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FOURTH EDITION



Beginning Android® Programming with Android Studio

J. F. DiMarzio

BEGINNING ANDROID® PROGRAMMING WITH ANDROID STUDIO

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BEGINNING

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J. F. DiMarzio



A Wiley Brand

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*To my children Christian, Sophia, and Giovanni;
Katie, Sarah, and Joe; and my love Jennifer.*

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J. F. DIMARZIO began developing computer programs—specifically games—in 1984 as a wide-eyed, curious child of the Atari age. Starting on the TRS-80 Color Computer II, in BASIC, he wrote several small text-based games and simple inventory applications. After leaving the Music program at the University of Massachusetts, J. F. moved into professional computer development; working for the United States Department of Defense, Walt Disney Imagineering, TechData, and The Walt Disney Company. In 2008, he started developing apps on the newly introduced Android platform (then on version 0.8). He has had 14 books published to date, 7 of which are on Android and Android game development.

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INTRODUCTION

I first started playing with the Android Software Development Kit (SDK) before it was officially released as version 0.8. Back then, the tools were unpolished, the application programming interfaces (APIs) in the SDK were unstable, and the documentation was sparse. Android is now one of the most popular mobile operating systems in the world.

Every day, more developers are trying Android development using Android Studio, either as a hobby or professionally. The current challenge for many beginning developers who want to move into the exciting world of android development is trying to determine where to start.

It was with this challenge in mind that I was motivated to write this book, one that could benefit beginning Android programmers and enable them to write progressively more sophisticated applications.

This book is written to help jump-start beginning Android developers, covering the necessary topics in a linear manner so that you can build on your knowledge without being overwhelmed by the details. I adopt the philosophy that the best way to learn is by doing. The numerous Try It Out sections in each chapter first show you how to build something. Then the follow-up How It Works sections explain how everything works. I have also taken this opportunity to further improve the previous edition of this book by addressing feedback from readers and adding additional topics that are important to beginning Android developers.

Although Android programming is a huge topic, my aim for this book is threefold: to get you started with the fundamentals, to help you understand the underlying architecture of the SDK, and to appreciate why things are done in certain ways. It is beyond the scope of any book to cover everything under the sun related to Android programming. However, I am confident that after reading this book (and doing the exercises), you will be well equipped to tackle your next Android programming challenge.

WHO THIS BOOK IS FOR

This book is targeted for the beginning Android developer who wants to start developing applications using Google’s Android SDK. To truly benefit from this book, you should have some background in programming and at least be familiar with object-oriented programming (OOP) concepts. If you are totally new to Java—the language used for Android development—you might want to take a programming course in Java programming or grab one of many good books on Java programming. In my experience, if you already know C# or VB.NET, learning Java doesn’t require too much effort. If you’re already comfortable with C# or VB.NET, you should be comfortable just following along with the Try It Outs.

For those totally new to programming, I know the lure of developing mobile apps and making some money is tempting. However, before attempting to try out the examples in this book, I think a better starting point would be to first learn the basics of programming.

NOTE All the examples discussed in this book were written and tested using version N (Nougat) of the Android SDK on Android Studio 2 previews (1 through 6). Although every effort is made to ensure that all the tools used in this book are the latest, it is always possible that by the time you read this book a newer version of the tools will be available. If so, some of the instructions and/or screenshots may differ slightly. However, any variations should be manageable.

WHAT THIS BOOK COVERS

This book covers the fundamentals of Android programming using the Android SDK. It is divided into 12 chapters and one appendix.

- **Chapter 1: Getting Started with Android Programming** covers the basics of the Android OS and its current state. You are introduced to the features of Android devices, as well as some of the popular devices on the market. You also find out how to download and install Android Studio to develop Android applications, and then you see how to test them on the Android emulator.
- **Chapter 2: Using Android Studio for Android Development** walks you through many of the different elements within Android Studio. You are introduced to the IDE (Integrated Development Environment) and its pieces. Finally, you discover how to publish a finished application
- **Chapter 3: Activities, Fragments, and Intents** gets you acquainted with these three fundamental concepts in Android programming. Activities and fragments are the building blocks of an Android application. You find out how to link activities to form a complete Android application using intents, one of the unique characteristics of the Android OS.
- **Chapter 4: Getting to Know the Android User Interface** covers the various components that make up the user interface (UI) of an Android application. You are introduced to the various layouts you can use to build the UI of your application. You also learn about the numerous events that are associated with the UI when users interact with the application.
- **Chapter 5: Designing Your User Interface with Views** walks you through the various basic views you can use to build your Android UI. You learn three main groups of views: basic views, picker views, and list views. You also find out about the specialized fragments available in Android 3.0 and 4.0.

- **Chapter 6: Displaying Pictures and Menus with Views** continues the exploration of views. Here, you see how to display images using the various image views, as well as display options and context menus in your application. This chapter ends with some additional cool views that you can use to spice up your application.
- **Chapter 7: Data Persistence** shows you how to save, or store, data in your Android application. In addition to being introduced to the various techniques to store user data, you also find out about file manipulation and how to save files onto internal and external storage (SD card). In addition, you learn how to create and use a SQLite database in your Android application.
- **Chapter 8: Content Providers** discusses how data can be shared among different applications on an Android device. You see how to use a content provider and then build one yourself.
- **Chapter 9: Messaging** explores two of the most interesting topics in mobile programming—sending SMS messages and email. You learn how to programmatically send and receive SMS and email messages, as well as how to intercept incoming SMS messages so that the built-in Messaging application is not able to receive any messages.
- **Chapter 10: Location-Based Services** demonstrates how to build a location-based service application using Google Maps. You also find out how to obtain geographical location data and then display the location on the map.
- **Chapter 11: Networking** explores how to connect to web servers to download data. You see how XML and JSON web services can be consumed in an Android application. This chapter also explains sockets programming, and you see how to build a chat client in Android.
- **Chapter 12: Developing Android Services** demonstrates how you can write applications using services. Services are background applications that run without a UI. You learn how to run your services asynchronously on a separate thread, and how your activities can communicate with them.
- **Appendix: Answers to Exercises** contains the solutions to the end-of-chapter exercises found in every chapter.

HOW THIS BOOK IS STRUCTURED

This book breaks down the task of learning Android programming into several smaller chunks, enabling you to digest each topic before delving into a more advanced one.

If you are a total beginner to Android programming, start with Chapter 1. After you have familiarized yourself with the basics, head to Chapter 2 and get to know the Android Studio IDE. When you are ready, continue with Chapter 3 and gradually move into more advanced topics.

A feature of this book is that all the code samples in each chapter are independent of those discussed in previous chapters. This gives you the flexibility to dive into the topics that interest you and start working on the Try It Out projects.

WHAT YOU NEED TO USE THIS BOOK

All the examples in this book run on the Android emulator (which is included as part of the Android SDK and Android Studio). However, to get the most out of this book, it would be useful to have a real Android device (though it's not absolutely necessary).

CONVENTIONS

To help you get the most from the text and keep track of what's happening, a number of conventions are used throughout the book.

TRY IT OUT These Are Exercises or Examples for You to Follow

The Try It Out sections appear once or more per chapter. These are exercises to work through as you follow the related discussion in the text.

1. They consist of a set of numbered steps.
2. Follow the steps with your copy of the project files.

How It Works

After each Try It Out, the code you've typed is explained in detail.

As for other conventions in the text:

- New terms and important words are *highlighted* in italic when first introduced.
- Keyboard combinations are treated like this: Ctrl+R.
- Filenames, URLs, and code within the text are treated like so: `persistence.properties`.
- Code is presented in two different ways:

We use a monofont type with no highlighting for most code examples.

We use bolding to emphasize code that is of particular importance in the present context.

NOTE Notes, tips, hints, tricks, and asides to the current discussion look like this.

SOURCE CODE

As you work through the examples in this book, you may choose either to type in all the code manually or to use the source code files that accompany the book. All the source code used in this book is available for download at www.wrox.com. When at the site, simply locate the book's title (use the Search box or one of the title lists) and click the Download Code link on the book's detail page to obtain all the source code for the book.

You'll find the filename of the project you need at the end of the title of the Try it Out features:

TRY IT OUT **Understanding the Life Cycle of an Activity (Activity101.zip)**

After you download the code, decompress it with your favorite compression tool. Alternatively, go to the main Wrox code download page at www.wrox.com/dynamic/books/download.aspx to see the code available for this book as well as for all other Wrox books.

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ERRATA

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2. Read the terms of use and click Agree.
3. Complete the required information to join as well as any optional information you want to provide and click Submit.
4. You will receive an email with information describing how to verify your account and complete the joining process.

NOTE *You can read messages in the forums without joining P2P, but in order to post your own messages, you must join.*

After you join, you can post new messages and respond to messages posted by other users. You can read messages at any time on the web. If you want to have new messages from a particular forum emailed to you, click the Subscribe to This Forum icon next to the forum name in the forum listing.

For more information about how to use the Wrox P2P, be sure to read the P2P FAQs for answers to questions about how the forum software works, as well as many common questions specific to P2P and Wrox books. To read the FAQs, click the FAQ link on any P2P page.

1

Getting Started with Android Programming

WHAT YOU WILL LEARN IN THIS CHAPTER

- What is Android?
- Android versions and its feature set
- The Android architecture
- The various Android devices on the market
- The Android Market application store
- How to obtain the tools and SDK for developing Android applications
- How to develop your first Android application

CODE DOWNLOAD *There are no code downloads for this chapter.*

Welcome to the world of Android! This chapter explains what Android is and what makes it so compelling to both developers and device manufacturers. It also shows you how to obtain and set up all the necessary tools so that you can test your application on an Android emulator in Android Studio 2 and how to get started with developing your first Android application. By the end of this chapter, you will be equipped with the basic knowledge you need to explore more sophisticated techniques and tricks for developing your next killer Android application.

WHAT IS ANDROID?

Android is a mobile operating system that is based on a modified version of Linux. It was originally developed by a startup of the same name, Android, Inc. In 2005, as part of its strategy to enter the mobile space, Google purchased Android, Inc. and took over its development work (as well as its development team).

Google wanted the Android OS to be open and free, so most of the Android code was released under the open source Apache License. That means anyone who wants to use Android can do so by downloading the full Android source code. Moreover, vendors (typically hardware manufacturers) can add their own proprietary extensions to Android and customize Android to differentiate their products from others. This development model makes Android very attractive to vendors, especially those companies affected by the phenomenon of Apple's iPhone, which was a hugely successful product that revolutionized the smartphone industry. When the iPhone was launched, many smartphone manufacturers had to scramble to find new ways of revitalizing their products. These manufacturers saw Android as a solution, meaning they will continue to design their own hardware and use Android as the operating system that powers it. Some companies that have taken advantage of Android's open source policy include Motorola and Sony Ericsson, which have been developing their own mobile operating systems for many years.

The main advantage to adopting Android is that it offers a unified approach to application development. Developers need only develop for Android in general, and their applications should be able to run on numerous different devices, as long as the devices are powered using Android. In the world of smartphones, applications are the most important part of the success chain.

Android Versions

Android has gone through quite a number of updates since its first release. Table 1-1 shows the various versions of Android and their codenames.

TABLE 1-1: A Brief History of Android Versions

ANDROID VERSION	RELEASE DATE	CODENAME
1.1	February 9, 2009	
1.5	April 30, 2009	Cupcake
1.6	September 15, 2009	Donut
2.0/2.1	October 26, 2009	Éclair
2.2	May 20, 2010	Froyo
2.3	December 6, 2010	Gingerbread
3.0/3.1/3.2	February 22, 2011	Honeycomb
4.0	October 18, 2011	Ice Cream Sandwich

ANDROID VERSION	RELEASE DATE	CODENAME
4.1	July 9, 2012	Jelly Bean
4.4	October 31, 2013	KitKat
5.0	November 12, 2014	Lollipop
6.0	October 5, 2015	Marshmallow
7.0	TBD	Nougat

In 2016, Google released Android 7.0; the following are the key changes in Android 7.0:

- Split-screen multi-window mode
- Redesigned notification shade
- Refined “Doze” feature
- Switch from JRE (Java Runtime Environment) to OpenJDK

One important thing to keep in mind as you are looking at Android versions is that each version has its own features and APIs (application programming interfaces). Therefore, if your application is written for the newest version of Android, and it uses an API that was not present in an older version of Android, then only devices running that newer version of Android will be able to use your application.

Features of Android

Because Android is open source and freely available to manufacturers for customization, there are no fixed hardware or software configurations. However, the base Android OS supports many features, including

- **Storage**—SQLite, a lightweight relational database, for data storage. Chapter 7 discusses data storage in more detail.
- **Connectivity**—GSM/EDGE, IDEN, CDMA, EV-DO, UMTS, Bluetooth (includes A2DP and AVRCP), Wi-Fi, LTE, and WiMAX. Chapter 11 discusses networking in more detail.
- **Messaging**—Both SMS and MMS. Chapter 9 discusses messaging in more detail.
- **Media support** H.263, H.264 (in 3GP or MP4 container), MPEG-4 SP, AMR, AMR-WB (in 3GP container), AAC, HE-AAC (in MP4 or 3GP container), MP3, MIDI, Ogg Vorbis, WAV, JPEG, PNG, GIF, and BMP.
- **Hardware support**—Accelerometer sensor, camera, digital compass, proximity sensor, and GPS.
- **Multi-touch**—Multi-touch screens.
- **Multi-tasking**—Multi-tasking applications.
- **Tethering**—Sharing of Internet connections as a wired/wireless hotspot.

Android’s web browser is based on the open source WebKit and Chrome’s V8 JavaScript engine.

Architecture of Android

To understand how Android works, take a look at Figure 1-1, which shows the various layers that make up the Android operating system (OS).

The Android OS is roughly divided into five sections in four main layers:

- **Linux kernel**—This is the kernel on which Android is based. This layer contains all the low-level device drivers for the various hardware components of an Android device.
- **Libraries**—These contain the code that provides the main features of an Android OS. For example, the SQLite library provides database support so that an application can use it for data storage. The WebKit library provides functionalities for web browsing.
- **Android runtime**—The Android runtime is located in the same layer with the libraries and provides a set of core libraries that enable developers to write Android apps using the Java programming language. The Android runtime also includes the Dalvik virtual machine, which enables every Android application to run in its own process, with its own instance of the Dalvik virtual machine. (Android applications are compiled into Dalvik executables). Dalvik is a specialized virtual machine designed specifically for Android and optimized for battery-powered mobile devices with limited memory and CPU power.
- **Application framework**—The application framework exposes the various capabilities of the Android OS to application developers so that they can make use of them in their applications.
- **Applications**—At this top layer are the applications that ship with the Android device (such as Phone, Contacts, Browser, and so on), as well as applications that you download and install from the Android Market. Any applications that you write are located at this layer.

Android Devices in the Market

Android devices come in all shapes and sizes including, but not limited to, the following types of devices:

- Smartphones
- Tablets
- E-reader devices
- Internet TVs
- Automobiles
- Smartwatches

Chances are good that you own at least one of the preceding devices. Figure 1-2 shows the Samsung Galaxy Edge 7.

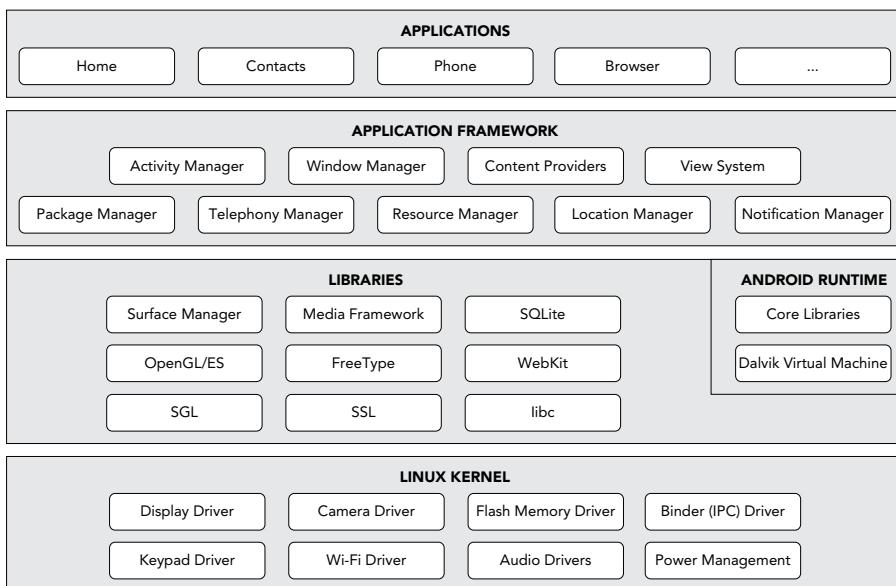


FIGURE 1-1



FIGURE 1-2

Another popular category of devices is the tablet. Tablets typically come in two sizes: 7" and 10", measured diagonally.

Besides smartphones and tablets, Android is used in dedicated devices, such as e-book readers. Figure 1-4 shows the Barnes and Noble's NOOK Color running the Android OS.

In addition to the popular mobile devices I've already mentioned, Android is finding its way onto your wrist. Smartwatches, and "wearables" in general, have become a major segment of the Android population. Figure 1-3 shows the Motorola Moto 360 Smartwatch, which runs Android Wear (a version of Android OS specifically designed for wearables).

At the time of writing, the Samsung Galaxy Nexus (see Figure 1-4) is the only device running a pure version of Android. Many manufacturers add their own modifications to the Android OS for use on their specific devices. Motorola devices



FIGURE 1-3