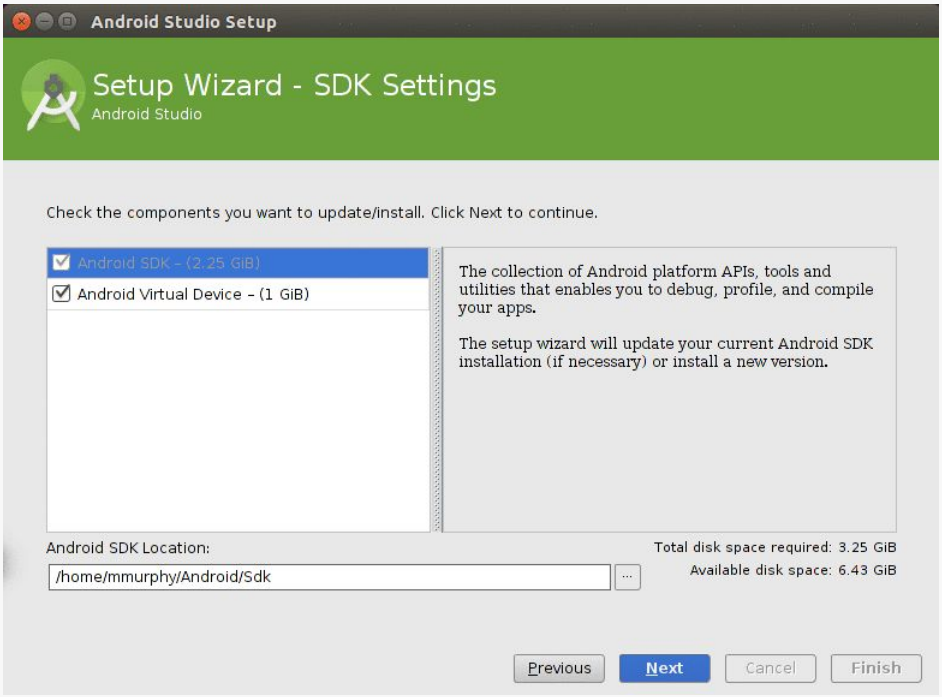

Figure 8: Android Studio Setup Wizard, Custom Page

Most likely, right now, you need all of that anyway, so the "Standard" route would be fine.

If you go the "Standard" route and click "Next", you may be taken to a wizard page explaining some information about the Android emulator:

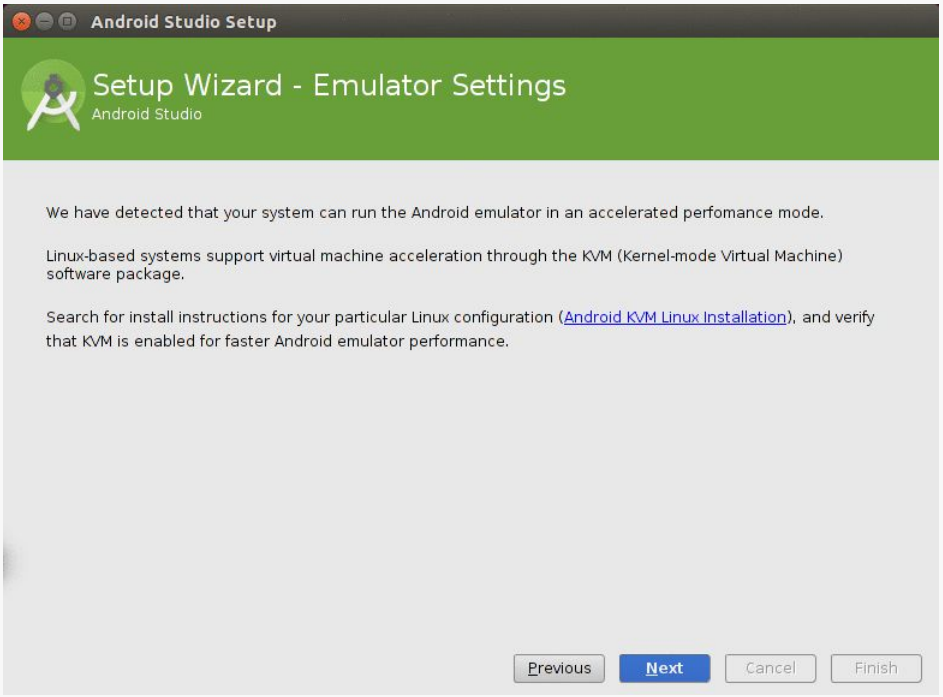

Figure 9: Android Studio Setup Wizard, Emulator Info Page

What is explained on this page may not make much sense to you. That is perfectly normal, and we will get into what this page is trying to say later in the book. Just click "Next" to advance to the next page:

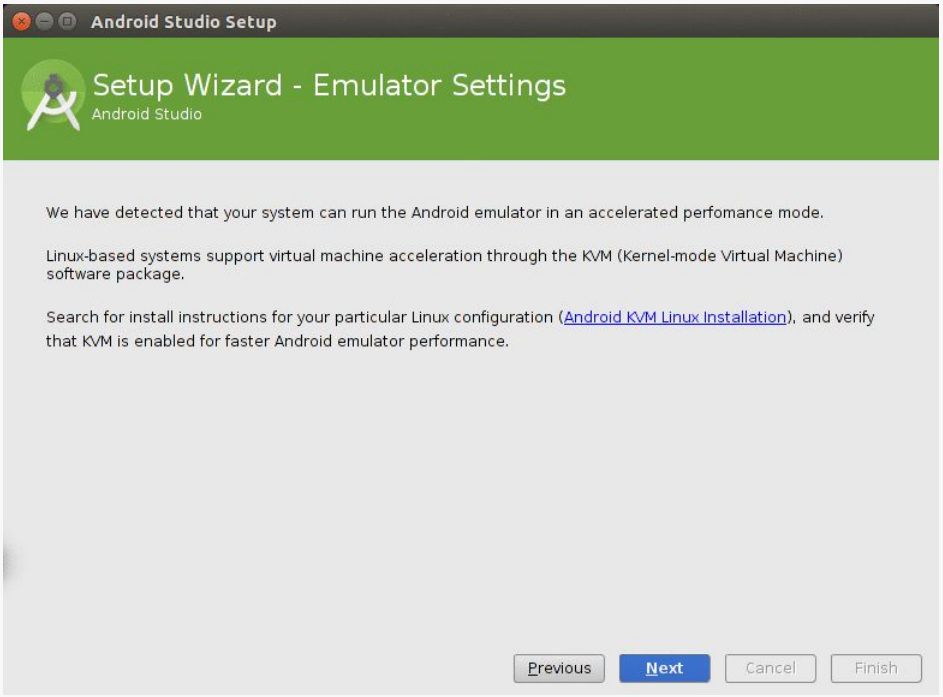

Figure 10: Android Studio Setup Wizard, License Page

Here, you will need to review the various licenses and click "Accept" if you wish to continue. At this point, clicking "Finish" will begin the setup process. This will include downloading a copy of the Android SDK and installing it into a directory adjacent to where Android Studio itself is installed.

When that is done, you will be taken to the Android Studio Welcome dialog:

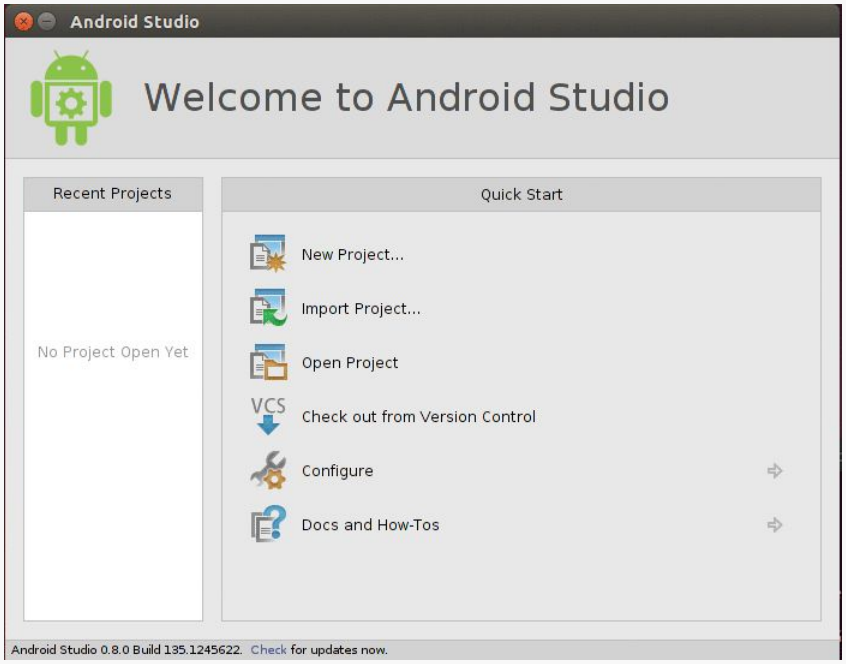

Figure 11: Android Studio Welcome Dialog

In very tiny print at the bottom of that dialog is a "Check for updates now" link. Click that, and if there are updates available, install them. This will automatically restart Android Studio. Android Studio *should* have downloaded the latest updates as part of the initial setup, so most likely this will indicate that nothing more is needed.

Then, in the welcome dialog, click Configure, to bring up a configuration sub-menu:

Figure 12: Android Studio Welcome Dialog, Configure Sub-Menu

There, tap on SDK Manager to bring up the SDK Manager.

Eclipse SDK Manager Launch

Eclipse may take a few extra moments on its first launch to get going, but it does not do anything especially unusual.

Then, choose Windows > Android SDK Manager from the main menu, or tap on the toolbar icon that looks like the Android "bugdroid" mascot peeking out of the top of a box with a downward-pointing white arrow.

Using SDK Manager and Updating Your Environment

You should now have the SDK Manager window open:

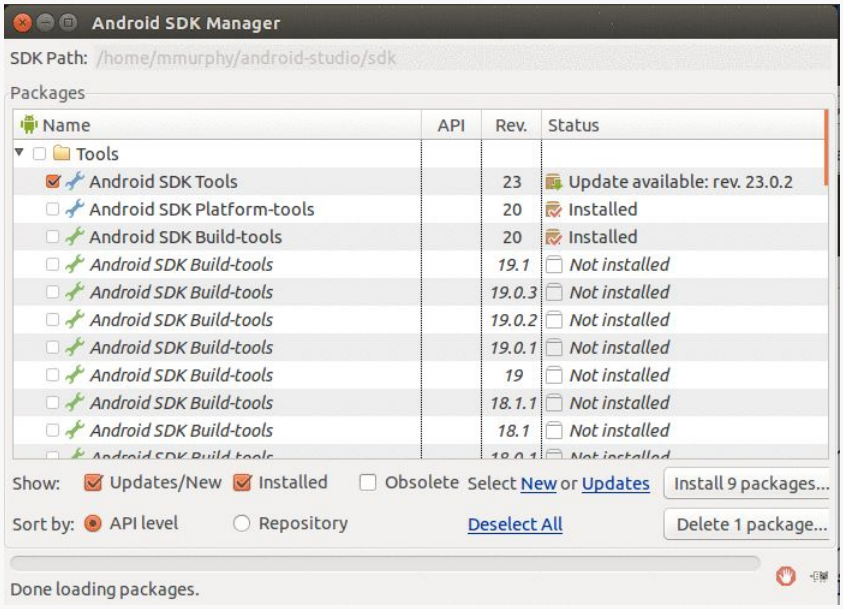

Figure 13: Android SDK Manager

At this point, while you have some of the build tools, you may lack the Java files necessary to compile an Android application. You also lack a few additional build tools, plus the files necessary to run an Android emulator. The checkboxes indicate which packages you want to install — by default, it pre-checks a number of them. If you chose the "ADT Bundle", some things will already be pre-installed for you.

You will want to install the following items, if they have not already been installed:

1. Android SDK Tools, Platform-tools, and the latest Build-tools.
2. "SDK Platform" for all Android SDK releases you want to code against — for this version of this book API 19 (Android 4.4) is recommended, along with any others with which you wish to experiment.
3. "ARM EABI v7a System Image", if there is an option for that for the API level you chose. You can also download the "Intel x86 Atom System Image", if one is available to you, as it is much faster, though setting that up is a bit of an advanced topic. You are also welcome to download similar images for any other Android API level that you are interested in testing against. However, for the purposes of this book, **DO NOT** choose the Android 4.4 or 4.4W emulator images, as the Android 4.4 emulator has a bug and the Android 4.4W emulator is only for Android Wear devices.
4. "Documentation for Android SDK" for the latest Android SDK release.

5. "Samples for SDK" for the Android SDK release you chose in item #2 above, and perhaps for older releases if you wish.
6. Android Support Library and the Android Support Repository (in the Extras group at the bottom of the tree).

If you are running Windows, also choose the Google USB Driver (in the Extras group at the bottom of the tree).

Also, if anything that you presently have installed has updates available, they should already be pre-checked and will be updated when you install the items that you are adding.

Then, click the Install button beneath the tree on the right, which brings up a license confirmation dialog:

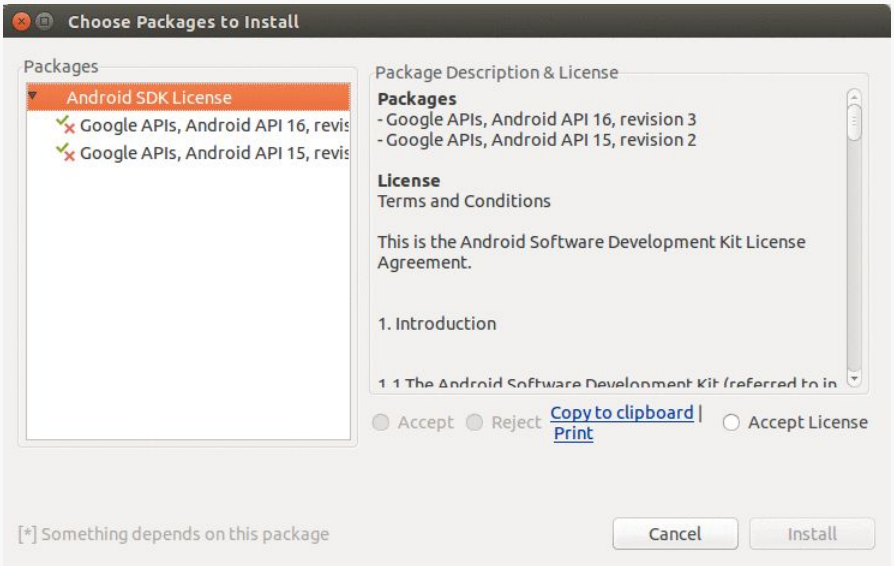

Figure 14: Android SDK Manager Installing Packages

Review and accept the licenses, then click the Install button.

When the download is complete, you can close up the SDK Manager.

In Our Next Episode…

… we will create an Android project that will serve as the basis for all our future tutorials, plus set up our emulator and device.