



DEITEL® DEVELOPER SERIES

THIRD EDITION

# Android™ 6

## for Programmers

An App-Driven Approach

8 Fully Coded  
Android™ Apps



PAUL DEITEL • HARVEY DEITEL  
ALEXANDER WALD



**ANDROID™ 6 FOR  
PROGRAMMERS**  
**AN APP-DRIVEN APPROACH**  
**THIRD EDITION**  
**DEITEL® DEVELOPER SERIES**

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# ANDROID™ 6 FOR PROGRAMMERS

## AN APP-DRIVEN APPROACH

### THIRD EDITION

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app developers to test the limits of their imagination*

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## 6 Cannon Game App

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*Manual Frame-By-Frame Animation, Graphics, Sound, Threading,  
SurfaceView and SurfaceHolder, Immersive Mode and Full-Screen*

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# Preface

Welcome to the dynamic world of Android *smartphone* and *tablet* app development with the Android Software Development Kit (SDK), the Java™ programming language and the rapidly evolving Android Studio Integrated Development Environment (IDE). Many of the Android techniques we present also apply to Android Wear and Android TV app development, so after reading this book, you'll be well prepared to investigate developing apps for these platforms.

*Android 6 for Programmers: An App-Driven Approach* presents leading-edge mobile computing technologies for professional software developers. In our *app-driven approach*, we present concepts in *complete working Android apps*, rather than using code snippets. Chapters 2–9 each present one app. Each chapter begins with an introduction to the app, an app test-drive showing one or more sample executions and an overview of the technologies we used to build the app. Then we present a detailed source-code walkthrough. All of the source code is available at

<http://www.deitel.com/books/AndroidFP3>

We recommend that you view each app's source code in the IDE as you read the chapter.

The opportunities for Android app developers are enormous. Sales of Android devices and app downloads have been growing exponentially. The first-generation Android phones were released in October 2008. According to IDC, after the first three months of 2015, Android had 78% of the global smartphone market share, compared to 18.3% for Apple, 2.7% for Microsoft and 0.3% for Blackberry.<sup>1</sup> Over one billion Android devices shipped in 2014 alone.<sup>2</sup> At the 2015 Google I/O conference, Google announced that in the prior 12 months there had been 50 billion app installs from Google Play™—Google's marketplace for Android apps.<sup>3</sup> Fierce competition among popular mobile platforms and carriers is leading to rapid innovation and falling prices. In addition, competition among the hundreds of Android device manufacturers is driving hardware and software innovation within the Android community.

## Copyright Notice and Code License

*All of the Android code and Android apps in the book are copyrighted by Deitel & Associates, Inc. The sample Android apps in the book are licensed under a Creative Commons Attribution 3.0 Unported License (<http://creativecommons.org/licenses/by/3.0>), with the exception that they may not be reused in any way in educational tutorials and textbooks, whether in print or digital format. Additionally, the authors and publisher make no warranty of any kind.*

1. <http://www.idc.com/prodserv/smartphone-os-market-share.jsp>.
2. <http://www.businessinsider.com/android-1-billion-shipments-2014-strategy-analytics-2015-2>.
3. <http://bit.ly/2015GoogleI0Keynote>.

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## Intended Audience

We assume that you're a Java programmer with object-oriented programming experience. We also assume that you're familiar with XML—as you'll see, Android projects contain many XML files, though you'll often interact with them through editors that hide much or all of the XML from you. We use only complete, working apps, so if you don't know Java but have object-oriented programming experience in a C-based language such as C++, C#, Swift or Objective-C you should be able to master the material quickly, learning a good amount of Java and Java-style object-oriented programming along the way.

This book is *not* a Java tutorial. If you're interested in learning Java, you may want to check out our publications:

- *Java for Programmers, 3/e* (<http://www.deitel.com/books/javafp3>)
- *Java Fundamentals, 2/e* LiveLessons videos. These videos are available to Safari-BooksOnline.com subscribers and may be purchased from Informit.com and Udemy.com. Visit <http://www.deitel.com/LiveLessons> for subscription and purchase links.
- *Java How to Program, 10/e* (<http://www.deitel.com/books/jhtp10>; ISBN# 0-13-380780-0)

If you're not familiar with XML, many free online tutorials are available, including:

- <http://www.ibm.com/developerworks/xml/newto>
- <http://www.w3schools.com/xml/default.asp>
- <http://bit.ly/DeitelXMLBasics>
- <http://bit.ly/StructureXMLData>

## Features

Here are some of this book's key features:

***App-Driven Approach.*** Chapters 2–9 each present one completely coded app—we discuss what the app does, show screenshots of the app in action, test-drive it and overview the technologies and architecture we used to build it. Then we build the app's GUI and resource files, present the complete code and do a detailed code walkthrough. We discuss the programming concepts and demonstrate the functionality of the Android APIs used in the app.

***Android 6 SDK.*** We cover various new Android 6 Software Development Kit (SDK) features.

***Android Studio IDE.*** The free Android Studio (based on IntelliJ IDEA Community Edition) is now Google's preferred IDE for Android app development (the original Android

development tools were based on the Eclipse IDE). Android Studio, combined with the free Android Software Development Kit (SDK) and the free Java Development Kit (JDK), provide all the software you'll need to create, run and debug Android apps, export them for distribution (e.g., upload them to Google Play™) and more. See the Before You Begin section after this Preface for download and installation instructions for all this software.

**Material Design.** With Android 5, Google introduced its new Android look-and-feel, based on their material design specification:

<http://www.google.com/design/spec/material-design/introduction.html>

In the specification, Google overviews the goals and principles of material design, then provides details on animation techniques, styling on-screen elements, positioning elements, uses of specific user-interface components, user-interaction patterns, accessibility, internationalization and more. Google now uses material-design principles in its mobile and browser-based apps.

Material design is a massive topic. In this book, we focus on the following aspects of material design:

- Using Android's built-in *Material themes*—these give Android's built-in user-interface components a look-and-feel that's consistent with material design principles.
- Using built-in Android Studio *app templates*—these are designed by Google to adhere to material design principles.
- Using *user-interface components*, as appropriate, that are recommended by the material design guidelines for specific purposes, such as `FloatingActionButton`s, `TextInputLayout`s and `RecyclerView`s.

In addition to Google's material design specification, you may want to read the book *Android User Interface Design: Implementing Material Design for Developers, 2nd Edition*:

<http://bit.ly/IanCliftonMaterialDesign>

by our professional colleague and past *Android for Programmers* reviewer Ian Clifton. From Ian: “Google announced the material design guidelines in 2014, creating a design system that suggested how an app should look as well as behave. The goal was to provide a design framework that would improve the visual appearance of all apps and create a behavioral consistency that did not exist previously across apps. *Android User Interface Design: Implementing Material Design for Developers, 2nd Edition* covers material design in detail, making user-centered design, color theory, typography, interaction patterns and other aspects of design accessible to all developers.”

**Support and App Compatibility Libraries.** A big challenge developers face when using new Android features is backward compatibility with earlier Android platforms. Many new Android features are now introduced via support libraries. These enable you to use new features in apps targeting current and past Android platforms. One such library is the `AppCompat` library. Android Studio's app templates have been updated to use the `AppCompat` library and its themes, enabling the new apps you create to run on most Android devices. By creating apps with the `AppCompat` library from the start, you avoid having to reimplement your code if you decide to support older Android versions to target a wider audience.

In addition, at the 2015 Google I/O developer conference, Google introduced the Android Design Support Library

<http://android-developers.blogspot.com/2015/05/android-design-support-library.html>

for using material design in Android 2.1 and higher. Material design support also is built into most of Android Studio's app templates.

**REST Web Services and JSON.** Chapter 7 presents the **Weather Viewer** app, which demonstrates how to invoke Representational State Transfer (REST) web services—in this case, the 16-day weather-forecast service from [OpenWeatherMap.org](http://OpenWeatherMap.org). This web service returns the weather forecast in JavaScript Object Notation (JSON)—a popular text-based data-interchange format used to represent objects as key–value pairs of data. The app also uses classes from the `org.json` package to process the web service's JSON response.

**Android 6.0 Permissions.** Android 6.0 has a new permissions model that's designed for a better user experience. Before Android 6.0, a user was required at installation time to grant in advance all permissions that an app would ever need, which often discouraged users from installing apps. With the new model, the app is installed without asking for any permissions. Instead, the user is asked to grant a permission only the first time the corresponding feature is used. Chapter 5 introduces the new permissions model and uses it to request permission from the user to store an image on the device's external storage.

**Fragments.** Starting with Chapter 4, we use **Fragments** to create and manage portions of each app's GUI. You can combine several fragments to create user interfaces that take advantage of tablet screen sizes. You also can easily interchange fragments to make your GUIs more dynamic, as you'll do in Chapter 9.

**View-Holder Pattern, ListView and RecyclerView.** The apps in Chapters 7–9 each display scrollable lists of data. Chapter 7 presents the data in a **ListView** and introduces the view-holder pattern, which improves scrolling performance by reusing GUI components that scroll off-screen. With **ListViews**, using the view-holder pattern is recommended. Chapters 8 and 9 each present a list of data in the more flexible and more efficient **RecyclerView** for which the view-holder pattern is required.

**Printing.** We demonstrate class **PrintHelper** (Chapter 5) from Android's printing framework for printing from an app. Class **PrintHelper** provides a user interface for selecting a printer, has a method for determining whether a given device supports printing and provides a method for printing a **Bitmap**. **PrintHelper** is part of the Android Support Library.

**Immersive Mode.** The status bar at the top of the screen and the menu buttons at the bottom can be hidden, allowing your apps to fill more of the screen. Users can access the status bar by swiping down from the top of the screen, and the system bar (with the back button, home button and recent apps button) by swiping up from the bottom.

**Testing on Android Smartphones, Tablets and the Android Emulator.** For the best app-development experience and results, you should test your apps on actual Android smartphones and tablets. You can still have a meaningful experience using just the Android emulator (see the Before You Begin section); however, it's processor intensive and can be slow, particularly with games that have a lot of moving parts. In Chapter 1, we mention some Android features that are not supported on the emulator.

**Cloud Test Lab.** Google is working on a new *Cloud Test Lab*—an online site for testing your apps across a wide range of devices, device orientations, locales, spoken languages and network conditions. You’ll be able to run automated tests and receive detailed reports containing screenshots and videos of your app in action, as well as error logs to help you find problems and improve your apps. For more information and to sign up to be notified when Cloud Test Lab becomes available, visit:

<http://developers.google.com/cloud-test-lab/>

**Android Wear and Android TV.** Android Wear runs on smart watches. Android TV runs directly on some smart TVs and media players that you can connect to your TV (typically via HDMI cables). Many Android techniques we present also apply to Android Wear and Android TV app development. The Android SDK provides Android Wear and Android TV emulators, so you can test your apps for these platforms, even if you don’t have devices. To learn more about these technologies from the developer perspective, visit:

<http://developer.android.com/wear/index.html>

for Android Wear and

<http://developer.android.com/tv/index.html>

for Android TV.

**Multimedia.** The apps use a range of Android multimedia capabilities, including graphics, images, frame-by-frame animation and audio.

**Uploading Apps to Google Play.** Chapter 10, Google Play and App Business Issues, discusses Google Play and setting up a merchant account so you can sell your apps. You’ll learn how to prepare apps for submission to Google Play, find tips for pricing your apps, and find resources for monetizing them with in-app advertising and in-app sales of virtual goods. You’ll also find resources for marketing your apps. Chapter 10 can be read after Chapter 1.

## Pedagogic Features

**Syntax Coloring.** For readability, we syntax color the code, similar to Android Studio’s use of syntax coloring. Our syntax-coloring conventions are as follows:

comments appear like this  
keywords appear like this  
constants and literal values appear like this  
all other code appears like this

**Code Highlighting.** We emphasize the key code segments in each program by enclosing them in yellow rectangles.

**Using Fonts for Emphasis.** We use various font conventions:

- The defining occurrences of key terms appear **bold maroon** for easy reference.
- On-screen IDE components appear in **bold Helvetica** (e.g., the **File** menu).
- Program source code appears in **Lucida** (e.g., `int x = 5;`).

In this book you'll create GUIs using a combination of visual programming (point-and-click, drag-and-drop) and writing code. We use different fonts when we refer to GUI elements in program code versus GUI elements displayed in the IDE:

- When we refer to a GUI component that we create in a program, we place its class name and object name in a Lucida font—e.g., `Button saveContactButton`.
- When we refer to a GUI component that's part of the IDE, we place the component's text in a **bold Helvetica** font and use a plain text font for the component's type—e.g., “the **File** menu” or “the **Run** button.”

*Using the > Character.* We use the `>` character to indicate selecting a menu item from a menu. For example, we use the notation **File > New** to indicate that you should select the **New** menu item from the **File** menu.

*Source Code.* All of the book's source code is available for download from

<http://www.deitel.com/books/AndroidFP3>

*Documentation.* All the Android documentation you'll need to develop Android apps is available at

<http://developer.android.com>

An overview of Android Studio is available at

<http://developer.android.com/tools/studio/index.html>

*Chapter Objectives.* Each chapter begins with a list of learning objectives.

*Figures.* Numerous tables, source-code listings and screenshots are included.

*Software Engineering.* We stress program clarity and performance, and we concentrate on building well-engineered, object-oriented software.

*Index.* We include an extensive index for reference. The page number of the defining occurrence of each key term is highlighted in **bold maroon**.

## Working with Open-Source Apps

The numerous free, open-source Android apps available online are excellent resources for learning Android app development. We encourage you to download open-source apps and read their source code to understand how they work.

**Caution:** The terms of open-source licenses vary considerably. Some allow you to use the app's source code freely for any purpose, while others stipulate that the code is available for personal use only—not for creating for-sale or publicly available apps. Be sure to read the licensing agreements carefully. If you wish to create a commercial app based on an open-source app, you should consider having an intellectual-property attorney read the license; be aware that these attorneys charge significant fees.

## Android 6 App-Development Fundamentals LiveLessons Video Training Products

Our *Android 6 App-Development Fundamentals* LiveLessons videos show you what you need to know to start building robust, powerful Android apps with Android 6, the Java™ pro-

gramming language and Android Studio. Included are approximately 16–20 hours of expert training synchronized with *Android 6 for Programmers: An App-Driven Approach*. For additional information about Deitel LiveLessons video products, visit

<http://www.deitel.com/livelessons>

or contact us at [deitel@deitel.com](mailto:deitel@deitel.com). You also can access our LiveLessons videos if you have a subscription to [SafariBooksOnline.com](http://SafariBooksOnline.com). For a free 10-day trial, register at

<http://www.safaribooksonline.com/register>

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## Contacting the Authors

We'd sincerely appreciate your comments, criticisms, corrections and suggestions for improvement. Please address all questions and other correspondence to

[deitel@deitel.com](mailto:deitel@deitel.com)

We'll respond promptly and post corrections and clarifications as Android evolves at:

<http://www.deitel.com/books/AndroidFP3>

and on Facebook, LinkedIn, Twitter, Google+ and the *Deitel® Buzz Online*.

Visit <http://www.deitel.com> to

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- receive information on our *Dive Into® Series* instructor-led programming-language training courses offered at customer sites worldwide.

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We thank Michael Morgano, a former colleague of ours at Deitel & Associates, Inc., now an Android developer at PHHHOTO, who co-authored the first editions of this book and our book, *iPhone for Programmers: An App-Driven Approach*. Michael is an extraordinarily talented software developer.

Finally, we thank Abbey Deitel, former President of Deitel & Associates, Inc., and a graduate of Carnegie Mellon University's Tepper School of Management where she received a B.S. in Industrial Management. Abbey managed the business operations of Deitel & Associates, Inc. for 17 years, along the way co-authoring a number of our publications, including the previous editions' versions of Chapters 1 and 10.

### ***Reviewers of the Content from Android 6 for Programmers: An App-Driven Approach and Android How to Program Recent Editions***

We'd like to thank the following professionals and academics who reviewed this book and/or its previous editions. They scrutinized the text and the code and provided countless suggestions for improving the presentation: Paul Beusterien (Principal, Mobile Developer Solutions), Eric J. Bowden, COO (Safe Driving Systems, LLC), Tony Cantrell (Georgia Northwestern Technical College), Ian G. Clifton (Independent Contractor, Android App Developer and author of *Android User Interface Design: Implementing Material Design for Developers, 2nd Edition*), Daniel Galpin (Android Advocate and author of *Intro to Android Application Development*), Jim Hathaway (Application Developer, Kellogg Company), Douglas Jones (Senior Software Engineer, Fullpower Technologies), Charles Lasky (Na-gautuck Community College), Enrique Lopez-Manas (Lead Android Architect, Sixt, and Computer Science Teacher at the University of Alcalá in Madrid), Sebastian Nykopp (Chief Architect, Reaktor), Michael Pardo (Android Developer, Mobiata), Luis Ramirez (Lead Android Engineer at Reverb), Ronan "Zero" Schwarz (CIO, OpenIntents), Arijit Sengupta (Wright State University), Donald Smith (Columbia College), Jesus Ubaldo Quevedo-Torrero (University of Wisconsin, Parkside), Dawn Wick (Southwestern Community College) and Frank Xu (Gannon University).

Well, there you have it! *Android 6 for Programmers: An App-Driven Approach* will quickly get you started developing Android apps with Android 6 and Android Studio. We hope you enjoy reading the book as much as we enjoyed writing it!

*Paul Deitel  
Harvey Deitel*

## **About the Authors**

**Paul Deitel**, CEO and Chief Technical Officer of Deitel & Associates, Inc., is a graduate of MIT, where he studied Information Technology. He holds the Java Certified Programmer and Java Certified Developer designations and is an Oracle Java Champion. Paul was also named as a Microsoft® Most Valuable Professional (MVP) for C# in 2012–2014.

Through Deitel & Associates, Inc., he has delivered hundreds of programming courses worldwide to clients, including Cisco, IBM, Siemens, Sun Microsystems, Dell, Fidelity, NASA at the Kennedy Space Center, the National Severe Storm Laboratory, White Sands Missile Range, Rogue Wave Software, Boeing, SunGard, Nortel Networks, Puma, iRobot, Invensys and many more. He and his co-author, Dr. Harvey Deitel, are the world's best-selling programming-language textbook/professional book/video authors.

**Dr. Harvey Deitel**, Chairman and Chief Strategy Officer of Deitel & Associates, Inc., has over 50 years of experience in the computer field. Dr. Deitel earned B.S. and M.S. degrees in Electrical Engineering from MIT and a Ph.D. in Mathematics from Boston University—he studied computing in each of these programs before they spun off Computer Science departments. He has extensive college teaching experience, including earning tenure and serving as the Chairman of the Computer Science Department at Boston College before founding Deitel & Associates, Inc., in 1991 with his son, Paul. The Deitels' publications have earned international recognition, with translations published in Japanese, German, Russian, Spanish, French, Polish, Italian, Simplified Chinese, Traditional Chinese, Korean, Portuguese, Greek, Urdu and Turkish. Dr. Deitel has delivered hundreds of programming courses to corporate, academic, government and military clients.

**Alexander Wald**, a Deitel summer intern, helped us convert the book and our Android apps from Android 4.3 and 4.4 using Eclipse to Android 6 using Android Studio. Alexander is currently pursuing a B.S. in Computer Science at Worcester Polytechnic Institute with a minor in Electrical Engineering. He became interested in mathematics and the sciences at an early age and has been writing code for approximately 9 years. He's motivated by his passion to be creative and innovative and his interest in sharing his knowledge with others.

## About Deitel & Associates, Inc.

Deitel & Associates, Inc., founded by Paul Deitel and Harvey Deitel, is an internationally recognized authoring and corporate training organization, specializing in Android and iOS app development, computer programming languages, object technology and Internet and web software technology. The company's clients include many of the world's largest corporations, government agencies, branches of the military, and academic institutions. The company offers instructor-led training courses delivered at client sites worldwide on major programming languages and platforms, including Android app development, iOS app development, Swift™, Java™, C++, C, Visual C#®, Visual Basic®, Internet and web programming and a growing list of additional programming and software-development courses.

Through its 40-year publishing partnership with Prentice Hall/Pearson, Deitel & Associates, Inc., publishes leading-edge programming professional books, college textbooks and *LiveLessons* video courses. Deitel & Associates, Inc. and the authors can be reached at:

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<http://www.informit.com/store/sales.aspx>



# Before You Begin

In this section, you'll set up your computer for use with this book. Google frequently updates the Android™ development tools, so before reading this section, check the book's website

<http://www.deitel.com/books/AndroidFP3>

to see if we've posted an updated version of this Before You Begin section.

## Software and Hardware System Requirements

To develop Android apps, you need a Windows®, Linux® or Mac® OS X® system. To view the latest operating-system requirements visit

<http://developer.android.com/sdk/index.html#Requirements>

and scroll down to the **System Requirements** heading. We developed the apps in this book using the following software:

- Java SE 7 Software Development Kit
- Android Studio 1.4 Integrated Development Environment (IDE)
- Android 6 SDK (API 23)

You'll see how to obtain each of these in the following sections.

## Installing the Java Development Kit (JDK)

Android requires the Java Development Kit version 7 (JDK 7). All Java language features in JDK 7 are supported in Android Studio, but the `try-with-resources` statement is supported only for Android platform versions with API levels 19 and higher. To download JDK 7 for Windows, OS X or Linux, go to

<http://www.oracle.com/technetwork/java/javase/downloads/java-archive-downloads-javase7-521261.html>

Choose the appropriate 32-bit or 64-bit version for your computer hardware and operating system. Be sure to follow the installation instructions at

<http://docs.oracle.com/javase/7/docs/webnotes/install/index.html>

Android does not yet support Java 8 language features, such as lambda expressions, new interface features and the stream APIs. You can use JDK 8 (as we did when developing this book's apps), provided that you use no Java 8 language features in your code.

## Installing Android Studio

Google's Android Studio comes with the latest Android Software Development Kit (SDK) and is based on the popular Java IDE from JetBrains called IntelliJ® IDEA. To download Android Studio, go to

<http://developer.android.com/sdk/index.html>

and click the **Download Android Studio** button. When the download completes, run the installer and follow the on-screen instructions to complete the installation. If you previously installed an earlier Android Studio version, a **Complete Installation** window will appear at the end of the install process and give you the option to import your previous settings. At the time of this writing, Android Studio 1.4 is the current released version and Android Studio 1.5 is available as an early access release.

### Using Early Access Releases

When building apps for release to Google Play or other app stores, it's best to use the currently released version of Android Studio. If you'd like to work with new features in Android Studio early access and beta releases, Google releases these versions in the so-called **Canary Channel** and **Beta Channel**. You can configure Android Studio to obtain updates from these channels. To update Android Studio to the latest early access or beta release:

1. Open Android Studio.
2. In the **Welcome to Android Studio** window, click **Configure**.
3. Click **Check for Update**.
4. In the **Platform and Plugin Updates** dialog, click the **Updates** link.
5. In the **Updates** dialog, select **Canary Channel** or **Beta Channel** from the dropdown to the right of the **Automatically check updates for** checkbox.
6. Click **OK**, then click **Close**.
7. Click **Check for Update** again.
8. The IDE will check for updates and tell you whether there are updates to apply.
9. Click **Update and Restart** to install the latest Android Studio version.

If you've previously opened a project in Android Studio and did not close the project, the IDE skips the **Welcome to Android Studio** window and opens the last project. In this case, you can access the **Updates** dialog on a Mac via **Android Studio > Check for Updates...** or on Windows/Linux via **Help > Check for Update....** Then continue from *Step 4* above. For a Google's list of Android Studio Tips and Tricks, visit:

<http://developer.android.com/sdk/installing/studio-tips.html>

## Configure Android Studio to Show Line Numbers

By default, Android Studio does not show line numbers next to the code that you write. To turn on line numbers to make it easier to follow our line-numbered code examples:

1. Open Android Studio ().

2. When the **Welcome to Android Studio** window appears, click **Configure**, then click **Settings** to open the **Default Settings** window. If the **Welcome to Android Studio** window does not appear, use the menus on Mac to select **Android Studio > Preferences...** or on Windows/Linux to select **File > Other Settings > Default Settings....**
3. Expand the **Editor > General** node and select **Appearance**, then ensure that **Show line numbers** is selected and click **OK**.

## Configure Android Studio to Disallow Code Folding

By default, Android Studio's code-folding feature is enabled. This feature collapses multiple lines of code into a single line so you can focus on other aspects of the code. For example, all the `import` statements in a Java source-code file can be collapsed into a single line to hide them, or an entire method can be collapsed into a single line. You can expand these lines if you need to look at the code in detail. We disabled this feature in our IDE. If you wish to do so, follow the steps in the preceding section, then under **Editor > General > Code Folding** uncheck **Show code folding outline**.

## Android 6 SDK

This book's code examples were written using Android 6. At the time of this writing, the Android 6 SDK was bundled with Android Studio. As new Android versions are released, the latest version will be bundled, which may prevent our apps from compiling properly. When you work with this book, we recommend using Android 6. You can install prior Android platform versions as follows:

1. Open Android Studio (.
2. When the **Welcome to Android Studio** window appears, click **Configure**, then click **SDK Manager** to display the **Android SDK** manager. If a project window appears rather than the **Welcome to Android Studio** window, you can access the **Android SDK** manager via **Tools > Android > SDK Manager**.
3. In the **SDK Platforms** tab, check the versions of Android you wish to install, then click **Apply** and **OK**. The IDE then downloads and installs the additional platform versions. The IDE also will help you keep your installed versions up-to-date.

## Creating Android Virtual Devices (AVDs)

The Android SDK's **Android emulator** allows you to test apps on your computer rather than on an Android device—this is essential, of course, if you do not have Android devices. To do so, you create Android Virtual Devices (AVDs) that run in the emulator. The emulator can be slow, so most Android developers prefer testing on actual devices. Also, the emulator does not support various features, including phone calls, USB connections, headphones and Bluetooth. For the latest emulator capabilities and limitations, visit

<http://developer.android.com/tools/devices/emulator.html>

That page's **Using Hardware Acceleration** section discusses features that can improve emulator performance, such as using the computer's graphics processing unit (GPU) to in-

crease graphics performance, and using the Intel HAXM (hardware accelerated execution manager) emulator to increase overall AVD performance. There are also faster third-party emulators, such as Genymotion.

After you've installed the Android Studio and before you run an app in the emulator, you must create at least one **Android Virtual Device (AVD)** for Android 6. Each AVD defines the characteristics of the device you wish to emulate, including

- its screen size in pixels
- its pixel density
- its screen's physical size
- the size of the SD card for data storage
- and more.

To test your apps for multiple Android devices, you can create AVDs that emulate each unique device. You also can use Google's new Cloud Test Lab

<https://developers.google.com/cloud-test-lab/>

a website that will enable you to upload your app and test it on many of today's popular Android devices. By default, Android Studio creates for you one AVD that's configured to use the version of Android bundled with the IDE. For this book, we use AVDs for two of Google's Android reference devices—the Nexus 6 phone and the Nexus 9 tablet—which run standard Android without the modifications made by many device manufacturers. It's easiest to create AVDs in Android Studio once you already have a project open in the IDE. For this reason, we'll show how to create the Android 6 AVDs in Section 1.9.

## Setting Up an Android Device for Testing Apps

Testing apps on Android devices tends to be quicker than using AVDs. In addition, recall that there are some features you can test only on actual devices. To execute your apps on Android devices, follow the instructions at

<http://developer.android.com/tools/device.html>

If you're developing on Microsoft Windows, you'll also need the Windows USB driver for Android devices that you installed earlier in this Before You Begin section. In some cases on Windows, you may also need the manufacturer's device-specific USB drivers. For a list of USB driver sites for various device brands, visit

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

## Downloading the Book's Code Examples

The source code for *Android 6 for Programmers: An App-Driven Approach* is available for download at

<http://www.deitel.com/books/AndroidFP3/>

Click the **Download Code Examples** link to download a ZIP archive file containing the examples to your computer. Depending on your operating system, double click the ZIP file

to unzip the archive or right click and select the option to extract the archive's contents. Remember where the extracted files are located on your system so you can access them later.

## A Note Regarding Android Studio and the Android SDK

If you import one of our apps into Android Studio and it does not compile, this could be the result of updates to Android Studio or the Android platform tools. For such issues, please check Android questions and answers on StackOverflow at:

<http://stackoverflow.com/questions/tagged/android>

and the Google+ Android Development community at:

<http://bit.ly/GoogleAndroidDevelopment>

or write to us at

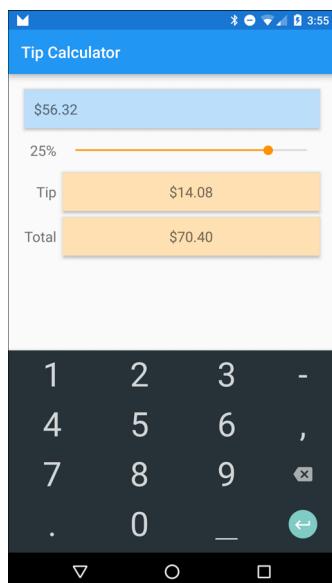
[deitel@deitel.com](mailto:deitel@deitel.com)

You've now installed all the software and downloaded the code examples you'll need to study Android app development with *Android 6 for Programmers: An App-Driven Approach* and to begin developing your own apps. Enjoy!

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# I

# Introduction to Android



## Objectives

In this chapter you'll be introduced to:

- The history of Android and the Android SDK.
- Google Play Store for downloading apps.
- The Android packages used in this book to help you create Android apps.
- A quick refresher of object-technology concepts.
- Key software for Android app development, including the Android SDK, the Java SDK and the Android Studio Integrated Development Environment (IDE).
- Important Android documentation.
- Test-driving an Android tip-calculator app in Android Studio.
- Characteristics of great Android apps.

- 1.1** Introduction
- 1.2** Android—The World’s Leading Mobile Operating System
- 1.3** Android Features
- 1.4** Android Operating System
  - 1.4.1 Android 2.2 (Froyo)
  - 1.4.2 Android 2.3 (Gingerbread)
  - 1.4.3 Android 3.0 through 3.2 (Honeycomb)
  - 1.4.4 Android 4.0 through 4.0.4 (Ice Cream Sandwich)
  - 1.4.5 Android 4.1–4.3 (Jelly Bean)
  - 1.4.6 Android 4.4 (KitKat)
  - 1.4.7 Android 5.0 and 5.1 (Lollipop)
  - 1.4.8 Android 6 (Marshmallow)
- 1.5** Downloading Apps from Google Play
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- 1.7** Android Software Development Kit (SDK)
- 1.8** Object-Oriented Programming: A Quick Refresher
- 1.8.1** The Automobile as an Object
- 1.8.2** Methods and Classes
- 1.8.3** Instantiation
- 1.8.4** Reuse
- 1.8.5** Messages and Method Calls
- 1.8.6** Attributes and Instance Variables
- 1.8.7** Encapsulation
- 1.8.8** Inheritance
- 1.8.9** Object-Oriented Analysis and Design (OOAD)
- 1.9** Test-Driving the **Tip Calculator** App in an Android Virtual Device (AVD)
  - 1.9.1** Opening the **Tip Calculator** App’s Project in Android Studio
  - 1.9.2** Creating Android Virtual Devices (AVDs)
  - 1.9.3** Running the **Tip Calculator** App on the Nexus 6 Smartphone AVD
  - 1.9.4** Running the **Tip Calculator** App on an Android Device
- 1.10** Building Great Android Apps
- 1.11** Android Development Resources
- 1.12** Wrap-Up

## 1.1 Introduction

Welcome to Android app development! We hope that working with *Android 6 for Programmers: An App-Driven Approach* will be an informative, challenging, entertaining and rewarding experience for you.

This book is geared toward *Java programmers*. We use only complete working apps, so if you don’t know Java but have object-oriented programming experience in another language, such as C#, Objective-C/Cocoa or C++ (with class libraries), you should be able to master the material quickly, learning a good amount of Java and Java-style object-oriented programming as you learn Android app development.

### *App-Driven Approach*

We use an **app-driven approach**—new features are discussed in the context of complete working Android apps, with one app per chapter. For each app, we first describe it, then have you *test-drive* it. Next, we briefly overview the key **Android Studio IDE** (Integrated Development Environment), Java and **Android SDK** (Software Development Kit) technologies we use to implement the app. For apps that require it, we walk through designing the GUI using Android Studio. Then we provide the complete source-code listing, using line numbers, *syntax coloring* and *code highlighting* to emphasize the key portions of the code. We also show one or more screenshots of the running app. Then we do a detailed code walkthrough, emphasizing the new programming concepts introduced in the app. You can download the source code for all of the book’s apps from

## 1.2 Android—The World's Leading Mobile Operating System

Android device sales are growing quickly, creating enormous opportunities for Android app developers.

- The first-generation Android phones were released in October 2008. As of June 2015, Android had 82.8% of the global smartphone market share, compared to 13.9% for Apple and 2.6% for Microsoft.<sup>1</sup>
- Billions of apps have been downloaded from Google Play and more than one billion Android devices were shipped worldwide in 2014.<sup>2</sup>
- According to *PC World*, approximately 230 million tablets shipped in 2014 of which 67.3% were Android tablets, compared to 27.6% for iOS and 5.1% for Microsoft Windows.<sup>3</sup>
- Android devices now include smartphones, tablets, e-readers, robots, jet engines, NASA satellites, game consoles, refrigerators, televisions, cameras, health-care devices, smartwatches, automobile in-vehicle “infotainment” systems (for controlling the radio, GPS, phone calls, thermostat, etc.) and more.<sup>4</sup>
- A recent report says that mobile app revenue (across all mobile platforms) is expected to reach \$99 billion by 2019.<sup>5</sup>

## 1.3 Android Features

### *Openness and Open Source*

One benefit of developing Android apps is the openness of the platform. The operating system is *open source* and free. This allows you to view Android’s source code and see how its features are implemented. You can contribute to Android by reporting bugs:

<http://source.android.com/source/report-bugs.html>

or by participating in the Open Source Project discussion groups

<http://source.android.com/community/index.html>

Numerous open-source Android apps from Google and others are available on the Internet (Fig. 1.1). Figure 1.2 shows you where you can get the Android source code, learn about the philosophy behind the open-source operating system and get licensing information.

- 
1. <http://www.idc.com/prodserv/smartphone-os-market-share.jsp>.
  2. <http://www.cnet.com/news/android-shipments-exceed-1-billion-for-first-time-in-2014/>.
  3. <http://www.pcworld.com/article/2896196/windows-forecast-to-gradually-grab-tablet-market-share-from-ios-and-android.html>.
  4. <http://www.businessweek.com/articles/2013-05-29/behind-the-internet-of-things-is-android-and-its-everywhere>.
  5. <http://www.telecompetitor.com/mobile-app-forecast-calls-for-revenue-of-99-billion-by-2019/>.

| URL   | Description   |
|---|---|
| <a href="http://en.wikipedia.org/wiki/List_of_open_source_Android_applications">http://en.wikipedia.org/wiki/<br/>List_of_open_source_Android<br/>_applications</a> | Extensive list of open-source apps, organized by category (e.g., games, communication, emulators, multimedia, security).  |
| <a href="http://developer.android.com/tools/samples/index.html">http://developer.android.com/<br/>tools/samples/index.html</a>                                      | Instructions for accessing Google's sample apps for the Android platform; includes approximately 100 apps and games demonstrating various Android capabilities. |
| <a href="http://github.com">http://github.com</a>   | GitHub allows you to share your apps and source code and contribute to others' open-source projects.  |
| <a href="http://f-droid.org">http://f-droid.org</a>   | Hundreds of free and open-source Android apps.  |
| <a href="http://www.openintents.org">http://www.openintents.org</a>   | Open-source libraries that can be used to enhance app capabilities.   |
| <a href="http://www.stackoverflow.com">http://www.stackoverflow.com</a>   | Stack Overflow is a question-and-answer website for programmers. Users can vote on each answer, and the best responses rise to the top.                         |

**Fig. 1.1** | Open-source Android app and library resource sites.

| Title                   | URL   |
|-------------------------|---|
| Get Android Source Code | <a href="http://source.android.com/source/downloading.html">http://source.android.com/source/downloading.html</a> |
| Licenses                | <a href="http://source.android.com/source/licenses.html">http://source.android.com/source/licenses.html</a>       |
| FAQs                    | <a href="http://source.android.com/source/faqs.html">http://source.android.com/source/faqs.html</a>               |

**Fig. 1.2** | Resources and source code for the open-source Android operating system.

The openness of the platform spurs rapid innovation. Unlike Apple's *proprietary* iOS, which is available only on Apple devices, Android is available on devices from dozens of original equipment manufacturers (OEMs) and through numerous telecommunications carriers worldwide. The intense competition among OEMs and carriers benefits customers.

## Java

Android apps are developed with Java—one of the world's most widely used programming languages. Java was a logical choice for the Android platform, because it's powerful, free, open source and used by millions of developers. Experienced Java programmers can quickly dive into Android development, using Google's Android APIs (Application Programming Interfaces) and others available from third parties.

Java is object oriented and has access to extensive class libraries that help you quickly develop powerful apps. GUI programming in Java is *event driven*—in this book, you'll write apps that respond to various user-initiated *events* such as *screen touches*. In addition to directly programming portions of your apps, you'll also use the Android Studio IDE to conveniently drag and drop predefined objects such as buttons and textboxes into place on your screen, and label and resize them. Using Android Studio, you can create, run, test and debug Android apps quickly and conveniently.

### Multitouch Screen

Android smartphones wrap the functionality of a mobile phone, Internet client, MP3 player, gaming console, digital camera and more into a handheld device with full-color *multitouch screens*. With the touch of your fingers, you can navigate easily between using your phone, running apps, playing music, web browsing and more. The screen can display a keyboard for typing e-mails and text messages and entering data in apps (some Android devices also have physical keyboards).

### Gestures

The multitouch screens allow you to control the device with *gestures* involving one touch or multiple simultaneous touches (Fig. 1.3).

| Gesture name | Physical action   | Used to   |
|--------------|---|---|
| Touch        | Tap the screen once.  | Open an app, “press” a button or a menu item.   |
| Double touch | Tap the screen twice.   | Zoom in on pictures, Google Maps and web pages. Tap the screen twice again to zoom back out.      |
| Long press   | Touch the screen and hold your finger in position.                          | Select items in a view—for example, checking an item in a list.                                   |
| Swipe        | Touch the screen, then move your finger in the swipe direction and release. | Flip item-by-item through a series, such as photos. A swipe automatically stops at the next item. |
| Drag         | Touch and drag your finger across the screen.                               | Move objects or icons, or scroll through a web page or list.                                      |
| Pinch zoom   | Pinch two fingers together, or spread them apart.                           | Zoom in and out on the screen (e.g., resizing text and pictures).                                 |

**Fig. 1.3** | Some common Android gestures.

### Built-in Apps

Android devices come with several default apps, which may vary, depending on the device, the manufacturer or the mobile service carrier. Some apps commonly included are **Phone**, **Contacts**, **Messenger**, **Browser**, **Calculator**, **Calendar**, **Clock** and **Photos**.

### Web Services

**Web services** are software components stored on one computer that can be accessed by an app (or other software component) on another computer over the Internet. With web services, you can create **mashups**, which enable you to rapidly develop apps by quickly *combining* complementary web services, often from different organizations and possibly other forms of information feeds. For example, 100 Destinations

<http://www.100destinations.co.uk>

combines the photos and tweets from Twitter with the mapping capabilities of Google Maps to allow you to explore countries around the world through the photos of others.

Programmableweb

<http://www.programmableweb.com/>

provides a directory of over 14,000 APIs and mashups, plus how-to guides and sample code for creating your own mashups. Figure 1.4 lists some popular web services. We use OpenWeatherMap.org's weather web services in Chapter 7.

| Web services source | How it's used                                 |
|---------------------|---|
| Google Maps         | Mapping services                              |
| Twitter             | Microblogging                                 |
| YouTube             | Video search                                  |
| Facebook            | Social networking                             |
| Instagram           | Photo sharing                                 |
| Foursquare          | Mobile check-in                               |
| LinkedIn            | Social networking for business                |
| Netflix             | Movie rentals                                 |
| eBay                | Internet auctions                             |
| Wikipedia           | Collaborative encyclopedia                    |
| PayPal              | Payments                                      |
| Amazon eCommerce    | Shopping for books and lots of other products |
| Salesforce.com      | Customer Relationship Management (CRM)        |
| Skype               | Internet telephony                            |
| Microsoft Bing      | Search  |
| Flickr              | Photo sharing                                 |
| Zillow              | Real-estate pricing                           |
| Yahoo Search        | Search  |
| WeatherBug          | Weather                                       |

**Fig. 1.4** | Some popular web services (<http://www.programmableweb.com/category/all/apis>).

## 1.4 Android Operating System

The Android operating system was developed by Android, Inc., which was acquired by Google in 2005. In 2007, the Open Handset Alliance™

[http://www.openhandsetalliance.com/oha\\_members.html](http://www.openhandsetalliance.com/oha_members.html)

was formed to develop, maintain and evolve Android, driving innovation in mobile technology and improving the user experience while reducing costs.

In this section, we walk through the evolution of the Android operating system, showing its versions and their key functionality. The Android marketplace is fragmented—many devices still use older Android versions—so as a developer it's helpful for you to be aware of the features introduced in each version.

### **Android Version Naming Convention**

Each new version of Android is named after a dessert, going in alphabetical order (Fig. 1.5).

| Android version | Name        | Android version | Name               |
|-----------------|-------------|-----------------|--------------------|
| Android 1.5     | Cupcake     | Android 4.0     | Ice Cream Sandwich |
| Android 1.6     | Donut       | Android 4.1–4.3 | Jelly Bean         |
| Android 2.0–2.1 | Eclair      | Android 4.4     | KitKat             |
| Android 2.2     | Froyo       | Android 5.0–5.1 | Lollipop           |
| Android 2.3     | Gingerbread | Android 6.0     | Marshmallow        |
| Android 3.0–3.2 | Honeycomb   |                 |                    |

**Fig. 1.5** | Android version numbers and the corresponding names.

#### **1.4.1 Android 2.2 (Froyo)**

Android 2.2 (also called **Froyo**, released in May 2010) introduced external storage, allowing you to store apps on an external memory device rather than just in the Android device's internal memory. It also introduced the **Android Cloud to Device Messaging (C2DM)** service. **Cloud computing** allows you to use software and data stored in the "cloud"—i.e., accessed on remote computers (or servers) via the Internet and available on demand—rather than having it stored on your desktop, notebook computer or mobile device. Cloud computing gives you the flexibility to increase or decrease computing resources to meet your resource needs at any given time, making it more cost effective than purchasing expensive hardware to ensure that you have enough storage and processing power for occasional peak levels. Android C2DM allows app developers to send data from their servers to their apps installed on Android devices, even when the apps are *not* currently running. The server notifies the apps to contact it directly to receive updated app or user data.<sup>6</sup> C2DM is now deprecated in favor of Google Cloud Messaging, which was introduced in 2012.

For information about additional Android 2.2 features—OpenGL ES 2.0 graphics capabilities, the media framework and more—visit

<http://developer.android.com/about/versions/android-2.2-highlights.html>

#### **1.4.2 Android 2.3 (Gingerbread)**

Android 2.3 (**Gingerbread**), released later in 2010, added more user refinements, such as a redesigned keyboard, improved navigation capabilities, increased power efficiency and more. It also added several developer features for communications (e.g., technologies that make it easier to make and receive calls from within an app), multimedia (e.g., new audio and graphics APIs) and gaming (e.g., improved performance and new sensors, such as a gyroscope for better motion processing).

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6. <http://code.google.com/android/c2dm/>.

One of the most significant new features in Android 2.3 was support for **near-field communication (NFC)**—a short-range wireless connectivity standard that enables communication between two devices within a few centimeters. NFC support and features vary by Android device. NFC can be used for payments (for example, touching your NFC-enabled Android device to a payment device on a soda machine), exchanging data such as contacts and pictures, pairing devices and accessories and more. For more Android 2.3 developer features, see

<http://developer.android.com/about/versions/android-2.3-highlights.html>

### 1.4.3 Android 3.0 through 3.2 (Honeycomb)

**Android 3.0 (Honeycomb)** included user-interface improvements specifically for large-screen devices (e.g., tablets), such as a redesigned keyboard for more efficient typing, a visually appealing 3D user interface, easier navigation between screens within an app and more. New Android 3.0 developer features included:

- fragments, which describe portions of an app’s user interface and can be combined into one screen or used across multiple screens
- a persistent Action Bar at the top of the screen providing users with options for interacting with apps
- the ability to add large-screen layouts to existing apps designed for small screens to optimize your app for use on different screen sizes
- a visually attractive and more functional user interface, known as “Holo” for its holographic look and feel
- a new animation framework
- improved graphics and multimedia capabilities
- ability to use multicore processor architectures for enhanced performance
- increased Bluetooth support (e.g., enabling an app to determine if there are any connected devices such as headphones or a keyboard)
- and an animation framework for animating user-interface or graphics objects.

For a list of Android 3.0 user and developer features and platform technologies, go to

<http://developer.android.com/about/versions/android-3.0-highlights.html>

### 1.4.4 Android 4.0 through 4.0.4 (Ice Cream Sandwich)

**Android 4.0 (Ice Cream Sandwich)**, released in 2011, merged Android 2.3 (Gingerbread) and Android 3.0 (Honeycomb) into one operating system for use on all Android devices. This allowed you to incorporate into your smartphone apps Honeycomb’s features that previously were available only on tablets—the “Holo” user interface, a new launcher (used to customize the device’s home screen and launch apps) and more—and easily scale your apps to work on different devices. Ice Cream Sandwich also added several APIs for improved communication between devices, accessibility for users with disabilities (e.g., vision

impairments), social networking and more (Fig. 1.6). For a complete list of Android 4.0 APIs, see

<http://developer.android.com/about/versions/android-4.0.html>

| Feature                  | Description   |
|--------------------------|---|
| Face detection           | Using the camera, compatible devices can determine the positioning of the user's eyes, nose and mouth. The camera also can track the user's eye movement, allowing you to create apps that change perspective, based on where the user is looking.  |
| Virtual camera operator  | When filming video of multiple people, the camera will automatically focus on the person who is speaking.   |
| Android Beam             | Using NFC, <b>Android Beam</b> allows you to touch two Android devices to share content (e.g., contacts, pictures, videos).   |
| Wi-Fi Direct             | Wi-Fi P2P (peer-to-peer) APIs allow you to connect multiple Android devices using Wi-Fi. The devices can communicate wirelessly at a greater distance than when using Bluetooth.  |
| Social API               | Access and share contact information across social networks and apps (with the user's permission).  |
| Calendar API             | Add and share events across multiple apps, manage alerts and attendees and more.  |
| Accessibility APIs       | Use the new Accessibility Text-to-Speech APIs to enhance the user experience of your apps for people with disabilities such as vision impairments and more. The explore-by-touch mode allows users with vision impairments to touch anywhere on the screen and hear a voice description of the touched content. |
| Android@Home framework   | Use the <b>Android@Home framework</b> to create apps that control appliances in users' homes, such as, thermostats, irrigation systems, networked light bulbs and more.   |
| Bluetooth health devices | Create apps that communicate with Bluetooth health devices such as scales, heart-rate monitors and more.  |

**Fig. 1.6** | Some Android Ice Cream Sandwich developer features (<http://developer.android.com/about/versions/android-4.0.html>).

## 1.4.5 Android 4.1–4.3 (Jelly Bean)

**Android Jelly Bean**, released in 2012, focused on many behind-the-scenes platform improvements, such as better performance, accessibility, support for international users and more. Other new features included support for enhanced Bluetooth connectivity (Bluetooth LE was introduced in Android 4.3), external displays, support for multiple users on one tablet, restricted user profiles, improved security, appearance enhancements (e.g., resizable app widgets, lock screen widgets, and expandable notifications), optimized location and sensor capabilities, better media capabilities (audio/video), and more seamless switching between apps and screens (Fig. 1.7). In addition, Google introduced new APIs that are developed separately from Android platform versions:

- Google Cloud Messaging—a cross-platform solution that enables developers to deliver messages to devices
- Google Play Services—a set of APIs for incorporating Google functionality into your apps.

For the Jelly Bean features list, see

<http://developer.android.com/about/versions/jelly-bean.html>

| Feature             | Description  |
|---------------------|--|
| Android Beam        | Enhanced to enable communication via Bluetooth in addition to NFC.   |
| Lock screen widgets | Create widgets that appear on the user's screen when the device is locked, or modify your existing home-screen widgets so that they're also visible when the device is locked.     |
| Photo Sphere        | APIs for working with the new panoramic photo features that enable users to take 360-degree photos, similar to those used for Google Maps Street View.                             |
| Daydreams           | Daydreams are interactive screensavers that are activated when a device is docked or charging. Daydreams can play audio and video and respond to user interactions.                |
| Language support    | New features help your apps reach international users, such as bidirectional text (left-to-right or right-to-left), international keyboards, additional keyboard layouts and more. |
| Developer options   | Several new tracking and debugging features help you improve your apps, such as bug reports that include a screenshot and device state information.                                |

**Fig. 1.7** | Some Android Jelly Bean features (<http://developer.android.com/about/versions/jelly-bean.html>).

#### 1.4.6 Android 4.4 (KitKat)

**Android 4.4 KitKat**, released in October 2013, includes several performance improvements that make it possible to run the operating system on all Android devices, including older, memory-constrained devices, which are particularly popular in developing countries.<sup>7</sup>

Enabling more users to update to KitKat reduced the “fragmentation” of Android versions in the market, which has been a challenge for developers who previously had to design apps to run across multiple versions of the operating system, or limit their potential market by targeting their apps to a specific version of the operating system.

Android KitKat also includes security and accessibility enhancements, improved graphics and multimedia capabilities, memory-use analysis tools and more. Figure 1.8 lists some of the key KitKat features. For a complete list, see

<http://developer.android.com/about/versions/kitkat.html>

7. <http://techcrunch.com/2013/10/31/android-4-4-kitkat-google/>.

| Feature                        | Description   |
|--------------------------------|---|
| Immersive mode                 | The status bar at the top of the screen and the menu buttons at the bottom can be hidden, allowing your apps to fill more of the screen. Users can access the status bar by swiping down from the top of the screen, and the system bar (with the back button, home button and recent apps button) by swiping up from the bottom. |
| Printing framework             | Build printing functionality into your apps, including locating available printers over Wi-Fi or the cloud, selecting the paper size and specifying which pages to print.   |
| Storage access framework       | Create document storage providers that allow users to browse, create and edit files (e.g., documents and images) across multiple apps.  |
| SMS provider                   | Create SMS (Short Message Service) or MMS (Multimedia Messaging Service) apps using the new SMS provider and APIs. Users can now select their default messaging app.  |
| Transitions framework          | The new framework makes it easier to create transition animations.  |
| Screen recording               | Record video of your app to create tutorials and marketing materials.   |
| Enhanced accessibility         | The captioning manager API allows apps to check the user's captioning preferences (e.g., language, text styles and more).   |
| Chromium WebView               | Supports the latest standards for displaying web content including HTML5, CSS3 and a faster version of JavaScript.  |
| Step detector and step counter | Create apps that detect whether the user is running, walking or climbing stairs and count the number of steps.  |
| Host Card Emulator (HCE)       | HCE enables any app to perform secure NFC transactions (e.g., mobile payments) without the need for a secure element on the SIM card controlled by the wireless carrier.  |

**Fig. 1.8** | Some Android KitKat features (<http://developer.android.com/about/versions/kitkat.html>).

### 1.4.7 Android 5.0 and 5.1 (Lollipop)

Android Lollipop—released in November 2014—was a major update with thousands of API enhancements for phones and tablets, and new capabilities that enable developers to create apps for wearables (e.g., smart watches), TVs and cars. One of the biggest changes was **material design**—a complete user-interface redesign (also used in Google’s web apps). Other features included: a new Android runtime, notification enhancements (enabling users to interact with a notification without leaving the current app), networking enhancements (Bluetooth, Wi-Fi, cellular and NFC), high-performance graphics (OpenGL ES 3.1 and the Android Extension Pack), better audio capabilities (capture, multichannel mixing, playback and support for USB peripherals), enhanced camera capabilities, screen sharing, new sensor support, enhanced accessibility features, multiple SIM card support and more. Figure 1.9 lists some of the key Lollipop features. For a complete list, see

<http://developer.android.com/about/versions/lollipop.html>  
<http://developer.android.com/about/versions/android-5.0.html>  
<http://developer.android.com/about/versions/android-5.1.html>

| Feature   | Description  |
|---|--|
| Material design   | Google's new look-and-feel for Android and web applications was the key new feature in Lollipop. Material design helps you create apps with nice transition effects, shadows that add depth to the user interface and emphasize actionable components, customization capabilities and more. For details, visit <a href="https://www.google.com/design/spec/material-design/introduction.html">https://www.google.com/design/spec/material-design/introduction.html</a> . |
| ART runtime   | Google replaced the original Android runtime with the new 64-bit compatible ART runtime, which uses a combination of interpretation, ahead-of-time (AOT) compilation and just-in-time (JIT) compilation to improve performance.  |
| Concurrent documents and activities in the recent apps screen | Apps can now specify that multiple activities and documents should appear on the recent apps screen. For example, if the user has multiple tabs open in a web browser or multiple documents open in a text-editing app, when the user touches the recent apps button (□), each browser tab or document can appear as a separate item that the user can select.   |
| Screen capturing and sharing                                  | Apps can now capture the device's screen and share the contents with other users across a network.   |
| Project Volta   | Features that help preserve battery life, including the new JobScheduler that can execute asynchronous tasks when the device is charging, connected to an unmetered network (i.e., use Wi-Fi vs. cellular data) or idle.   |

**Fig. 1.9** | Some Android Lollipop features (<http://developer.android.com/about/versions/lollipop.html>).

#### 1.4.8 Android 6 (Marshmallow)

**Android Marshmallow**, released in September 2015, is the current version of Android at the time of this writing. Some new features include Now on Tap (for getting Google Now information in the context of an app), Doze and App Standby (for saving battery), a new permissions model to make apps easier to install, fingerprint authentication, better data protection, better text-selection support, 4K display support, new audio and video capabilities, new camera capabilities (flashlight and image-reprocessing APIs) and more. Figure 1.10 lists some of the key Lollipop features. For a complete list, see

<http://developer.android.com/about/versions/marshmallow/android-6.0-changes.html>

| Feature | Description  |
|---------|--|
| Doze    | Using software and sensors, Android determines when a device is stationary for a period of time—such as when you place it on a table overnight—and defers background processes that drain the battery. |

**Fig. 1.10** | Some Android Marshmallow features (<http://developer.android.com/about/versions/marshmallow/android-6.0-changes.html>). (Part 1 of 2.)

| Feature                    | Description   |
|----------------------------|---|
| App Standby                | For apps that a user has open but has not interacted with recently, Android defers background network activity.   |
| Now on Tap                 | Tap and hold the home button while inside any app and Google Now inspects what's on the screen and presents relevant information in the form of cards. For example, in a text message discussing a movie, a card containing information about that movie is displayed. Similarly, in a text message mentioning a restaurant name, a card with the ratings, location and phone number appears. |
| New permissions model      | Before Android 6.0, a user was required at installation time to grant in advance all permissions that an app would ever need—this caused many people not to install certain apps. With the new model, the app is installed without asking for any permissions. Instead, the user is asked to grant a permission only the first time the corresponding feature is used.                        |
| Fingerprint authentication | For devices with fingerprint readers, apps can now authenticate users via their fingerprints.   |
| App linking                | Enables developers to associate apps with their own web domains and craft web links that launch specific apps from the same developer.  |
| Automatic backup           | Android can automatically backup and restore an app's data.   |
| Direct Share               | You can define direct share targets in your app that enable users to share data via other apps, directly from your app.   |
| Voice Interaction API      | Enables apps to respond to voice interactions.  |
| Bluetooth stylus support   | Apps can respond to pressure-sensitive interactions from a Bluetooth stylus—for example, in a drawing app, pressing the stylus against the screen harder could result in a thicker line.  |

**Fig. 1.10** | Some Android Marshmallow features (<http://developer.android.com/about/versions/marshmallow/android-6.0-changes.html>). (Part 2 of 2.)

## 1.5 Downloading Apps from Google Play

At the time of this writing, there were over 1.6 million apps in **Google Play**, and the number is growing quickly.<sup>8</sup> Figure 1.11 lists some popular free and fee-based apps in various categories. You can download apps through the **Play Store** app installed on your Android device. You also can log into your Google Play account at

<http://play.google.com>

then specify the Android device on which to install the app. It will then download via the device's Wi-Fi or 3G/4G connection. In Chapter 10, Google Play and App Business Issues, we discuss additional app stores, offering your apps for free or charging a fee, app pricing and more.

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8. <http://www.statista.com/statistics/266210/number-of-available-applications-in-the-google-play-store/>.

| Google Play category | Some popular apps in the category                             |
|----------------------|---|
| Books and Reference  | WolframAlpha, Dictionary.com, Audible for Android, Kindle     |
| Business             | Polaris Office, OfficeSuite 8, QuickBooks Online, PayPal Here |
| Communication        | Snapchat, LinkedIn, Pinterest, Instagram, WeChat, Line        |
| Education            | Google Classroom, Star Tracker, Sight Words, Math Tricks      |
| Entertainment        | Showtime Anytime, History Channel, Discovery Channel          |
| Finance              | PayPal, Credit Karma, Google Wallet, Chase Mobile             |
| Games                | Pac-Man 256, Angry Birds 2, Fruit Ninja, Tetris, Solitaire    |
| Health & Fitness     | RunKeeper, ViewRanger GPS, Calorie Counter                    |
| Lifestyle            | Assistant, Horoscope, Food Network, Starbucks                 |
| Live Wallpaper       | Facebook, Next Launcher 3D Shell, Weather Live                |
| Media & Video        | VHS Camera Recorder, VivaVideo Pro, musical.ly, GIF Keyboard  |
| Medical              | Feed Baby Pro, CareZone, FollowMyHealth, Essential Anatomy    |
| Music & Audio        | SoundCloud, Spotify, Beats Music, Pandora, iHeartRadio        |
| News & Magazines     | BBC News, CBS News, NPR News, Reuters, NBC News               |
| Photography          | Google Camera, Instagram, Retrica, GoPro App, Pencil Sketch   |
| Productivity         | Pocket, Wunderlist, Microsoft Word, Google Docs, SwiftKey     |
| Shopping             | Zappos, Groupon, JackThreads, Fancy, Etsy, Home Depot         |
| Social               | Snapchat, Instagram, Meetup, textPlus, Pinterest, Tumblr      |
| Sports               | Fox Sports, theScore, NBA 2015–16, ESPN, CBS Sports           |
| Tools                | CM Security Antivirus, Clean Master, Google Translate         |
| Transportation       | Uber, Lyft, MarrisonTraffic, BringGo, DigiHUD Speedometer     |
| Travel & Local       | Priceline, Google Earth, Eat24, GasBuddy, Hotels.com          |
| Weather              | AccuWeather, Weather Underground, Yahoo Weather               |
| Widgets              | Facebook, Pandora, Pocket Casts, Tasker, Weather Timeline     |

**Fig. 1.11** | Some popular Android apps in Google Play.

## 1.6 Packages

Android uses a collection of *packages*, which are named groups of related, predefined classes. Some of the packages are Android specific, some are Java specific and some are Google specific. These packages allow you to conveniently access Android OS features and incorporate them into your apps. The Android packages help you create apps that adhere to Android's unique look-and-feel conventions and style guidelines,

<http://developer.android.com/design/index.html>

Figure 1.12 lists many of the packages we discuss in this book. For a complete list of Android packages, see

<http://developer.android.com/reference/packages.html>

Several of the packages we use are from the Android Support libraries, which enable you to use newer Android features in apps that run on current and older platforms. For an overview of the key features in the Android Support libraries, visit:

<https://developer.android.com/tools/support-library/features.html>

| Package                       | Description  |
|-------------------------------|--|
| android.animation             | Classes for property animation. (Chapter 4's <b>Flag Quiz</b> app and Chapter 5's <b>Doodlz</b> app.)  |
| android.app                   | Includes high-level classes in the Android app model. (Chapter 4's <b>Flag Quiz</b> app and Chapter 5's <b>Doodlz</b> app.)  |
| android.content               | Access and publish data on a device. (Chapter 6's <b>Cannon Game</b> app.)   |
| android.content.res           | Classes for accessing app resources (e.g., media, colors, drawables, etc.), and device-configuration information affecting app behavior. (Chapter 4's <b>Flag Quiz</b> app.)   |
| android.database              | Handling data returned by the content provider. (Chapter 9's <b>Address Book</b> app.)   |
| android.database.sqlite       | SQLite database management for private databases. (Chapter 9's <b>Address Book</b> app.)   |
| android.graphics              | Graphics tools used for drawing to the screen. (Chapter 4's <b>Flag Quiz</b> app and Chapter 5's <b>Doodlz</b> app.)   |
| android.graphics.drawable     | Classes for display-only elements (e.g., gradients, etc.). (Chapter 4's <b>Flag Quiz</b> app.)   |
| android.hardware              | Device hardware support. (Chapter 5's <b>Doodlz</b> app.)  |
| android.media                 | Classes for handling audio and video media interfaces. (Chapter 6's <b>Cannon Game</b> app.)   |
| android.net                   | Network access classes. (Chapter 8's <b>Twitter® Searches</b> app.)  |
| android.os                    | Operating-systems services. (Chapter 3's <b>Tip Calculator</b> app.)   |
| android.preference            | Working with an app's user preferences. (Chapter 4's <b>Flag Quiz</b> app.)  |
| android.provider              | Access to Android content providers. (Chapter 5's <b>Doodlz</b> app.)  |
| android.support.design.widget | Android Design Support Library classes that enable recent GUI enhancements to run on current and older Android platforms. (Chapter 7's <b>Weather Viewer</b> app.)   |
| android.support.v4.print      | Part of the v4 Android Support Library for use in platform API levels 4 and higher. Includes features for using the Android 4.4 printing framework. (Chapter 5's <b>Doodlz</b> app.)   |
| android.support.v7.app        | Part of the v7 Android Support Library for use in platform API levels 7 and higher. Includes application-compatibility library components, such as app bars (formerly action bars). (Chapter 7's <b>Weather Viewer</b> app.) |

**Fig. 1.12** | Android and Java packages used in this book, listed with the chapter in which they first appear. We discuss additional packages in Volume 2. (Part 1 of 2.)

| Package                   | Description   |
|---------------------------|---|
| android.support.v7.widget | Part of the v7 Android Support Library for use in platform API levels 7 and higher. Includes GUI components and layouts. (Chapter 7's <b>Weather Viewer</b> app.) |
| android.text              | Rendering and tracking text changes. (Chapter 3's <b>Tip Calculator</b> app.)   |
| android.util              | Utility methods and XML utilities. (Chapter 4's <b>Flag Quiz</b> app.)  |
| android.widget            | User-interface classes for widgets. (Chapter 3's <b>Tip Calculator</b> app.)  |
| android.view              | User interface classes for layout and user interactions. (Chapter 4's <b>Flag Quiz</b> app.)  |

**Fig. 1.12** | Android and Java packages used in this book, listed with the chapter in which they first appear. We discuss additional packages in Volume 2. (Part 2 of 2.)

## 1.7 Android Software Development Kit (SDK)

The Android SDK provides the tools you'll need to build Android apps. It gets installed with Android Studio. See the Before You Begin section (after the Preface) for details on downloading the software you'll need to develop Android apps, including Java SE 7 and Android Studio.

### Android Studio

**Android Studio**<sup>9</sup> was announced at the Google I/O developer conference in 2013 and is now Google's preferred Android IDE. The IDE includes:

- GUI designer
- code editor with support for syntax coloring and line numbering
- auto-indenting and auto-complete (i.e., type hinting)
- debugger
- version control system
- refactoring support

and more.

### The Android Emulator

The **Android emulator**, included in the Android SDK, allows you to run Android apps in a simulated environment within Windows, Mac OS X or Linux, without using an actual Android device. The emulator displays a realistic Android user-interface window. It's particularly useful if you do not have access to Android devices for testing. You should certainly test your apps on a variety of Android devices before uploading them to Google Play.

Before running an app in the emulator, you'll need to create an **Android Virtual Device (AVD)**, which defines the characteristics of the device on which you want to test, including the hardware, system image, screen size, data storage and more. If you want to

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9. Android Studio is based on the JetBrains IntelliJ IDEA Java IDE (<http://www.jetbrains.com/idea/>)

test your apps for multiple Android devices, you'll need to create separate AVDs to emulate each unique device, or use Google's Cloud Test Lab

<https://developers.google.com/cloud-test-lab>

which enables you to test on many different devices.

You can reproduce on the emulator most of the Android gestures (Fig. 1.13) and controls (Fig. 1.14) using your computer's keyboard and mouse. The gestures on the emulator are a bit limited, since your computer probably cannot simulate all the Android hardware features. For example, to test GPS apps in the emulator, you'll need to create files that simulate GPS readings. Also, although you can simulate orientation changes (to *portrait* or *landscape* mode), simulating particular **accelerometer** readings (the accelerometer allows the device to respond to up/down, left/right and forward/backward acceleration) requires features that are not built into the emulator. The emulator can, however, use sensor data from an actual Android device connected to the computer, as described at

<http://tools.android.com/tips/hardware-emulation>

Figure 1.15 lists Android functionality that's *not* available on the emulator. You can install your app on an Android device to test these features. You'll start creating AVDs and using the emulator to develop Android apps in Chapter 2's **Welcome** app.

| Gesture      | Emulator action  |
|--------------|--|
| Touch        | Click the mouse once. Introduced in Chapter 3's <b>Tip Calculator</b> app.   |
| Double touch | Double click the mouse.  |
| Long press   | Click and hold the mouse. Introduced in Chapter 8's <b>Twitter® Searches</b> app.  |
| Drag         | Click, hold and drag the mouse. Introduced in Chapter 6's <b>Cannon Game</b> app.  |
| Swipe        | Click and hold the mouse, move the pointer in the swipe direction and release the mouse. Introduced in Chapter 7's <b>Weather Viewer</b> app.  |
| Pinch zoom   | Press and hold the <i>Ctrl</i> ( <i>Control</i> ) key. Two circles that simulate the two touches will appear. Move the circles to the start position, click and hold the mouse and drag the circles to the end position. |

**Fig. 1.13** | Android gestures on the emulator.

| Control             | Emulator action                       |
|---------------------|---------------------------------------|
| Back                | <i>Esc</i>                            |
| Call/dial button    | <i>F3</i>                             |
| Camera              | <i>Ctrl-KEYPAD_5</i> , <i>Ctrl-F3</i> |
| End call button     | <i>F4</i>                             |
| Home                | <i>Home</i> button                    |
| Menu (left softkey) | <i>F2</i> or <i>Page Up</i> button    |

**Fig. 1.14** | Android hardware controls in the emulator (for additional controls, go to <http://developer.android.com/tools/help/emulator.html>). (Part 1 of 2.)

| Control                        | Emulator action                            |
|--------------------------------|--|
| Power button                   | <i>F7</i>                                  |
| Search                         | <i>F5</i>                                  |
| * (right softkey)              | <i>Shift-F2</i> or <i>Page Down</i> button |
| Rotate to previous orientation | <i>KEYPAD_7, Ctrl-F11</i>                  |
| Rotate to next orientation     | <i>KEYPAD_9, Ctrl-F12</i>                  |
| Toggle cell networking on/off  | <i>F8</i>                                  |
| Volume up button               | <i>KEYPAD_PLUS, Ctrl-F5</i>                |
| Volume down button             | <i>KEYPAD_MINUS, Ctrl-F6</i>               |

**Fig. 1.14** | Android hardware controls in the emulator (for additional controls, go to <http://developer.android.com/tools/help/emulator.html>). (Part 2 of 2.)

| Android functionality not available on the emulator  |
|--|
| <ul style="list-style-type: none"> <li>• Making or receiving real phone calls (the emulator allows simulated calls only)</li> <li>• Bluetooth</li> <li>• USB connections</li> <li>• Device-attached headphones</li> <li>• Determining network connected state</li> <li>• Determining battery charge or power charging state</li> <li>• Determining SD card insert/eject</li> <li>• Direct support for sensors (accelerometer, barometer, compass, light sensor, proximity sensor)—it is possible, however, to use sensor data from a USB-connected device</li> </ul> |

**Fig. 1.15** | Android functionality not available in the emulator (<http://developer.android.com/tools/devices/emulator.html#limitations>).

## 1.8 Object-Oriented Programming: A Quick Refresher

Android uses object-oriented programming techniques, so in this section we review the basics of object technology. We use all of these concepts in this book.

Building software quickly, correctly and economically remains an elusive goal at a time when demands for new and more powerful software are soaring. *Objects*, or more precisely—as we'll see in Chapter 3—the *classes* objects come from, are essentially *reusable* software components. There are date objects, time objects, audio objects, video objects, automobile objects, people objects, etc. Almost any *noun* can be reasonably represented as a software object in terms of *attributes* (e.g., name, color and size) and *behaviors* (e.g., calculating, moving and communicating). Software developers are discovering that using a modular, object-oriented design-and-implementation approach can make software development groups much more productive than they could be with earlier popular techniques like “structured programming”—object-oriented programs are often easier to understand, correct and modify.

### 1.8.1 The Automobile as an Object

To help you understand objects and their contents, let's begin with a simple analogy. Suppose you want to *drive a car and make it go faster by pressing its accelerator pedal*. What must happen before you can do this? Well, before you can drive a car, someone has to *design* it. A car typically begins as engineering drawings, similar to the *blueprints* that describe the design of a house. These drawings include the design for an accelerator pedal. The pedal *hides* from the driver the complex mechanisms that actually make the car go faster, just as the brake pedal *hides* the mechanisms that slow the car, and the steering wheel *hides* the mechanisms that turn the car. This enables people with little or no knowledge of how engines, braking and steering mechanisms work to drive a car easily.

Just as you cannot cook meals in the kitchen of a blueprint, you cannot drive a car's engineering drawings. Before you can drive a car, it must be *built* from the engineering drawings that describe it. A completed car has an *actual* accelerator pedal to make it go faster, but even that's not enough—the car won't accelerate on its own (hopefully!), so the driver must *press* the pedal to accelerate the car.

### 1.8.2 Methods and Classes

Let's use our car example to introduce some key object-oriented programming concepts. Performing a task in a program requires a **method**. The method houses the program statements that actually perform its tasks. The method hides these statements from its user, just as the accelerator pedal of a car hides from the driver the mechanisms of making the car go faster. A class houses the methods that perform the class's tasks. For example, a class that represents a bank account might contain one method to *deposit* money to an account, another to *withdraw* money from an account and a third to *inquire* what the account's current balance is. A class is similar in concept to a car's engineering drawings, which house the design of an accelerator pedal, steering wheel, and so on.

### 1.8.3 Instantiation

Just as someone has to *build a car* from its engineering drawings before you can actually drive a car, you must *build an object* of a class before a program can perform the tasks that the class's methods define. The process of doing this is called *instantiation*. An object is then referred to as an **instance** of its class.

### 1.8.4 Reuse

Just as a car's engineering drawings can be *reused* many times to build many cars, you can *reuse* a class many times to build many objects. **Reuse** of existing classes when building new classes and programs saves time and effort. Reuse also helps you build more reliable and effective systems, because existing classes and components often have gone through extensive testing, debugging and performance tuning. Just as the notion of *interchangeable parts* was crucial to the Industrial Revolution, reusable classes are crucial to the software revolution that has been spurred by object technology.

### 1.8.5 Messages and Method Calls

When you drive a car, pressing its gas pedal sends a *message* to the car to perform a task—that is, to go faster. Similarly, you *send messages to an object*. Each message is a **method call**

that tells a method of the object to perform its task. For example, a program might call a particular bank-account object’s *deposit* method to increase the account’s balance.

### 1.8.6 Attributes and Instance Variables

A car, besides having capabilities to accomplish tasks, also has *attributes*, such as its color, its number of doors, the amount of gas in its tank, its current speed and its record of total miles driven (i.e., its odometer reading). Like its capabilities, the car’s attributes are represented as part of its design in its engineering diagrams (which, for example, include an odometer and a fuel gauge). As you drive an actual car, these attributes are carried along with the car. Every car maintains its *own* attributes. For example, each car knows how much gas is in its own gas tank, but *not* how much is in the tanks of *other* cars.

An object, similarly, has attributes that it carries along as it’s used in a program. These attributes are specified as part of the object’s class. For example, a bank-account object has a *balance attribute* that represents the amount of money in the account. Each bank-account object knows the balance in the account it represents, but *not* the balances of the *other* accounts in the bank. Attributes are specified by the class’s **instance variables**.

### 1.8.7 Encapsulation

Classes **encapsulate** (i.e., wrap) attributes and methods into objects—an object’s attributes and methods are intimately related. Objects may communicate with one another, but they’re normally not allowed to know how other objects are implemented—implementation details are *hidden* within the objects themselves. This **information hiding** is crucial to good software engineering.

### 1.8.8 Inheritance

A new class of objects can be created quickly and conveniently by **inheritance**—the new class absorbs the characteristics of an existing one, possibly customizing them and adding unique characteristics of its own. In our car analogy, a “convertible” certainly *is an* object of the more *general* class “automobile,” but more *specifically*, the roof can be raised or lowered.

### 1.8.9 Object-Oriented Analysis and Design (OOAD)

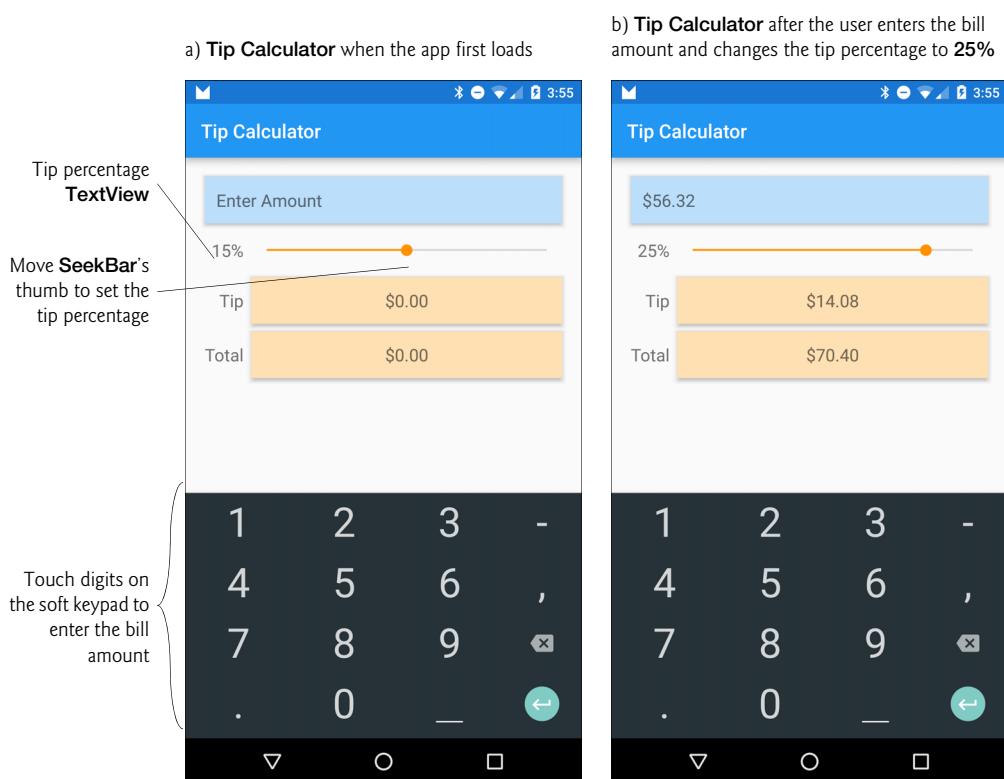
How will you create the code for your programs? Perhaps, like many programmers, you’ll simply turn on your computer and start typing. This approach may work for small programs, but what if you were asked to create a software system to control thousands of automated teller machines for a major bank? Or suppose you were asked to work on a team of 1,000 software developers building the next U.S. air traffic control system? For projects so large and complex, you should not simply sit down and start writing programs.

To create the best solutions, you should follow a detailed **analysis** process for determining your project’s **requirements** (i.e., defining *what* the system is supposed to do) and developing a **design** that satisfies them (i.e., deciding *how* the system should do it). Ideally, you’d go through this process and carefully review the design (and have your design reviewed by other software professionals) before writing any code. If this process involves analyzing and designing your system from an object-oriented point of view, it’s called an **object-oriented analysis and design (OOAD) process**. Languages like Java are object ori-

ented. Programming in such a language, called **object-oriented programming (OOP)**, allows you to implement an object-oriented design as a working system.

## 1.9 Test-Driving the Tip Calculator App in an Android Virtual Device (AVD)

In this section, you'll run and interact with your first Android app using an Android Virtual Device and, if you have one, an actual Android device. The **Tip Calculator** (Fig. 1.16(a))—which you'll build in Chapter 3—calculates and displays for a restaurant bill the tip amount and the total bill amount. As you enter each digit of the bill amount by touching the numeric keypad, the app calculates and displays the tip and total bill for a tip percentage that you specify with the app's **SeekBar**—we use 15% by default (Fig. 1.16(a)). You can select a tip percentage in the range 0–30% by moving the **SeekBar**'s thumb—this updates the tip percentage **TextView** and displays the updated tip and bill total in the **TextViews** below the **SeekBar** (Fig. 1.16(b)).



**Fig. 1.16** | Tip Calculator when the app first loads, then after the user enters the bill amount and changes the tip percentage.

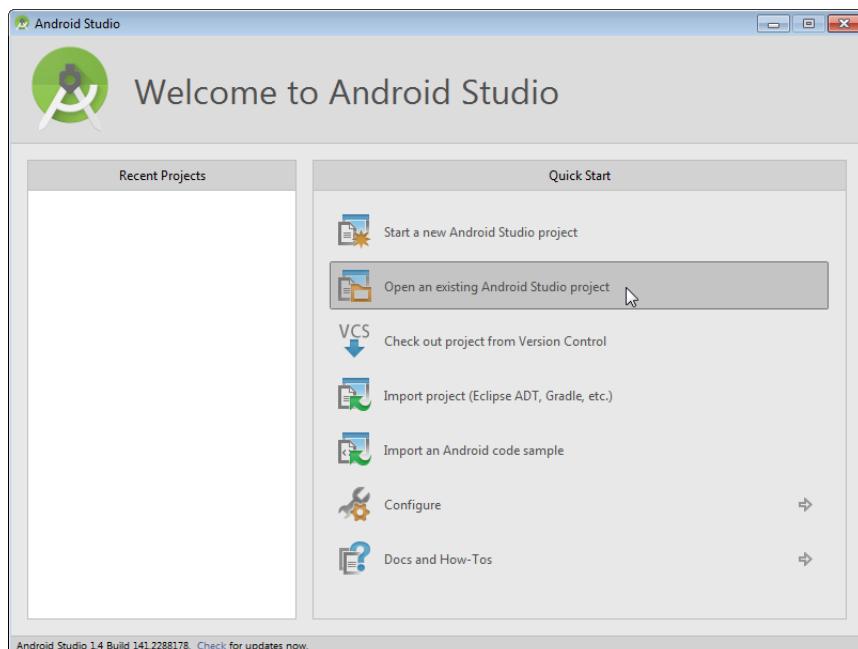
### 1.9.1 Opening the Tip Calculator App's Project in Android Studio

To open the **Tip Calculator** app's project, perform the following steps:

1. **Checking your setup.** If you have not done so already, perform the steps specified in the Before You Begin section.
2. **Opening Android Studio.** Use the Android Studio shortcut



to open the IDE. On Windows, the shortcut will appear in your **Start** menu or **Start** screen. On OS X, the shortcut is located in your Applications folder. On Linux, the shortcut's location depends on where you extract the ZIP file containing the Android Studio files. Once you open Android Studio for the first time, the **Welcome to Android Studio** window appears (Fig. 1.17).



**Fig. 1.17** | Welcome to Android Studio window.

3. **Opening the Tip Calculator app's project.** In Android Studio, when another project is already open, you can select **File > Open...** to navigate to that project's location and open it, or in the **Welcome to Android Studio Window** (Fig. 1.17), you can click **Open an existing Android Studio Project** to open the **Open File or Project** dialog (Fig. 1.18). Navigate to the book's examples folder, select the **TipCalculator** folder and click **Choose** (Mac) or **OK** (Windows/Linux). Android Studio stores the Android SDK's path in the project settings for each project you create. When you open our projects on your system, you'll receive an error message if the SDK on your system is in a different location from ours. Simply click the **OK** button in the

error dialog that appears, and Android Studio will update the project settings to use the SDK on your system. At this point, the IDE opens the project and displays its contents in the **Project** window (Fig. 1.19) at the IDE's left side. If the **Project** window is not visible, you can view it by selecting **View > Tool Windows > Project**.

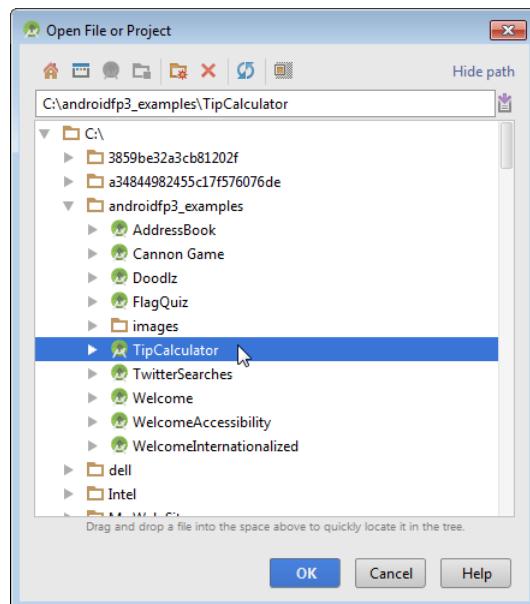


Fig. 1.18 | Open File or Project dialog.

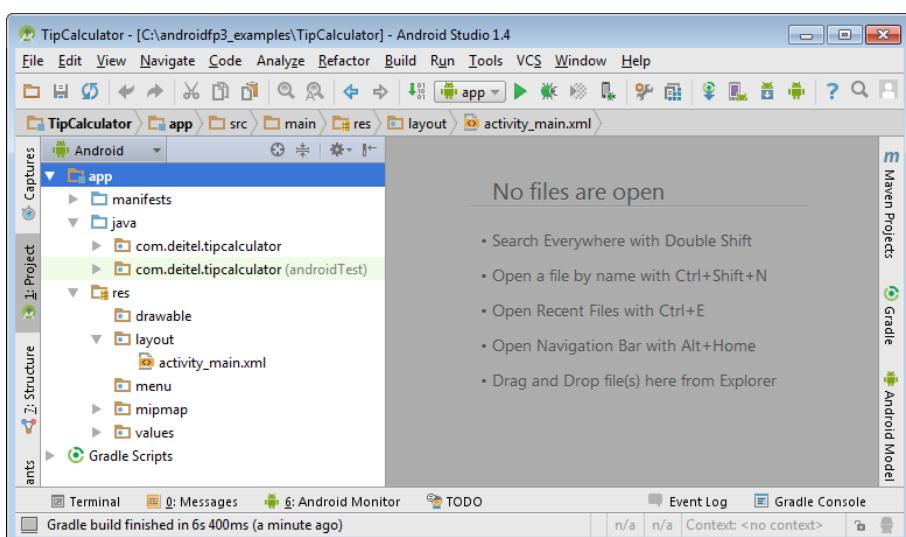
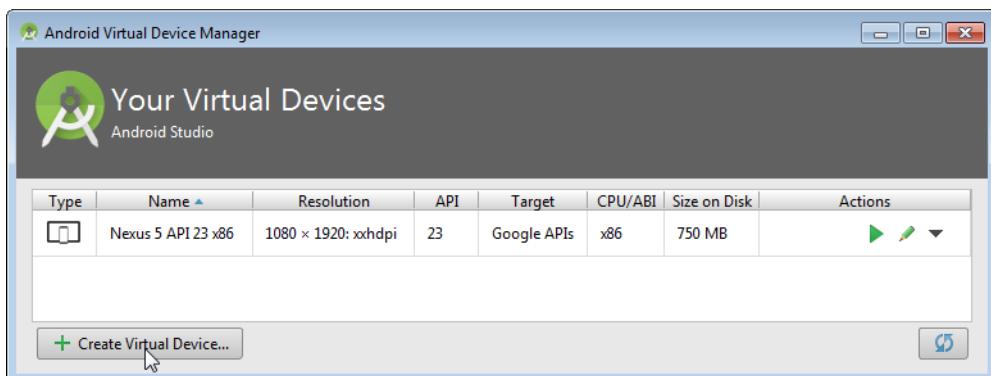


Fig. 1.19 | Project window for the Tip Calculator project.

### 1.9.2 Creating Android Virtual Devices (AVDs)

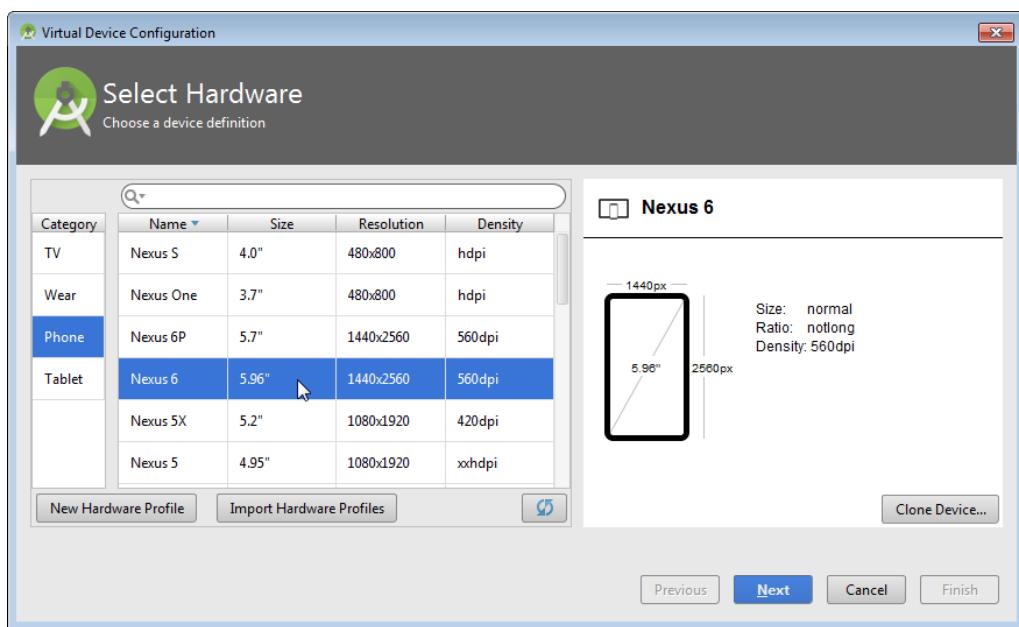
As we discussed in the Before You Begin section, you can test apps for multiple Android devices by creating Android Virtual Devices (AVDs) that emulate each unique device.<sup>10</sup> In this section you'll create Android 6 AVDs for the devices we used to test this book's apps—the Google's Nexus 6 phone and the Nexus 9 tablet. To create these AVDs, perform the following steps:

1. In Android Studio, select **Tools > Android > AVD Manager** to display the **Android Virtual Device Manager** window (Fig. 1.20).



**Fig. 1.20** | Android Virtual Device Manager window.

2. Click **Create Virtual Device...** to open the **Virtual Device Configuration** window (Fig. 1.21). By default the **Category “Phone”** is selected, but you may also create AVDs for **Tablet**, **Wear** and **TV**. For your convenience, Google provides many pre-configured devices that you can use to quickly create AVDs. Select **Nexus 6**, then click **Next**.
  3. Select the system image for the virtual device you wish to create—in this case, the one with the Android platform **Release Name** value **Marshmallow**, the **API Level** value **23**, the **ABI** (application binary interface) value **x86** and the **Target** value **Android 6.0 (with Google APIs)**, then click **Next**. This **Target** creates an Android AVD for Android 6 that also includes support for Google Play Services APIs.
  4. For the **AVD Name**, specify **Nexus 6 API 23**.
  5. Click the **Show Advanced Settings** button in the lower-left of the **Virtual Device Configuration** window, then scroll to the bottom of the advanced settings and *uncheck* the **Enable Keyboard Input** option and click **Finish** to create the AVD.
  6. Repeat Steps 1–6 to create a Nexus 9 tablet AVD named **Nexus 9 API 23**—you'll use this tablet AVD in Chapter 2.
- 
10. At the time of this writing, when you set up Android Studio, it configures an AVD that emulates a Google Nexus 5 phone running Android 6.0 (Marshmallow). You'll still need to perform Section 1.9.2's steps to create the additional AVDs you need for testing.



**Fig. 1.21 |** Virtual Device Configuration window.

If you leave the **Enable Keyboard Input** option checked in Step 5 above, you can use your computer's keyboard to enter data into apps running in the AVD. However, this prevents the soft keyboard shown in the screen captures from displaying.

Each AVD you create has many other options specified in its config.ini file. To more precisely match a particular device's hardware configuration, you can modify config.ini as described at:

<http://developer.android.com/tools/devices/managing-avds.html>

### 1.9.3 Running the Tip Calculator App on the Nexus 6 Smartphone AVD

To test-drive the Tip Calculator app, perform the following steps:

1. *Checking your setup.* If you have not done so already, perform the steps specified in the Before You Begin section.
2. *Launching the Nexus 6 AVD.* For this test-drive, we'll use the Nexus 6 smartphone AVD that you configured in Section 1.9.2. To launch the Nexus 6 AVD, select **Tools > Android > AVD Manager** to display the **Android Virtual Device Manager** dialog (Fig. 1.22). Click the **Launch this AVD in the emulator** button (▶) in the row for the **Nexus 6 API 23** AVD. An AVD can take some time to load—do not attempt to execute the app until the AVD finishes loading. When it's done loading, the AVD will display the lock screen. On an actual device, you unlock it by swiping up with your finger. You perform the swipe gesture on an AVD by placing the mouse over the AVD's "screen" and dragging up with the mouse. Figure 1.23 shows the AVD after you unlock it.

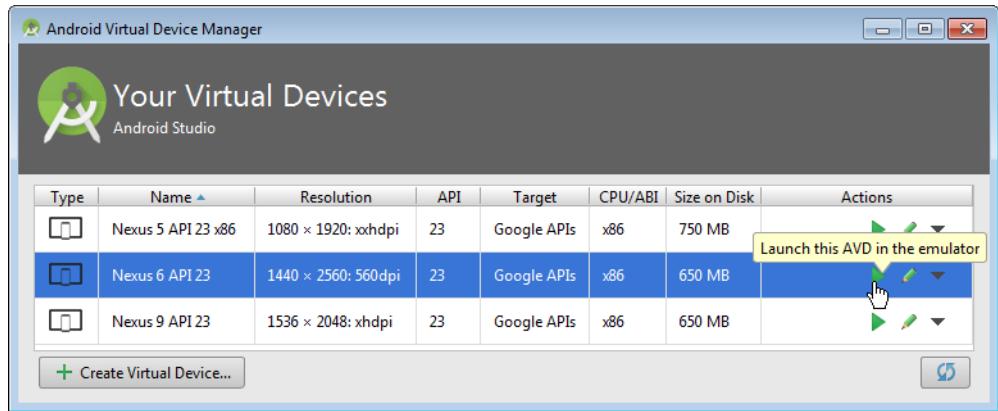


Fig. 1.22 | Android Virtual Device Manager dialog.

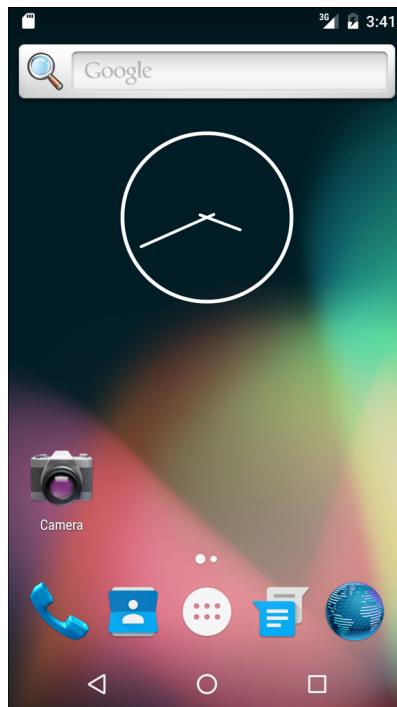
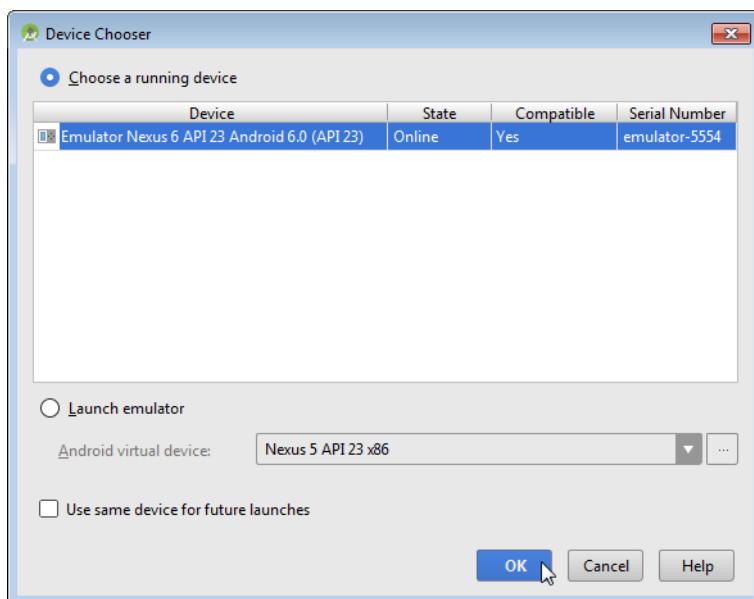


Fig. 1.23 | Nexus 6 AVD home screen after you unlock the AVD.

3. *Launching the Tip Calculator app.* In Android Studio, select Run > Run 'app' or click the Run 'app' button () on the Android Studio toolbar. This will display a Device Chooser dialog (Fig. 1.24) with the currently running AVD already selected. Click OK to run the Tip Calculator in the AVD (Fig. 1.25) that you

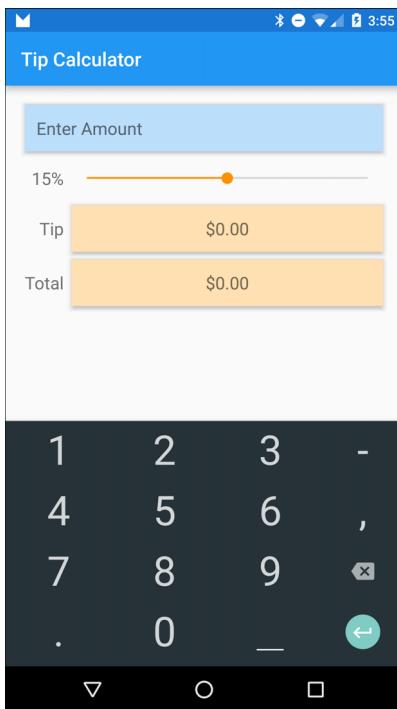
launched in Step 2.<sup>11</sup> As an alternative to opening the **Android Virtual Device Manager** dialog in Step 2, you can click the **Run 'app'** button (▶) on the Android Studio toolbar and the **Device Chooser** dialog will appear. You can then use the **Launch emulator** option at the bottom of the dialog to select an AVD to launch, and in which to run the app.



**Fig. 1.24** | Device Chooser for selecting AVD or device on which to test an app.

**4. Exploring the AVD.** At the AVD screen's bottom are various *soft buttons* that appear on the device's touch screen. You touch these to interact with apps and the Android OS. In an AVD touches are performed by clicking with the mouse. The down button (▼) dismisses the keypad. When there is no keypad on the screen the back button (◀) appears instead. Touching this button takes you back to an app's prior screen, or back to a prior app if you're in the current app's initial screen. The home button (●) returns you to the device's home screen. The recent apps button (□) allows you to view the recently used apps list, so that you can switch back to recent apps quickly. At the screen's top is the app's app bar, which displays the app's name and may contain other app-specific soft buttons—some may appear on the app bar and the rest in the app's **options menu**, which

11. The keypad in Fig. 1.25 may differ, based on your AVD's or device's Android version or whether you've installed and selected a custom keyboard. We configured our AVD to display the dark keyboard for better contrast in our screen captures. To do so: Touch the home (●) icon on your AVD or device. On the home screen, touch the launcher (⋮) icon, then open the **Settings** app. In the **Personal** section, touch **Language and Input**. On an AVD, touch **Android Keyboard (AOSP)**. On a device touch **Google Keyboard** (the standard Android keyboard). Touch **Appearance & layouts**, then touch **Theme**. Touch **Material Dark** to change to the keyboard with the dark background.

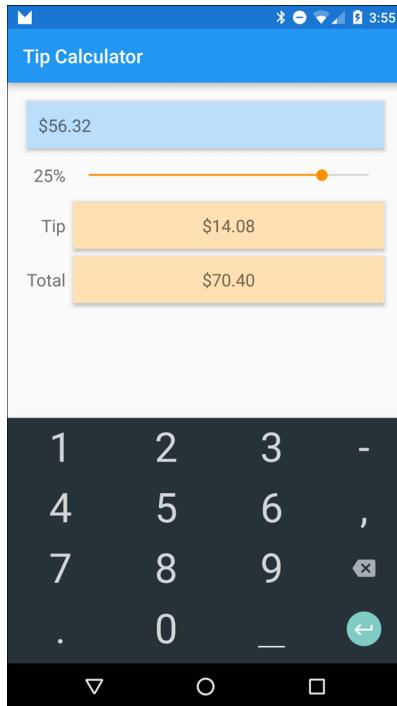


**Fig. 1.25** | Tip Calculator app running in the AVD.

appears in the app bar at the top of the screen as . The number of options on the app bar depends on the size of the device—we discuss this in Chapter 5.

5. **Entering a Bill Total.** Enter the bill total 56.32 by touching numbers on the numeric keypad. If you make a mistake, press the delete button ( in the bottom-right corner of the keypad to erase the last digit you entered. Even though the keypad contains a decimal point, the app is configured so that you may enter only the digits 0–9. Each time you touch a digit or delete one, the app reads what you've entered so far and converts it to a number—if you delete all the digits the app redisplays **Enter Amount** in the **TextView** at the top of the app. The app divides the value by 100 and displays the result in the blue **TextView**. The app then calculates and updates the tip and total amounts that are displayed. We use Android's locale-specific currency-formatting capabilities to display monetary values formatted for the device's current locale. For the U.S. locale, as you enter the four digits 5, 6, 3 and 2, the bill total is displayed successively as \$0.05, \$0.56, \$5.63 and \$56.32, respectively.
6. **Selecting a Custom Tip Percentage.** The **SeekBar** allows you to select a custom percentage, and the **TextViews** in the right column below the **SeekBar** display the corresponding tip and the total bill. Drag the **SeekBar** thumb to the right until the custom percentage reads 25%. As you drag the thumb, the **SeekBar** value continuously changes. The app updates the tip percentage, the tip amount and the

bill total accordingly for each **SeekBar** value until you release the thumb. Figure 1.26 shows the app after you've entered the bill amount and selected the tip percentage.



**Fig. 1.26 |** Tip Calculator after entering the bill amount and selecting a 25% tip.

7. *Returning to the home screen.* You can return to the AVD's home screen by tapping the home (○) button on the AVD.

#### Troubleshooting AVD Startup

If you have trouble executing an Android Virtual Device, it might be that too much of your computer's memory is allocated to the AVD. To reduce AVD's memory size:

1. In Android Studio, select Tools > Android > AVD Manager to open the **Android Virtual Device Manager** window.
2. You'll see a list of existing AVDs. For the AVD you'd like to reconfigure, click the pencil icon (✎) in the **Actions** column.
3. In the **Virtual Device Configuration** window, click **Show Advanced Settings**, and scroll to the **Memory and Storage** section.
4. Decrease value for **RAM** from the default 1536 MB (1.5 GB) down to 1 GB.
5. Click **Finish** and close the **Android Virtual Device Manager** window.

If you still cannot run the AVD, repeat these steps and reduce the memory to 768 MB.

### 1.9.4 Running the Tip Calculator App on an Android Device

If you have an Android device, you can easily execute an app on it for testing purposes.

- Enabling the developer options on the device.* First, you must enable debugging on the device. To do so, go to the device's **Settings** app, then select **About phone** (or **About tablet**), locate the **Build number** (at the bottom of the list) and tap it seven times until you see **You are now a developer** on the screen. This will enable an entry named **Developer options** in the **Settings** app.
- Enabling debugging on the device.* Return to the **Settings** app's main screen, select **Developer options** and ensure that **USB debugging** is checked—this is the default when you first enable the developer options on the device.
- Connecting your device.* Next, use the USB cable that came with your device to connect the device to your computer. If you're a Windows user, recall from the Before You Begin section that you might need to install a USB driver for your device. See the following web pages for details:

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

- Running Tip Calculator on the Android device.* In Android Studio, select **Run > Run 'app'** or click the **Run 'app'** button (▶) on the Android Studio toolbar. This will display the **Device Chooser** dialog that you saw in Fig. 1.24. Select your device from the list of running AVDs and devices. Click **OK** to run the **Tip Calculator** on the AVD or device you selected.

#### *Test-Drives for the Book's Apps*

To get a broad sense of the capabilities that you'll learn in this book, check out the test-drives of the book's apps in Chapters 2–9.

#### *Preparing to Distribute Apps*

When you build apps for distribution via app stores like Google Play, you should test the apps on as many actual devices as you can. Remember that some features can be tested *only* on actual devices. If you don't have Android devices available to you, create AVDs that simulate the various devices on which you'd like your app to execute—the AVD Manager provides many preconfigured AVD templates. When you configure each AVD to simulate a particular device, look up the device's specifications online and configure the AVD accordingly. In addition, you can modify the AVD's `config.ini` file as described in the section **Setting hardware emulation options** at

```
http://developer.android.com/tools/devices/managing-avds-cmdline.html#hardwareopts
```

This file contains options that are not configurable via the **Android Virtual Device Manager**. Modifying these options allows you to more precisely match the hardware configuration of an actual device.

## 1.10 Building Great Android Apps

With over 1.6 million apps in Google Play,<sup>12</sup> how do you create an Android app that people will find, download, use and recommend to others? Consider what makes an app fun,

useful, interesting, appealing and enduring. A clever app name, an attractive icon and an engaging description might lure people to your app on Google Play or one of the many other Android app marketplaces. But once users download the app, what will make them use it regularly and recommend it to others? Figure 1.27 shows some characteristics of great apps.

**Characteristics of great apps**

***Great Games***

- Entertaining and fun.
- Challenging.
- Progressive levels of difficulty.
- Show your scores and use leaderboards to record high scores.
- Provide audio and visual feedback.
- Offer single-player, multiplayer and networked versions.
- Have high-quality animations.
- Offloading input/output and compute-intensive code to separate threads of execution to improve interface responsiveness and app performance.
- Innovate with augmented reality technology—enhancing a real-world environment with virtual components; this is particularly popular with video-based apps.

***Useful Utilities***

- Provide useful functionality and accurate information.
- Increase personal and business productivity.
- Make tasks more convenient (e.g., maintaining a to-do list, managing expenses).
- Make the user better informed.
- Provide topical information (e.g., the latest stock prices, news, severe-storm warnings, traffic updates).
- Use location-based services to provide local services (e.g., coupons for local businesses, best gas prices, food delivery).

***General Characteristics***

- Up-to-date with the latest Android features, but compatible with multiple Android versions to support the widest possible audience.
- Work properly.
- Bugs are fixed promptly.
- Follow standard Android app GUI conventions.
- Launch quickly.
- Are responsive.

**Fig. 1.27** | Characteristics of great apps. (Part I of 2.)

12. <http://www.statista.com/statistics/266210/number-of-available-applications-in-the-google-play-store/>.

| Characteristics of great apps   |  |
|---|--|
| <i>General Characteristics (cont.)</i>  |  |
| <ul style="list-style-type: none"> <li>• Don't require excessive memory, bandwidth or battery power.</li> <li>• Are novel and creative.</li> <li>• Enduring—something that your users will use regularly.</li> <li>• Use professional-quality icons that will appear in Google Play and on the user's device.</li> <li>• Use quality graphics, images, animations, audio and video.</li> <li>• Are intuitive and easy to use (don't require extensive help documentation).</li> <li>• Accessible to people with disabilities (<a href="http://developer.android.com/guide/topics/ui/accessibility/index.html">http://developer.android.com/guide/topics/ui/accessibility/index.html</a>).</li> <li>• Give users reasons and a means to tell others about your app (e.g., you can give users the option to post their game scores to Facebook or Twitter).</li> <li>• Provide additional content for content-driven apps (e.g., game levels, articles, puzzles).</li> <li>• Localized (Chapter 2) for each country in which the app is offered (e.g., translate the app's text and audio files, use different graphics based on the locale, etc.).</li> <li>• Offer better performance, capabilities and ease-of-use than competitive apps.</li> <li>• Take advantage of the device's built-in capabilities.</li> <li>• Do not request excessive permissions.</li> <li>• Are designed to run optimally across a broad variety of Android devices.</li> <li>• Future-proofed for new hardware devices—specify the exact hardware features your app uses so Google Play can filter and display it in the store for only compatible devices (<a href="http://android-developers.blogspot.com/2010/06/future-proofing-your-app.html">http://android-developers.blogspot.com/2010/06/future-proofing-your-app.html</a>).</li> </ul> |  |

**Fig. 1.27** | Characteristics of great apps. (Part 2 of 2.)

## 1.11 Android Development Resources

Figure 1.28 lists some of the key documentation from the Android Developer site. As you dive into Android app development, you may have questions about the tools, design issues, security and more. There are several Android developer newsgroups and forums where you can get the latest announcements or ask questions (Fig. 1.29). Figure 1.30 lists several websites where you'll find Android development tips, videos and resources.

| Title                             | URL   |
|-----------------------------------|---|
| <i>App Components</i>             | <a href="http://developer.android.com/guide/components/index.html">http://developer.android.com/guide/components/index.html</a> |
| <i>Using the Android Emulator</i> | <a href="http://developer.android.com/tools/devices/emulator.html">http://developer.android.com/tools/devices/emulator.html</a> |
| <i>Package Index</i>              | <a href="http://developer.android.com/reference/packages.html">http://developer.android.com/reference/packages.html</a>         |
| <i>Class Index</i>                | <a href="http://developer.android.com/reference/classes.html">http://developer.android.com/reference/classes.html</a>           |

**Fig. 1.28** | Key online documentation for Android developers. (Part 1 of 2.)

| Title   | URL   |
|---|---|
| <i>Android Design</i>                               | <a href="http://developer.android.com/design/index.html">http://developer.android.com/design/index.html</a>   |
| <i>Data Backup</i>                                  | <a href="http://developer.android.com/guide/topics/data/backup.html">http://developer.android.com/guide/topics/data/backup.html</a>                   |
| <i>Security Tips</i>                                | <a href="http://developer.android.com/training/articles/security-tips.html">http://developer.android.com/training/articles/security-tips.html</a>     |
| <i>Android Studio</i>                               | <a href="http://developer.android.com/sdk/index.html">http://developer.android.com/sdk/index.html</a>   |
| <i>Debugging</i>                                    | <a href="http://developer.android.com/tools/debugging/index.html">http://developer.android.com/tools/debugging/index.html</a>                         |
| <i>Tools Help</i>                                   | <a href="http://developer.android.com/tools/help/index.html">http://developer.android.com/tools/help/index.html</a>                                   |
| <i>Performance Tips</i>                             | <a href="http://developer.android.com/training/articles/perf-tips.html">http://developer.android.com/training/articles/perf-tips.html</a>             |
| <i>Keeping Your App Responsive</i>                  | <a href="http://developer.android.com/training/articles/perf-anr.html">http://developer.android.com/training/articles/perf-anr.html</a>               |
| <i>Launch Checklist (for Google Play)</i>           | <a href="http://developer.android.com/distribute/tools/launch-checklist.html">http://developer.android.com/distribute/tools/launch-checklist.html</a> |
| <i>Getting Started with Publishing</i>              | <a href="http://developer.android.com/distribute/googleplay/start.html">http://developer.android.com/distribute/googleplay/start.html</a>             |
| <i>Managing Your App's Memory</i>                   | <a href="http://developer.android.com/training/articles/memory.html">http://developer.android.com/training/articles/memory.html</a>                   |
| <i>Google Play Developer Distribution Agreement</i> | <a href="http://play.google.com/about/developer-distribution-agreement.html">http://play.google.com/about/developer-distribution-agreement.html</a>   |

**Fig. 1.28** | Key online documentation for Android developers. (Part 2 of 2.)

| Title              | Subscribe   | Description  |
|--------------------|---|--|
| Android Discuss    | <i>Subscribe using Google Groups:</i><br>android-discuss<br><i>Subscribe via e-mail:</i><br>android-discuss-<br>subscribe@googlegroups.com              | A general Android discussion group where you can get answers to your app-development questions.                        |
| Stack Overflow     | <a href="http://stackoverflow.com/questions/tagged/android">http://stackoverflow.com/questions/tagged/android</a>                                       | Use this for Android app-development questions and questions about best practices.                                     |
| Android Developers | <a href="http://groups.google.com/forum/?fromgroups#!forum/android-developers">http://groups.google.com/forum/?fromgroups#!forum/android-developers</a> | Experienced Android developers use this list for troubleshooting apps, GUI design issues, performance issues and more. |
| Android Forums     | <a href="http://www.androidforums.com">http://www.androidforums.com</a>   | Ask questions, share tips with other developers and find forums targeting specific Android devices.                    |

**Fig. 1.29** | Android newsgroups and forums.

| Android development tips, videos and resources                     | URL   |
|--|---|
| Android Sample Code and Utilities from Google                      | <a href="https://github.com/google">https://github.com/google</a> (use the filter "android")                          |
| Bright Hub™ website for Android programming tips and how-to guides | <a href="http://www.brighthub.com/mobile/google-android.aspx">http://www.brighthub.com/mobile/google-android.aspx</a> |
| The Android Developers Blog  | <a href="http://android-developers.blogspot.com/">http://android-developers.blogspot.com/</a>                         |
| HTC's Developer Center for Android                                 | <a href="http://www.htcdev.com/">http://www.htcdev.com/</a>   |
| The Motorola Android development site                              | <a href="http://developer.motorola.com/">http://developer.motorola.com/</a>   |
| Top Android Users on Stack Overflow                                | <a href="http://stackoverflow.com/tags/android/topusers">http://stackoverflow.com/tags/android/topusers</a>           |
| Android Weekly Newsletter  | <a href="http://androidweekly.net/">http://androidweekly.net/</a>   |
| Chet Haase's Codependent blog                                      | <a href="http://graphics-geek.blogspot.com/">http://graphics-geek.blogspot.com/</a>                                   |
| Romain Guy's Android blog  | <a href="http://www.curious-creature.org/category/android/">http://www.curious-creature.org/category/android/</a>     |
| Android Developers Channel on YouTube®                             | <a href="http://www.youtube.com/user/androiddevelopers">http://www.youtube.com/user/androiddevelopers</a>             |
| Google I/O 2015 Developer Conference session videos                | <a href="https://events.google.com/io2015/videos">https://events.google.com/io2015/videos</a>                         |

**Fig. 1.30** | Android development tips, videos and resources.

## 1.12 Wrap-Up

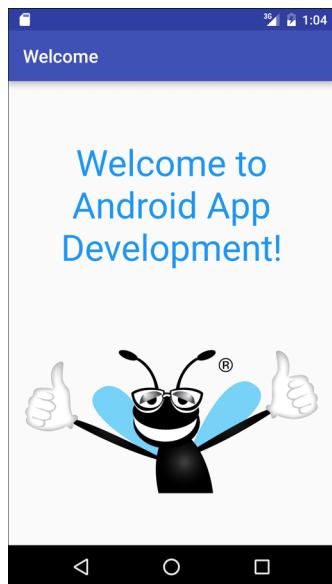
This chapter presented a brief history of Android and discussed its functionality. We provided links to some of the key online documentation and to the newsgroups and forums you can use to connect with the developer community and get your questions answered. We discussed features of the Android operating system. We introduced the Java, Android and Google packages that enable you to use the hardware and software functionality you'll need to build a variety of Android apps. You'll use many of these packages in this book. We also discussed Java programming and the Android SDK. You learned the Android gestures and how to perform each on an Android device and on the emulator. We provided a quick refresher on basic object-technology concepts, including classes, objects, attributes, behaviors, encapsulation, information hiding, inheritance and more. You test-drove the **Tip Calculator** app on the Android emulator for both smartphone and tablet AVDs.

In Chapter 2, you'll build your first Android app in Android Studio. The app will display text and an image. You'll also learn about Android accessibility and internationalization.

# 2

# Welcome App

Dive-Into® Android Studio: Introducing Visual GUI Design, Layouts, Accessibility and Internationalization



## Objectives

In this chapter you'll:

- Understand the basics of the Android Studio IDE, which you'll use to write, test and debug your Android apps.
- Use the IDE to create a new app project.
- Design a graphical user interface (GUI) visually (without programming) using the IDE's layout editor.
- Display text and an image in a GUI.
- Edit the properties of views (GUI components).
- Build and launch an app in the Android emulator.
- Make the app more accessible to visually impaired people by specifying strings for use with Android's TalkBack and Explore-by-Touch features.
- Support internationalization so your app can display strings localized in different languages.

**Outline**

|            |   |            |  |
|------------|---|------------|--|
| <b>2.1</b> | Introduction  | 2.5.6      | Configuring the <code>TextView</code> 's <code>textSize</code> Property—Scaled Pixels and Density-Independent Pixels |
| <b>2.2</b> | Technologies Overview   | 2.5.7      | Setting the <code>TextView</code> 's <code>textColor</code> Property   |
| 2.2.1      | Android Studio  | 2.5.8      | Setting the <code>TextView</code> 's <code>gravity</code> Property   |
| 2.2.2      | <code>LinearLayout</code> , <code>TextView</code> and <code>ImageView</code>              | 2.5.9      | Setting the <code>TextView</code> 's <code>layout:gravity</code> Property  |
| 2.2.3      | Extensible Markup Language (XML)  | 2.5.10     | Setting the <code>TextView</code> 's <code>layout:weight</code> Property   |
| 2.2.4      | App Resources   | 2.5.11     | Adding an <code>ImageView</code> to Display the Image  |
| 2.2.5      | Accessibility   | 2.5.12     | Previewing the Design  |
| 2.2.6      | Internationalization  | <b>2.6</b> | Running the <b>Welcome</b> App   |
| <b>2.3</b> | Creating an App   | <b>2.7</b> | Making Your App Accessible   |
| 2.3.1      | Launching Android Studio  | <b>2.8</b> | Internationalizing Your App  |
| 2.3.2      | Creating a New Project  | 2.8.1      | Localization   |
| 2.3.3      | Create New Project Dialog   | 2.8.2      | Naming the Folders for Localized Resources   |
| 2.3.4      | Target Android Devices Step   | 2.8.3      | Adding String Translations to the App's Project  |
| 2.3.5      | Add an Activity to Mobile Step  | 2.8.4      | Localizing Strings   |
| 2.3.6      | Customize the Activity Step   | 2.8.5      | Testing the App in Spanish on an AVD   |
| <b>2.4</b> | Android Studio Window   | 2.8.6      | Testing the App in Spanish on a Device   |
| 2.4.1      | Project Window  | 2.8.7      | TalkBack and Localization  |
| 2.4.2      | Editor Windows  | 2.8.8      | Localization Checklist   |
| 2.4.3      | Component Tree Window   | 2.8.9      | Professional Translation   |
| 2.4.4      | App Resource Files  | <b>2.9</b> | Wrap-Up  |
| 2.4.5      | Layout Editor   |            |  |
| 2.4.6      | Default GUI   |            |  |
| 2.4.7      | XML for the Default GUI   |            |  |
| <b>2.5</b> | Building the App's GUI with the Layout Editor   |            |  |
| 2.5.1      | Adding an Image to the Project  |            |  |
| 2.5.2      | Adding an App Icon  |            |  |
| 2.5.3      | Changing <code>RelativeLayout</code> to a <code>LinearLayout</code>                       |            |  |
| 2.5.4      | Changing the <code>LinearLayout</code> 's <code>id</code> and <code>orientation</code>    |            |  |
| 2.5.5      | Configuring the <code>TextView</code> 's <code>id</code> and <code>text</code> Properties |            |  |

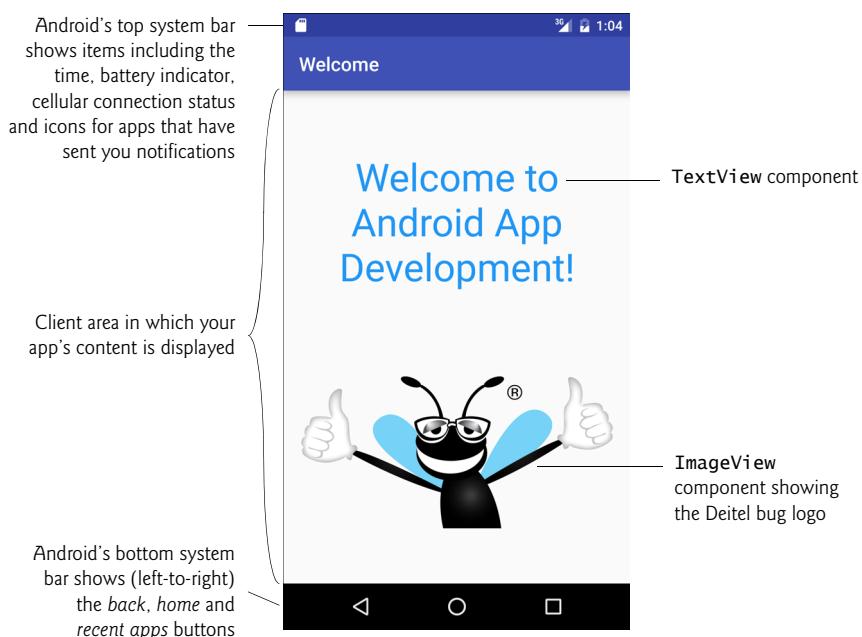
## 2.1 Introduction

In this chapter, you'll build the **Welcome** app that displays a welcome message and an image. You'll use Android Studio to create a simple app (Fig. 2.1) that runs on Android phones and tablets in both portrait and landscape orientations:

- In portrait the device's height is greater than its width.
- In landscape the width is greater than the height.

You'll use Android Studio's layout editor to build the GUI using *drag-and-drop* techniques. You'll also edit the GUI's XML directly. You'll execute your app in the Android *emulator* and on an Android device, if you have one.

You'll provide descriptive text for the app's image to make the app more *accessible* for people with visual impairments. As you'll see, Android's *Explore by Touch* enables users to touch items on the screen and hear *TalkBack* speak the corresponding descriptive text. We'll discuss how to test these features, which are available only on Android devices.



**Fig. 2.1 |** **Welcome** app running in the Android emulator.

Finally, you'll *internationalize* the app so that you can provide *localized* strings in different languages. You'll then change the locale setting on the Android emulator so that you can test the app in Spanish. When your app executes, Android chooses the correct strings based on the device's locale. We show how to change the locale on a device. We assume that you've read the Preface, Before You Begin and Section 1.9.

## 2.2 Technologies Overview

This section introduces the technologies you'll use to build the **Welcome** app.

### 2.2.1 Android Studio

In Section 2.3, you'll use the Android Studio integrated development environment (IDE) to create a new app. As you'll see, the IDE creates a default GUI that contains the text "Hello world!". You'll then use the layout editor's **Design** and **Text** views and the **Properties** window to visually build a simple graphical user interface (GUI) consisting of text and an image (Section 2.5).

### 2.2.2 LinearLayout, TextView and ImageView

GUI components in Android are called **views**. **Layouts** are views that contain and arrange other views. You'll use a vertical **LinearLayout** to arrange the app's text and image with each occupying half the **LinearLayout**'s vertical space. A **LinearLayout** also can arrange views horizontally.

This app’s text is displayed in a `TextView` and its image is displayed in an `ImageView`. The default GUI created by Android Studio already contains a `TextView`. You’ll modify its properties, including its text, font size and font color and its size relative to the `ImageView` within the `LinearLayout` (Section 2.5.5). You’ll use the layout editor’s `Palette` of views (Fig. 2.11) to drag and drop an `ImageView` onto the GUI (Section 2.5.11), then configure its properties, including its image source and positioning within the `LinearLayout`.

### 2.2.3 Extensible Markup Language (XML)

**Extensible Markup Language (XML)** is a natural way to express GUIs. XML is human- and computer-readable text and, in the context of Android, helps you specify the layouts and components to use, as well as their attributes, such as size, position, color, text size, margins and padding. Android Studio parses the XML to display your design in the layout editor and to generate the Java code that produces the runtime GUI. You’ll also use XML files to store **app resources**, such as strings, numbers and colors (Section 2.2.4).

### 2.2.4 App Resources

It’s considered good practice to define all strings, numeric values and other values in XML resource files that are placed in the subfolders of a project’s `res` folder. In Section 2.5.5, you’ll create resources for strings (such as the text on a `TextView`) and measurements (such as a font’s size). For the `TextView`’s font color, you’ll create a color resource using a color selected from Google’s Material Design color palette:

<http://www.google.com/design/spec/style/color.html>

### 2.2.5 Accessibility

Android provides *accessibility* features to help people with certain disabilities use their devices. People with visual impairments can use Android’s **TalkBack** to allow a device to speak screen text or text that you provide to help them understand the purpose and contents of a view. Android’s **Explore by Touch** enables the user to touch the screen to hear TalkBack speak what’s on the screen near the touch. Section 2.7 shows how to enable these features and configure your app’s views for accessibility.

### 2.2.6 Internationalization

Android devices are used worldwide. To reach the most users with your apps, you should consider customizing them for various *locales* and spoken languages. Configuring your app so that it can be customized for various locales is known as **internationalization**. Customizing your app for a specific locale is known as **localization**. Section 2.8 shows how to provide Spanish text for the `Welcome` app’s `TextView` and the `ImageView`’s accessibility string, and how to test the app on an AVD or device configured for Spanish.

## 2.3 Creating an App

This book’s examples were developed using the Android 6 SDK that was current at the time of this writing. This section shows you how to use Android Studio to create a new project. We introduce additional features of the IDE throughout the book.

### 2.3.1 Launching Android Studio

As you did in Section 1.9, open Android Studio via its shortcut:

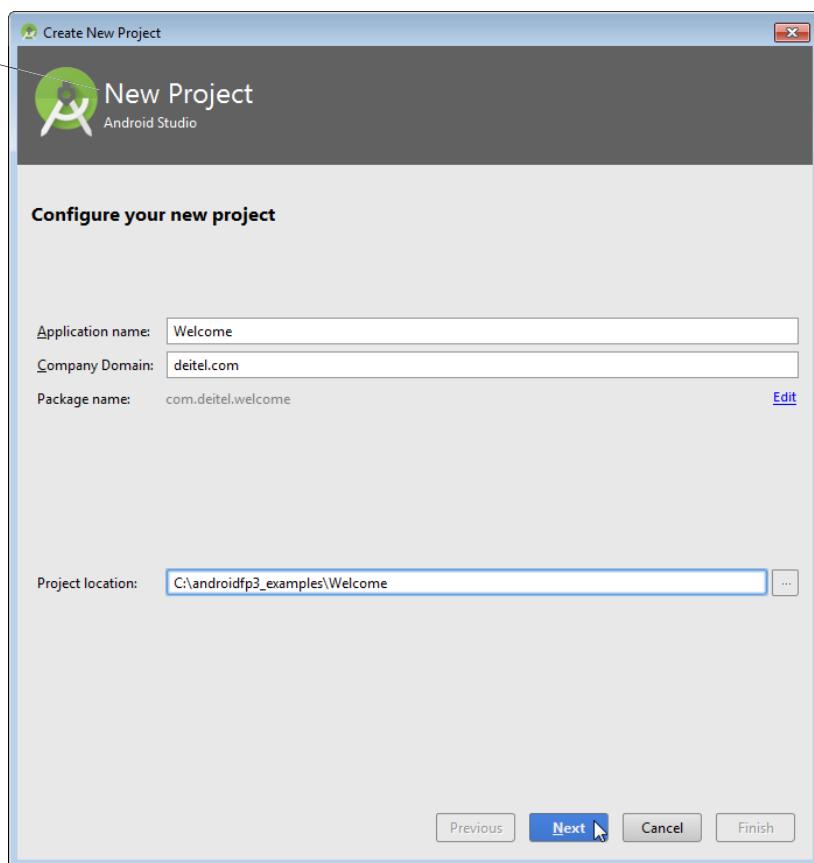


The IDE displays either the **Welcome** window (Fig. 1.17) or the last project you had open.

### 2.3.2 Creating a New Project

A **project** is a group of related files, such as code files, resource files and images that make up an app. To create an app, you must first create its project. To do so, click **Start a new Android Studio project** in the **Welcome** window or, if a project is open, select **File > New > New Project....** This displays the **Create New Project** dialog (Fig. 2.2).

Current step being performed in the  
**Create New Project** dialog



**Fig. 2.2** | Create New Project dialog—New Project step.

### 2.3.3 Create New Project Dialog

In the **Create New Project** dialog's **Configure your new project** step (Fig. 2.2), specify the following information, then click **Next**:

- 1. Application name:** field—Your app's name. Enter **Welcome** in this field.
- 2. Company Domain:** field—Your company website's domain name. We used our **deitel.com** website domain. For learning purposes you can use **example.com**, but this must be changed if you intend to distribute your app.
- 3. Package name:** field—The Java package name for your app's source code. Android and the Google Play store use this as the app's *unique identifier*, which must remain the same in all versions of your app that you upload to the Google Play store. The package name normally begins with your company's or institution's **Company Domain in reverse**—our **Company Domain** is **deitel.com**, so our Java package names begin with **com.deitel**. This is followed by a dot (.) and the app's name in all lowercase letters with any spaces removed. By convention, package names use only lowercase letters. The IDE sets the package name using the text you enter for **Application Name** and **Company Domain**. You can click the **Edit** link to the right of the generated package name to customize the **Package name**.
- 4. Project location:** field—The path of the location on your computer in which to store the project. By default, Android Studio places new project folders in the subfolder **AndroidStudioProjects** in your user account directory. A project's folder name consists of the project name with the spaces removed. You also can customize the location by entering a path or clicking the ellipsis (...) button to the right of the field and browsing for a location to store the project. After selecting a location, click **OK**. Click **Next** to move to the next step.



#### Error-Prevention Tip 2.1

If the path to the folder in which you wish to save a project contains spaces, the **Create New Project** dialog displays the message “Your project location contains whitespace. This can cause problems on some platforms and is not recommended.” To resolve this, click the ellipsis (...) button to the right of the **Create New Project** dialog's **Project location** field and select a location that does not contain spaces; otherwise, your project might not compile or execute correctly.

### 2.3.4 Target Android Devices Step

In the **Create New Project** dialog's **Target Android Devices** step (Fig. 2.3):

1. Check the checkbox for each Android device type (**Phone and Tablet**, **TV**, **Wear**, **Android Auto** and **Glass**) that your app should support. For the **Welcome** app, ensure that only the **Phone and Tablet** type is checked.
2. Next, select a **Minimum SDK** in the drop-down for each type of device that you selected, then click **Next**. The **Minimum SDK** is the minimum Android API level that's required to run your app. This allows your app to execute on devices supporting that API level and higher. Select **API23: Android 6.0 (Marshmallow)** for this

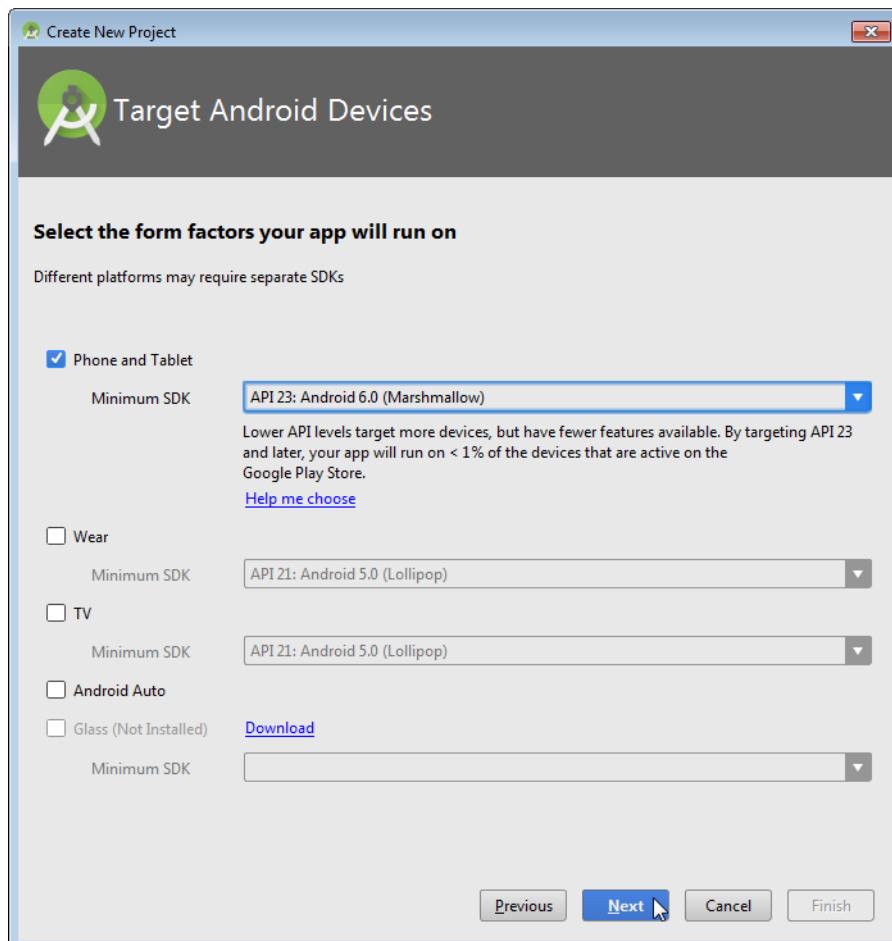
book's apps and click **Next**. Figure 2.4 shows the Android SDK versions and their API levels—versions not shown here are deprecated and should not be used. The percentage of Android devices running each platform version is shown at

<http://developer.android.com/about/dashboards/index.html>



### Software Engineering Observation 2.1

*Lower Minimum SDK values enable your app to run on more devices—e.g., at the time of this writing, you could reach 94% of devices with API 15. Generally you should target the lowest API level on which your app can run. You must disable newer features that are not available on older platforms when your app is installed on those platforms.*



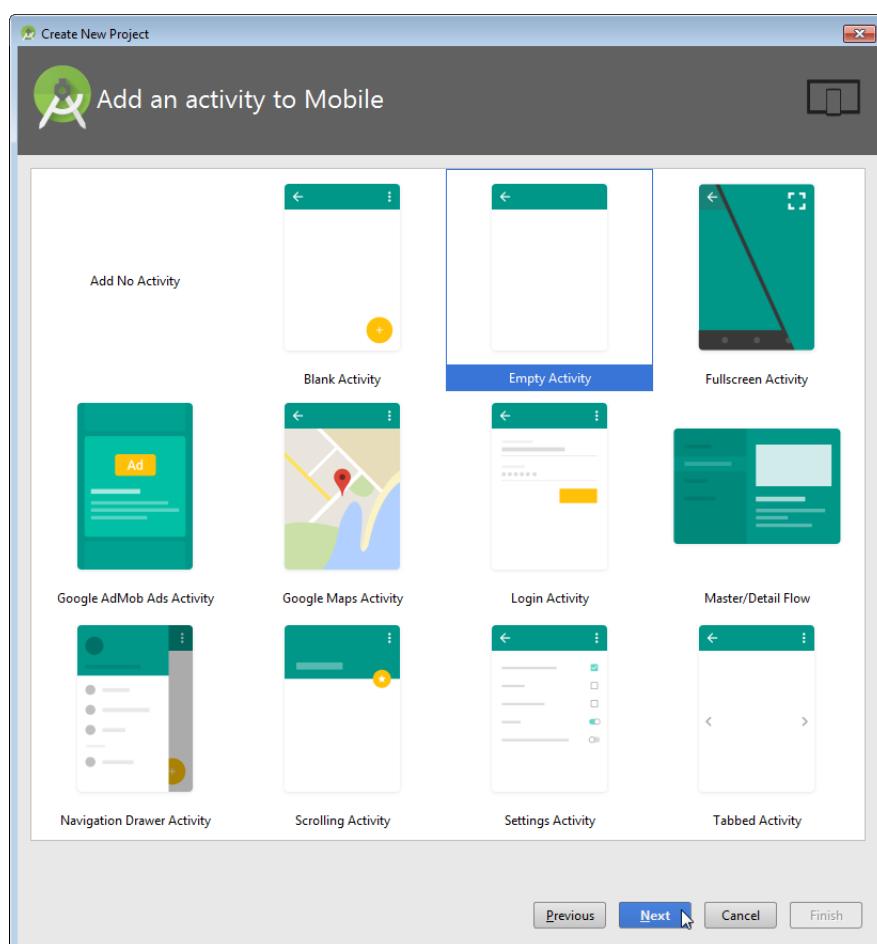
**Fig. 2.3** | Create New Project dialog—Target Android Devices step.

| SDK version | API level | SDK version | API level | SDK version | API level |
|-------------|-----------|-------------|-----------|-------------|-----------|
| 6.0         | 23        | 4.3         | 18        | 2.3.3–2.3.7 | 10        |
| 5.1         | 22        | 4.2.x       | 17        | 2.2         | 8         |
| 5.0         | 21        | 4.1.x       | 16        |             |           |
| 4.4         | 19        | 4.0.3–4.0.4 | 15        |             |           |

**Fig. 2.4** | Android SDK versions and API levels. (<http://developer.android.com/about/dashboards/index.html>)

### 2.3.5 Add an Activity to Mobile Step

In the **Add an Activity to Mobile** step (Fig. 2.5), you'll select an app template. Templates provide preconfigured starting points for common app designs and app logic.



**Fig. 2.5** | Create New Project dialog—Add an activity to Mobile step.

Figure 2.6 briefly describes four commonly used templates from Fig. 2.5. For this app, select **Empty Activity**, then click **Next**. This template defines a one-screen app that displays **Hello World!**. We'll use other templates in later chapters. For multiscreen apps, you also can define a new screen by adding one of the Fig. 2.5 activities to an existing app. For example, in Chapter 4's **Flag Quiz** app, we'll add a **Settings Activity** that provides a screen in which the user can specify the quizzes settings.

| Template                   | Description   |
|----------------------------|---|
| <b>Blank Activity</b>      | Used for a <i>single-screen app</i> in which you build most of the GUI yourself. Provides an <i>app bar</i> at the top of the app that displays the app's name and can display controls that enable a user to interact with the app. Also includes a material design <i>FloatingActionButton</i> .  |
| <b>Fullscreen Activity</b> | Used for a <i>single-screen app</i> (similar to <b>Blank Activity</b> ) that occupies the entire screen, but can toggle visibility of the device's status bar and the app's app bar.  |
| <b>Master/Detail Flow</b>  | Used for an app that displays a <i>master list</i> of items from which a user can choose one item to see its <i>details</i> —similar to the built-in <b>Email</b> and <b>Contacts</b> apps. Includes basic logic for enabling a user to select an item from the master list and display that item in the detail view. For tablets, the master list and details are shown side-by-side on the same screen. For phones, the master list is shown on one screen, and selecting an item displays the item's details in a separate screen. |

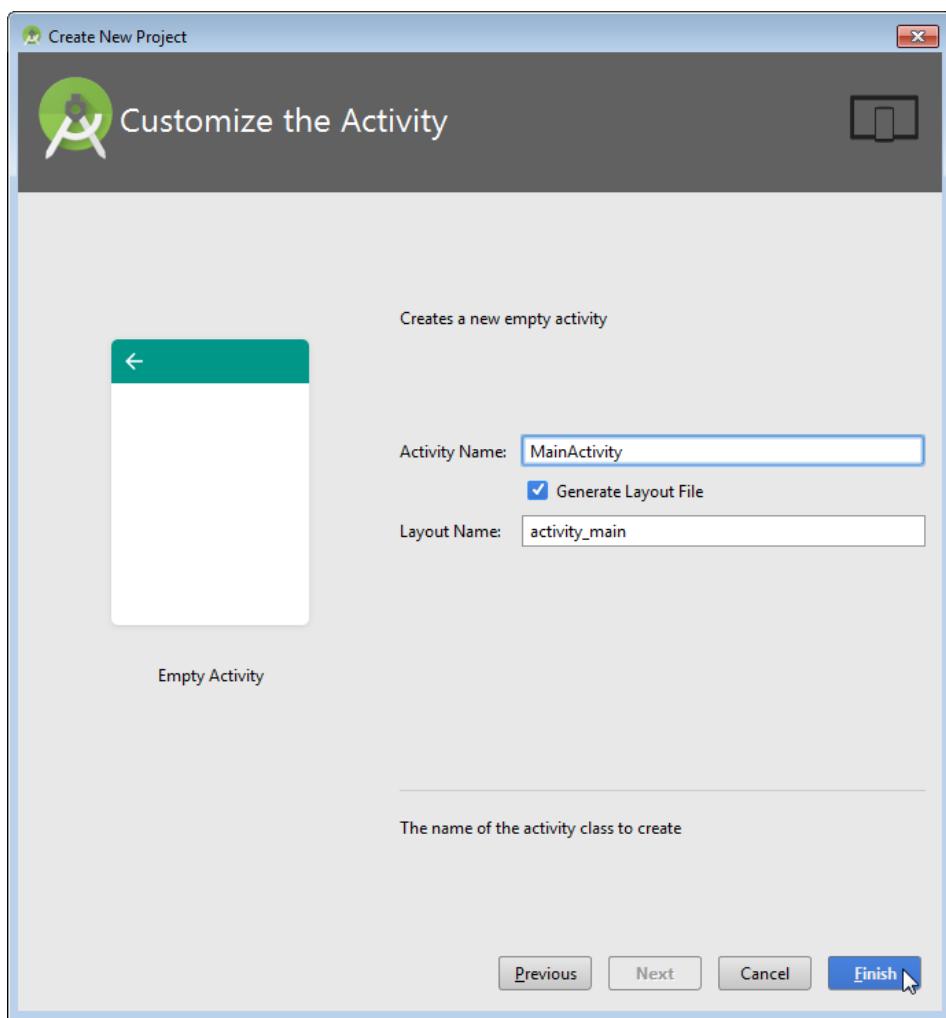
**Fig. 2.6** | Activity templates.

### 2.3.6 Customize the Activity Step

This step (Fig. 2.7) depends on the template selected in the previous step. For the **Empty Activity** template, this step allows you to specify:

- **Activity Name**—`MainActivity` is the default name provided by the IDE. This is the name of an `Activity` subclass that controls the app's execution. Starting in Chapter 3, we'll modify this class to implement the app's functionality.
- **Layout Name**—`activity_main` is the default name provided by the IDE. This file (which has the `.xml` extension) stores an XML representation of the app's GUI that you'll build in Section 2.5 using visual techniques.

For this app, keep the default settings, then click **Finish** to create the project.



**Fig. 2.7** | Create New Project dialog—Customize the Activity step.

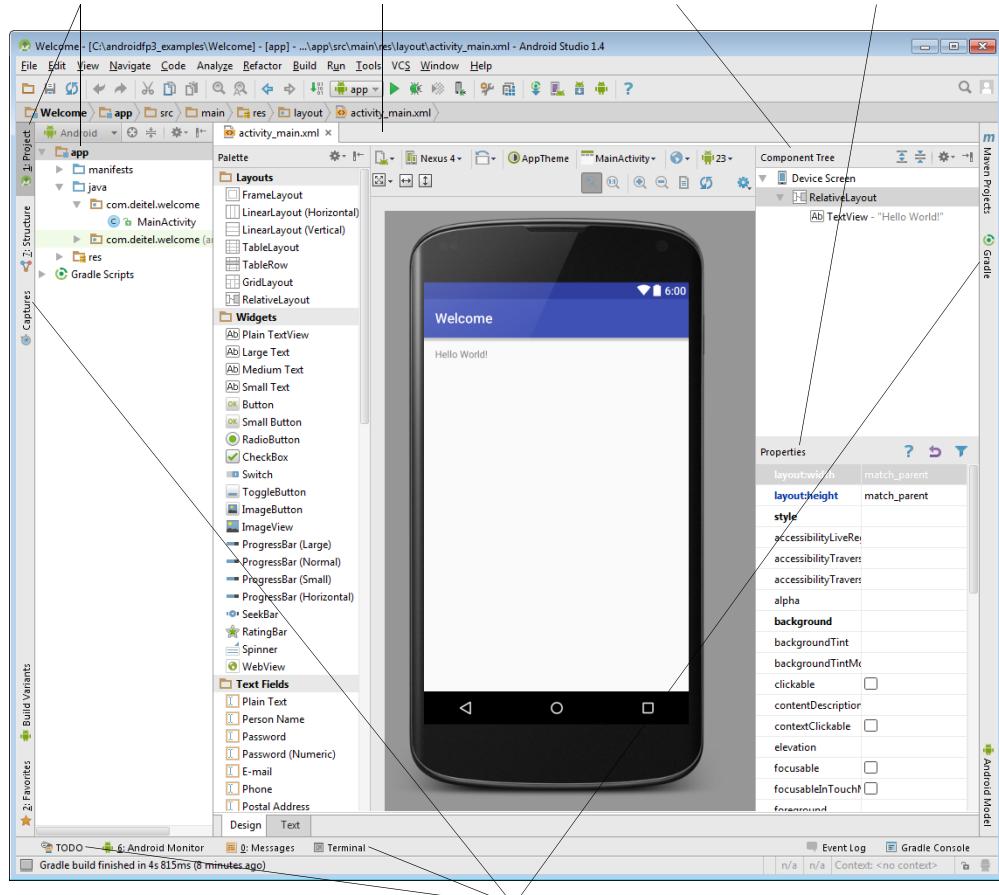
## 2.4 Android Studio Window

When you finish creating the project, the IDE opens both `MainActivity.java` and `activity_main.xml`. Close `MainActivity.java` so that the IDE appears as shown in Fig. 2.8. The IDE shows the layout editor, so you can begin designing your app’s GUI. In this chapter, we discuss only the IDE features we need to build the `Welcome` app. We’ll introduce more IDE features throughout the book.

**Project** window displays the project's files in the **app** node

Editor windows—like the layout and code editors—appear here

**Component Tree** with the currently selected item properties displayed in the **Properties** window



Collapsed window tabs—you can click a tab to expand the corresponding window

**Fig. 2.8** | Welcome project open in the Android Studio.

## 2.4.1 Project Window

The **Project** window provides access to all of the project's files. You can have many projects open in the IDE at once—each in its own window. Figure 2.9 shows the **Welcome** app project's contents in the **Project** window—we expanded the **res** folder and its nested **layout** folder. The **app** folder contains the files you'll edit to create your apps' GUIs and logic. The **app** folder's contents are organized into nested folders containing files. In this chapter, you'll use only files located in the **res** folder, which we discuss in Section 2.4.4—we'll discuss the other folders and files as we use them in later chapters.

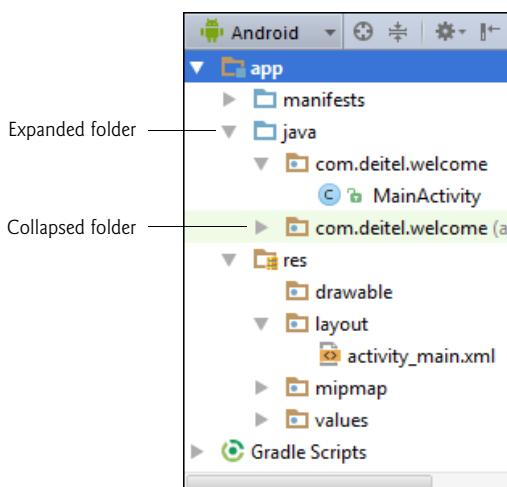


Fig. 2.9 | Project window.

### 2.4.2 Editor Windows

To the right of the Project window in Fig. 2.8 is the layout editor window. When you double click a file in the Project window, its contents are displayed in an appropriate editor window, depending on the file's type. For a Java file, the Java source-code editor is displayed. For an XML file that represents a GUI (such as `activity_main.xml`), the layout editor's **Design** tab is displayed by default and you can click the **Text** tab to view the corresponding XML side-by-side with a design preview—if the preview does not appear, you can view it by selecting **View > Tool Windows > Preview**. For other XML files, a custom XML editor or text-based XML editor is displayed, depending on the XML files' purposes. The code editors for Java and XML help you write code quickly and correctly via *code-completion*—as you type, you can press *Enter* (or *Return*) to auto-complete a Java code element or an XML element name, attribute name or value that is currently highlighted in the code-completion window.

### 2.4.3 Component Tree Window

When the layout editor is open in **Design** view, the **Component Tree** appears at the right side of the IDE (Fig. 2.8). This window shows the *layouts* and *views* (GUI components) that comprise the GUI and their parent-child relationships—for example, a layout (the parent) might contain many nested views (the children), including other layouts.

### 2.4.4 App Resource Files

Layout files like `activity_main.xml` are app resources and are stored in subfolders of the project's **res** folder. The subfolders contain different resource types. The ones we use in this app are shown in Fig. 2.10, and the others (`menu`, `animator`, `anim`, `color`, `mipmap`, `raw` and `xml`) are discussed as we need them later in the book.

| Resource subfolder | Description  |
|--------------------|--|
| drawable           | Folder names that begin with <code>drawable</code> typically contain images. These folders may also contain XML files representing shapes and other types of drawables (such as the images that represent a button's <i>unpressed</i> and <i>pressed</i> states).  |
| layout             | Folder names that begin with <code>layout</code> contain XML files that describe GUIs, such as the <code>activity_main.xml</code> file.  |
| values             | Folder names that begin with <code>values</code> contain XML files that specify values for <i>arrays</i> ( <code>arrays.xml</code> ), <i>colors</i> ( <code>colors.xml</code> ), <i>dimensions</i> ( <code>dimens.xml</code> )—values such as widths, heights and font sizes), <i>strings</i> ( <code>strings.xml</code> ) and <i>styles</i> ( <code>styles.xml</code> ). These file names are used by convention but are <i>not</i> required—actually, you can place all resources of these types in <i>one</i> file. It's considered good practice to define the data from hard-coded arrays, colors, sizes, strings and styles as <i>resources</i> so they can be modified easily without changing the app's Java code. For example, if a <i>dimension resource</i> is referenced from many locations in your code, you can change the dimension's value in the resource file, rather than search for every occurrence of a hard-coded dimension value in your app's Java source files. |

**Fig. 2.10** | Subfolders of the project's `res` folder that are used in this chapter.

## 2.4.5 Layout Editor

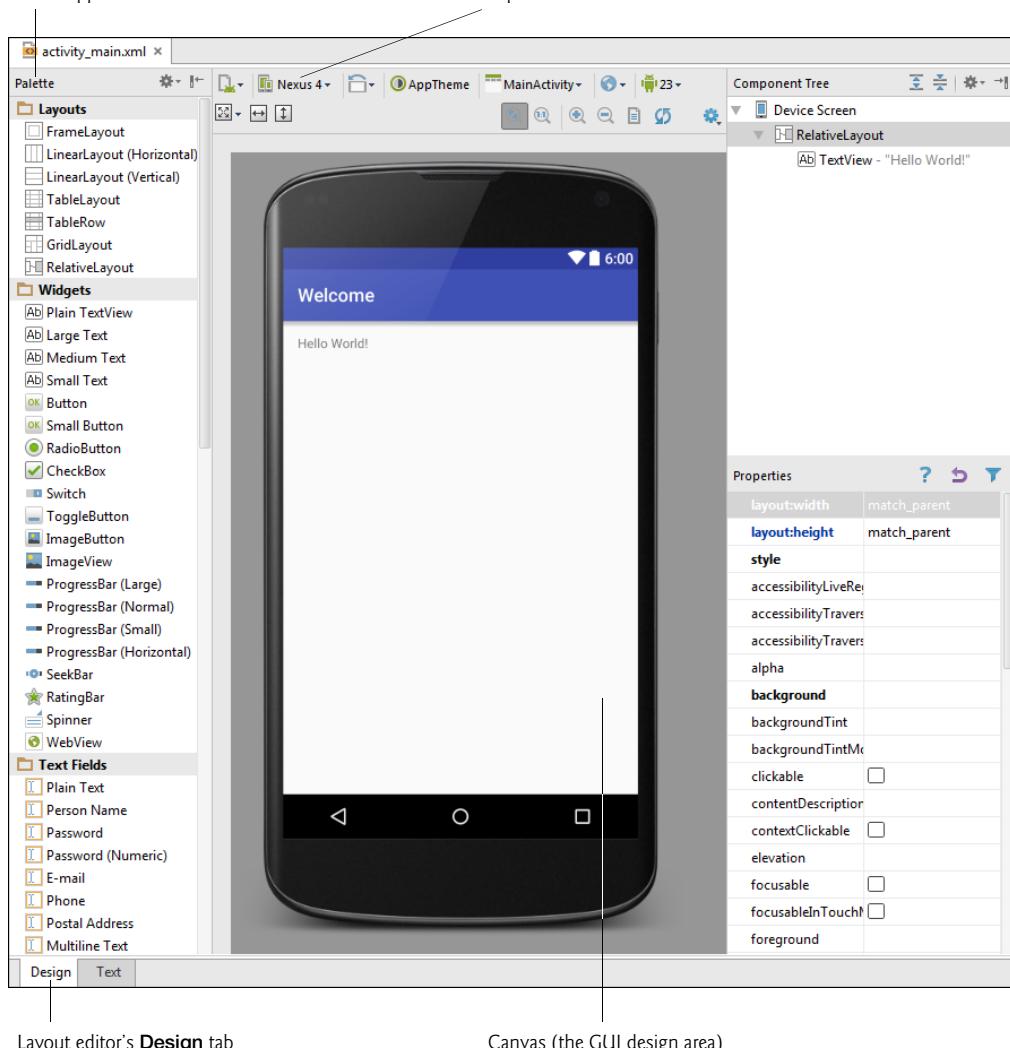
When you first create a project, the IDE opens the app's `activity_main.xml` file in the layout editor (Fig. 2.11). You also can double click `activity_main.xml` in the `res/layout` folder to open the file in the layout editor.

### Selecting the Screen Type for GUI Design

Android devices can run on many types of devices. In this chapter, you'll design an Android phone GUI. As we mentioned in the Before You Begin section, we use an AVD that emulates the Google Nexus 6 phone for this purpose. The layout editor comes with many device configurations that represent various screen sizes and resolutions that you can use to design your GUI. For this chapter, we use the predefined **Nexus 6**, which you can select in the virtual-device drop-down at the top of the layout editor in Fig. 2.11—**Nexus 4** is selected by default. This does not mean that the app can execute only on a Nexus 6 device—it simply means that the design is for devices similar in screen size and resolution to the Nexus 6. In later chapters, you'll see how to design your GUIs to scale appropriately for a wide range of devices.

The **Palette** contains **Widgets** (views), **Layouts** and other items that can be dragged and dropped onto the canvas

The virtual device drop-down lists devices you can use to design your GUI—select **Nexus 6** for this chapter



**Fig. 2.11** | Layout editor view of the app's default GUI.

## 2.4.6 Default GUI

The default GUI for a **Blank Page** app (Fig. 2.11) consists of a **RelativeLayout** with a white background and a **TextView** containing "Hello World!". A **RelativeLayout** arranges views *relative to one another or relative to the layout itself*—for example, you can specify that one view should appear *below* another and be *centered horizontally* within the **RelativeLayout**. For the **Welcome** app, you'll change the **RelativeLayout** to a vertical **LinearLayout** in which text and an image will be arranged top-to-bottom on the screen

and each will occupy half the layout's height. A `TextView` displays text. You'll add an `ImageView` to display the image. We'll say more about each of these in Section 2.5.

### 2.4.7 XML for the Default GUI

As we mentioned previously, the file `activity_main.xml` contains the GUI's XML representation. Figure 2.12 shows the initial XML. We reduced the amount of indentation in the default XML for book-publication purposes. You'll edit this XML directly to change the `RelativeLayout` to a `LinearLayout`.

---

```
1 <?xml version="1.0" encoding="utf-8"?>
2 <RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
3     xmlns:tools="http://schemas.android.com/tools"
4     android:layout_width="match_parent"
5     android:layout_height="match_parent"
6     android:paddingBottom="@dimen/activity_vertical_margin"
7     android:paddingLeft="@dimen/activity_horizontal_margin"
8     android:paddingRight="@dimen/activity_horizontal_margin"
9     android:paddingTop="@dimen/activity_vertical_margin"
10    tools:context=".MainActivity">
11
12    <TextView
13        android:layout_width="wrap_content"
14        android:layout_height="wrap_content"
15        android:text="@string/hello_world" />
16
17 </RelativeLayout>
```

---

**Fig. 2.12** | Initial contents of the project's `activity_main.xml` file.

The attribute values that begin with @, such as

```
@dimen/activity_vertical_margin
```

in line 6, are *resources* with values defined in other files. By default, the XML editor displays a resource's literal value (16dp for the resource in line 6) and highlights the value with a light green background (or light gray, if you're using the dark Android Studio theme). This enables you to see the resource's actual value that's used in a particular context. If you click the literal value (16dp for `@dimen/activity_vertical_margin`), the editor instead displays the corresponding resource name.

## 2.5 Building the App's GUI with the Layout Editor

You'll now create the `Welcome` app's GUI. The IDE's layout editor allows you to build your GUI by dragging and dropping views—such as `TextViews`, `ImageViews` and `Buttons`—onto the layout editor. By default, the GUI layout for an app based on the `Empty Activity` template is stored in an XML file called `activity_main.xml`, located in the project's `res` folder in the `layout` subfolder. In this chapter, we'll use the layout editor and the `Component Tree` window to build the GUI. You'll edit the XML in `activity_main.xml` only to change the layout used to arrange this app's `TextView` and `ImageView`.

### 2.5.1 Adding an Image to the Project

For this app, you'll need to add an image to the project. We'll use the Deitel bug logo<sup>1</sup> image (`bug.png`), which is located with the book's examples in the `images` folder's `Welcome` subfolder. File names for image resources—and all the other resources you'll use in later chapters—must be in all *lowercase* letters.

#### **drawable Folders**

Android devices have various *screen sizes*, *resolutions* and *pixel densities* (that is, dots per inch or DPI), so you typically provide images in various resolutions that the operating system chooses based on a device's pixel density. These are placed in `drawable` folders (in a project's `res` folder) that store images with different pixel densities (Fig. 2.13). For example, images for devices that are similar in pixel density to the Google Nexus 6 phone (560 dpi) we use in our phone AVD would be placed in the folder `drawable-xxxhdpi`. Images for devices with lower pixel densities are placed in the other `drawable` folders—normally the folder that represents the closest pixel density to the actual device.

| Density                       | Description   |
|-------------------------------|---|
| <code>drawable-ldpi</code>    | <i>Low density</i> —approximately 120 dots-per-inch.                    |
| <code>drawable-mdpi</code>    | <i>Medium density</i> —approximately 160 dots-per-inch.                 |
| <code>drawable-hdpi</code>    | <i>High density</i> —approximately 240 dots-per-inch.                   |
| <code>drawable-xhdpi</code>   | <i>Extra-high density</i> —approximately 320 dots-per-inch.             |
| <code>drawable-xxhdpi</code>  | <i>Extra-Extra-high density</i> —approximately 480 dots-per-inch.       |
| <code>drawable-xxxhdpi</code> | <i>Extra-Extra-Extra-high density</i> —approximately 640 dots-per-inch. |

**Fig. 2.13** | Android pixel densities.

Android Studio displays only one `drawable` folder containing the app's `drawable` resources, even if your project contains resources for multiple densities. For a resource stored in the project's folder `drawable-xxxhdpi` on disk, Android Studio displays

`filename.xml (xxxhdpi)`

in the project's `drawable` folder.

For this app, we provide only one version of the image. If Android cannot find an image in the `drawable` folder that most closely matches the device's pixel density, Android will scale the version from another `drawable` folder up or down as necessary. By default, Android Studio creates only a `drawable` folder without a DPI qualifier, which we'll use for this initial app. For detailed information on supporting multiple screens and screen sizes in Android, visit:

[http://developer.android.com/guide/practices/screens\\_support.html](http://developer.android.com/guide/practices/screens_support.html)

- 
1. Before you use any image in an app, you should ensure that you've properly licensed the image. Some image licenses require you to pay for the right to use an image and others provide free open-source or Creative Commons ([creativecommons.org](http://creativecommons.org)) licenses.



### Look-and-Feel Observation 2.1

*Low-resolution images do not scale well. For images to render nicely, a high-pixel-density device needs high-resolution images than a low-pixel-density device.*

#### **Adding bug.png to the Project**

Perform the following steps to add the images to this project:

1. In the **Project** window, expand the project's **res** folder.
2. In the book's examples folder on your file system, open the **images** folder, then the **Welcome** subfolder.
3. Copy the **bug.png** file, then in Android Studio's **Project** window select **res** folder's **drawable** subfolder and paste the file into that subfolder.
4. In the **Copy** dialog that appears, click **OK**.

The image can now be used in the app.

#### **2.5.2 Adding an App Icon**

When your app is installed on a device, its icon and name appear with all other installed apps in the launcher, which you can access via the  icon on your device's home screen. To add the app's launcher icon, right click the **res** folder, then select **New > Image Asset**. This will open the **Asset Studio** window (Fig. 2.14), which enables you to configure the app's icon from an existing image, a piece of clip art or text.

For this app, we chose the **DeitelOrange.png** image located in the **images** folder with the book's examples. To use this image:

1. Click the ellipsis button to the right of the **Image file:** field.
2. Navigate to the **images** folder in the book's examples folder.
3. Select **DeitelOrange.png** and click **OK**. Previews of the scaled images are shown in the dialog's **Preview** area.
4. Click **Next**, then click **Finish**.

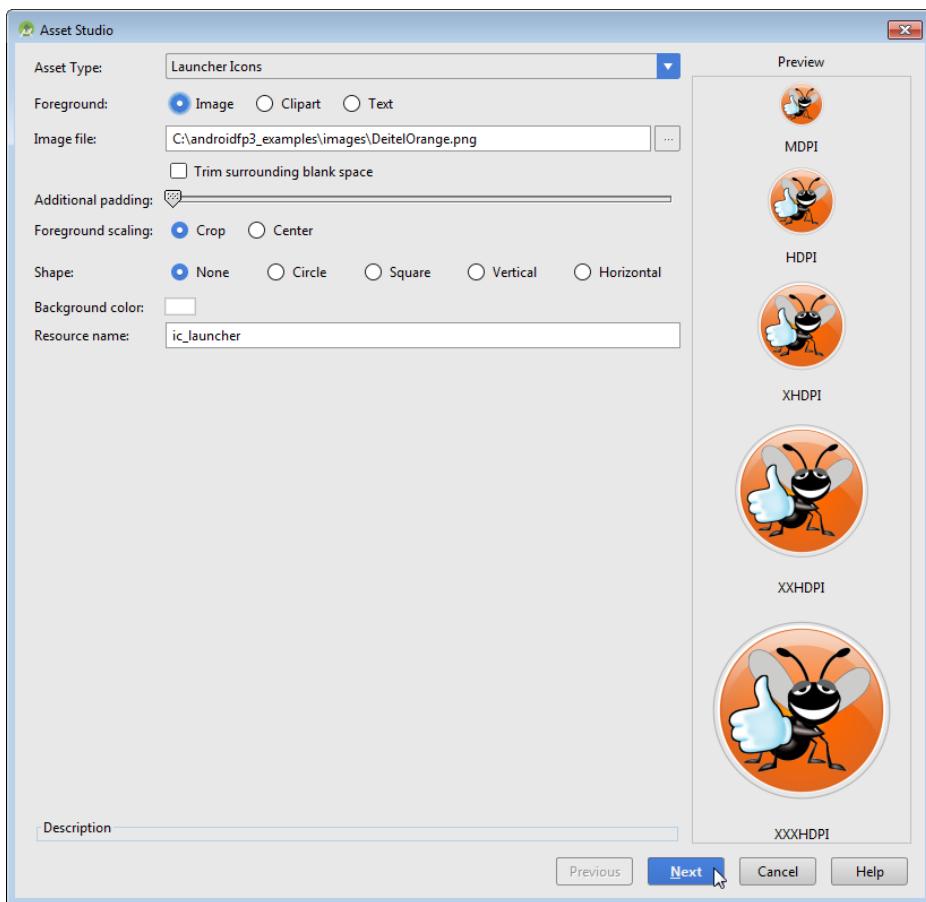
The IDE creates several scaled versions of the image, each named **ic\_launcher.png**, and places them in the project's **mipmap<sup>2</sup>** subfolders of the **res** folder. The **mipmap** subfolders are similar to the **drawable** subfolders, but are specifically for the app's icon. When you upload an app to Google Play, you can upload multiple versions of the app for various device sizes and screen resolutions. All images in the **mipmap** folders are uploaded with every versions of your app, whereas you can remove extra **drawable** folders for specific pixel densities from a given app version to minimize the total installation size for a particular device.



### Look-and-Feel Observation 2.2

*Images do not always scale well. For apps that you intend to place in the Google Play store, you might want to have an artist design icons for the appropriate resolutions. In Chapter 10, we discuss submitting apps to the Google Play store and list several companies that offer free and fee-based icon-design services.*

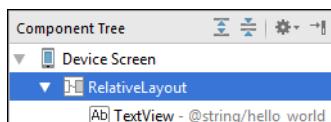
2. For the origin of the term *mipmap*, see <https://en.wikipedia.org/wiki/Mipmap>.



**Fig. 2.14** | Configuring the launcher icon in the **Asset Studio** window.

### 2.5.3 Changing RelativeLayout to a LinearLayout

When you open a layout XML file, the layout's design appears in the layout editor and the layout's views and their hierarchical relationships appear in the **Component Tree** window (Fig. 2.15). To configure a layout or view, you can select it in the layout editor or in the **Component Tree**, then use the **Properties** window below the **Component Tree** to specify the view's property values without editing the XML directly. When designing and modifying more complex layouts, it's often easier to work directly in the **Component Tree**.

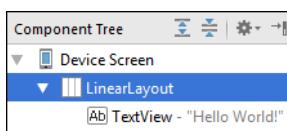


**Fig. 2.15** | Hierarchical GUI view in the **Component Tree** window.

For some GUI modifications—such as changing the default `RelativeLayout` to a `LinearLayout`—you must edit the layout's XML directly. (This might change as Google improves the layout editor's capabilities.) To do so:

1. Click the `Text` tab at the bottom of the layout editor to switch from the `Design` view to the layout's XML text.
2. At the top of the XML (line 2 in Fig. 2.12), double click the XML element name `RelativeLayout` to select it, then start typing `LinearLayout`.
3. As you type in line 2, the IDE edits the corresponding ending XML tag (line 17 in Fig. 2.12) simultaneously to keep them in sync, and a code-completion window appears containing element names that begin with the letters you've typed so far. Once `LinearLayout` appears in the code-completion window and is highlighted, press *Enter* (or *Return*) to select `LinearLayout` and enable Android Studio to auto-complete the edit.
4. Save the changes and switch back to the layout editor's `Design` tab.

The **Component Tree** should now appear as in Fig. 2.16.



**Fig. 2.16** | Component Tree after changing from a `RelativeLayout` to a `LinearLayout`.

## 2.5.4 Changing the `LinearLayout`'s `id` and `orientation`

In this section, you'll customize the `LinearLayout`'s properties. In general, give each layout and component a relevant name. This helps you easily identify each view in the **Component Tree** and enables you to manipulate the views programmatically, as we'll do in subsequent apps.

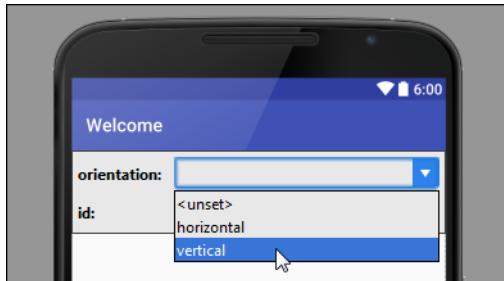
When a GUI is displayed in the layout editor, you can use the **Properties** window below the **Component Tree** (Fig. 2.8) to configure the selected view's properties. You also can edit a view's most commonly used properties (as you'll do in this section) by double clicking the view in the canvas. The layout editor then displays a small dialog in which you can set the view's `id` property and other properties that depend on the specific view:

- For a `LinearLayout`, you can set the `orientation` to specify whether the layout's children are arranged in `horizontal` or `vertical` orientation.
- For a `TextView`, you can set the `text` that's displayed.
- For an `ImageView`, you can set the `src` (source) of the image to display.

### Setting the `LinearLayout`'s `orientation` and `id` Properties

To change the `LinearLayout`'s `orientation`, double click the virtual phone screen's white background in the layout editor to display the dialog of common `LinearLayout` properties, then select `vertical` from the `orientation`: drop-down as shown in Fig. 2.17. This sets the property's value and dismisses the dialog. A view's name is defined by setting its `id`

**property**, which is specified in the layout's XML with the attribute `android:id`. Double click the virtual phone screen's white background, enter the name `welcomeLinearLayout` in the `id:` field, then press *Enter* (or *Return*) to set the value and dismiss the dialog.



**Fig. 2.17** | Setting the `LinearLayout`'s `orientation`.

### The `id` Property's XML Representation

In the layout's XML representation—viewable via the `Text` tab at the bottom of the layout editor—the `LinearLayout`'s `android:id` has the value:

```
@+id/welcomeLinearLayout
```

The `+` in the syntax `@+id` indicates that a *new id* should be created with the identifier to the right of the forward slash (`/`). In some cases, the XML contains the same syntax without the `+` to refer to an existing view—for example, to specify the relationships between views in a `RelativeLayout`.

### 2.5.5 Configuring the `TextView`'s `id` and `text` Properties

The `Welcome` app's default GUI already contains a `TextView`, so you'll simply modify its properties.

#### Setting the `TextView`'s `id` Property

Double click the `TextView` in the layout editor, then in the dialog that appears set the `id:` to `welcomeTextView` and press *Enter* (or *Return*).

#### Configuring the `TextView`'s `text` Property Using a String Resource

According to the Android documentation for application resources

```
http://developer.android.com/guide/topics/resources/index.html
```

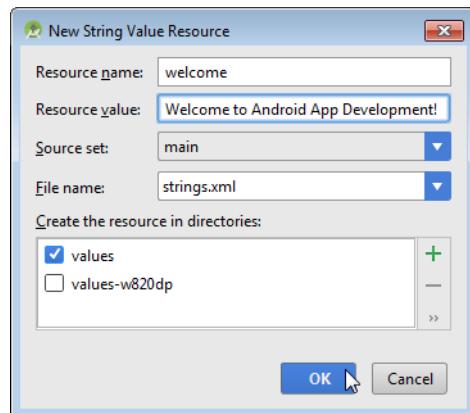
it's considered good practice to place strings, string arrays, images, colors, font sizes, dimensions and other app resources in XML files within the subfolders of the project's `res` folder, so these resources can be managed separately from your app's Java code. This is known as *externalizing* the resources. For example, if you externalize color values, all components that use the same color can be updated to a new color simply by changing the color value in a central resource file.

If you wish to *localize* your app in several languages, storing the strings *separately* from the app's code allows you to change them easily. In your project's `res` folder, the subfolder

values contains a `strings.xml` file that's used to store the app's default language strings—English for our apps. To provide localized strings for other languages, you can create separate `values` folders for each language, as we'll demonstrate in Section 2.8.

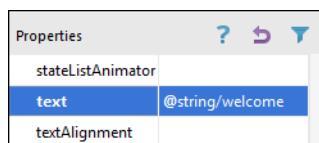
To set the `TextView`'s `text` property, create a new string resource in the `strings.xml` file as follows:

1. Either double click the `welcomeTextView` in the layout editor or select `welcomeTextView` and locate its `text` property in the **Properties** window
2. Click the ellipsis (...) button to the right of the property's value to display the **Resources** dialog.
3. In the **Resources** dialog, click **New Resource**, then select **New String Value...** to display the **New String Value Resource** dialog and fill the **Resource name:** and **Resource value:** fields as shown in Fig. 2.18. Leave the other settings (we'll discuss these in later sections and apps) and click **OK** to create the new string resource named `welcome` and set it as the value of the `TextView`'s `text` property.



**Fig. 2.18** | New String Value Resource dialog.

In the **Properties** window, the `text` property should now appear as in Fig. 2.19. The `@string/` prefix indicates that a string resource will be used to obtain the value for the `text` property and `welcome` indicates the specific string resource to use. By default, the resource is placed in the `strings.xml` file (located in the project's `res/values` folder).



**Fig. 2.19** | Properties window after changing the `TextView`'s `text` property.

## 2.5.6 Configuring the TextView's textSize Property—Scaled Pixels and Density-Independent Pixels

Sizes can be specified in various measurement units (Fig. 2.20). The documentation for supporting multiple screen sizes recommends that you use *density-independent pixels* for dimensions of views and other screen elements, and *scale-independent pixels* for font sizes:

[http://developer.android.com/guide/practices/screens\\_support.html](http://developer.android.com/guide/practices/screens_support.html)

| Unit      | Description               | Unit | Description |
|-----------|---------------------------|------|-------------|
| px        | pixel                     | in   | inches      |
| dp or dip | density-independent pixel | mm   | millimeters |
| sp        | scale-independent pixel   |      |             |

**Fig. 2.20** | Measurement units.

Defining your GUIs with **density-independent pixels** enables the Android platform to *scale* the GUI, based on the pixel density of a given device's screen. One *density-independent pixel* is equivalent to one pixel on a 160-dpi screen. On a 240-dpi screen, each density-independent pixel will be scaled by a factor of 240/160 (i.e., 1.5). So, a component that's 100 *density-independent pixels* wide will be scaled to 150 *actual pixels* wide. On a screen with 120 dpi, each density-independent pixel is scaled by a factor of 120/160 (i.e., 0.75). So, the same component that's 100 density-independent pixels wide will be 75 actual pixels wide. **Scale-independent pixels** are scaled like density-independent pixels, but they're also scaled by the user's *preferred font size* (as specified in the device's settings).

### Creating a Dimension Resource for the Font Size on a Phone Device

You'll now increase the TextView's font size. To change the font size:

1. Select the `welcomeTextView` in the layout editor.
2. Locate the **textSize** property, then click in the right column to reveal the ellipsis (...) button and click the button to display the **Resources** dialog.
3. In the **Resources** dialog, click **New Resource**, then select **New Dimension Value...** to display the **New Dimension Value Resource** dialog.
4. In the dialog that appears, specify `welcome_textsize` for the **Resource name** and `40sp` for the **Resource value**, then click **OK** to dismiss the dialog and return to the **Resources** dialog. The letters `sp` in the value `40sp` indicate that this is a scale-independent pixel measurement. The letters `dp` in a dimension value (e.g., `10dp`) indicate a density-independent pixel measurement. We used the value `40sp` for displaying text on a phone.

In the **Properties** window, the **textSize** property now contains the value:

```
@dimen/welcome_textsize
```

The `@dimen/` prefix indicates that the **textSize** property's value is a dimension resource and `welcome_textsize` indicates the specific dimension resource to use. By default, the resource is placed in the `dimens.xml` file—located in the project's `res/values` folder.

### ***Creating a Dimension Resource for the Font Size on a Large Tablet Device***

The 40sp font size works well for phone-sized devices, but is small for tablets. Android can automatically choose different resource values based on device sizes, orientations, pixel densities, spoken languages, locales and more. To specify a separate font size for larger devices such as tablets:

1. Reopen the **New Dimension Value Resource** dialog as described above.
2. Enter `welcome_textsize` for the **Resource name** (the resource names must match for Android to select different resource values automatically) and enter `80sp` for the **Resource value**.
3. Next, you'll create a new `values` resource folder that's specific to larger devices such as tablets that have widths and heights that are each *at least* `600dp`. In the **New Dimension Value Resource** dialog, uncheck the `values` checkbox, and click the **Add** button (+) to open the **New Resource Directory** dialog. In this dialog's **Available qualifiers** list, select **Screen Width**, then click the **>>** button to add the screen **Screen Width** qualifier to the **Chosen qualifiers** list. Next, enter `600` in the **Screen width** field.
4. Next, add the **Screen Height** qualifier to the **Chosen qualifiers** list and enter `600` for the **Screen height**.
5. Click **OK** to create a new resource folder named `values-xlarge`.
6. In the **New Dimension Value Resource** dialog, check the `values-w600dp-h600dp` checkbox, then click **OK**. This creates another `welcome_textsize` dimension resource in a `dimens.xml` file that's stored on disk in the project's `res/values-w600dp-h600dp` folder. Android will use that resource for devices with extra-large screen widths and heights that are at least `600dp`, typical of most Android tablets. The new `dimens.xml` resource file appears in Android Studio in the project's `res/values/dimens.xml` node as

`dimens.xml (w600dp-h600dp)`

### **2.5.7 Setting the TextView's textColor Property**

When you need custom colors in your apps, Google's Material Design guidelines recommend using colors from the Material Design color palette at:

<http://www.google.com/design/spec/style/color.html>

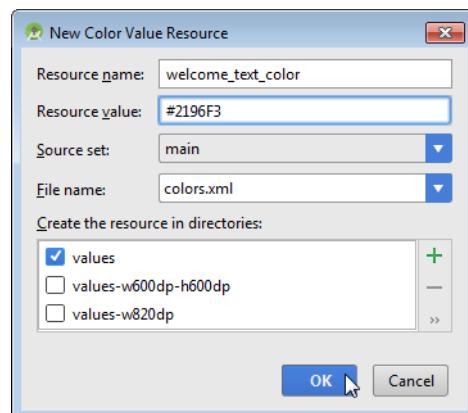
Colors are specified as RGB (red-green-blue) or ARGB (alpha-red-green-blue) values. An RGB value consists of integer values in the range 0–255 that define the amounts of red, green and blue in the color, respectively. Custom colors are defined in *hexadecimal* format, so the RGB components are values in the range 00 (the hexadecimal value for 0) to FF (the hexadecimal value for 255).

Android also supports alpha (transparency) values in the range 00 (completely transparent) to FF (completely opaque). To use alpha, you specify the color as `#AARRGGBB`, where the first two hexadecimal digits represent the alpha value.

If both digits of each color component are the same, you can use the abbreviated value formats `#RGB` or `#ARGB`. For example, the RGB value `#9AC` is equivalent to `#99AAC` and the ARGB value `#F9AC` is equivalent to `FF99AAC`.

To set the `TextView`'s **textColor** property to a new color resource:

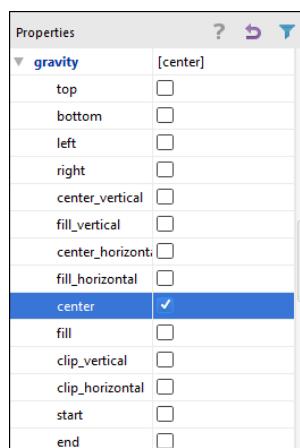
1. In the **Properties** window click the ellipsis (...) button to display the **Resources** dialog, then click **New Resource** and select **New Color Value....**
2. In the **New Color Value Resource** dialog, enter `welcome_text_color` for the **Resource name** and `#2196F3` for the **Resource value** (Fig. 2.21), then click **OK**.



**Fig. 2.21** | Creating a New Color Value Resource for the `TextView`'s **textColor** property.

### 2.5.8 Setting the `TextView`'s **gravity** Property

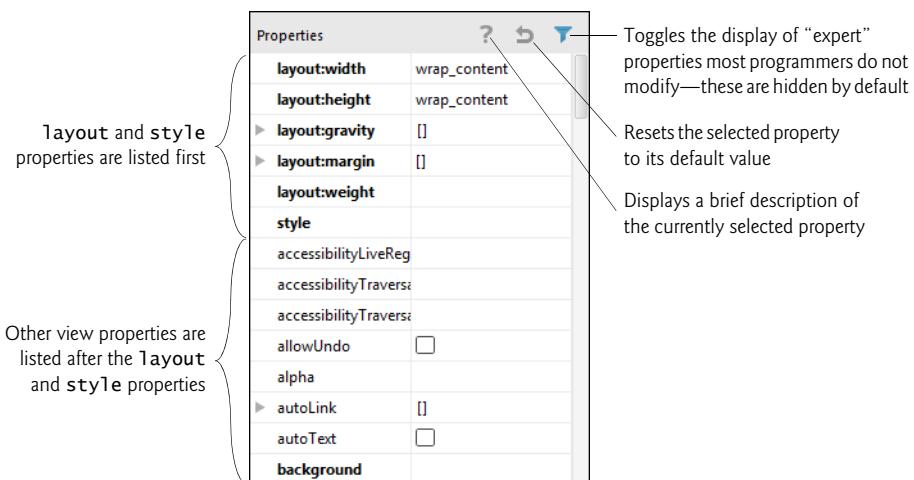
To center the text in the `TextView` if it wraps to multiple lines, you can set its **gravity** property to center. To do so, expand the node for this property, then check the **center** checkbox (Fig. 2.22).



**Fig. 2.22** | Options for the **Gravity** property of a `TextView`.

### 2.5.9 Setting the TextView's layout:gravity Property

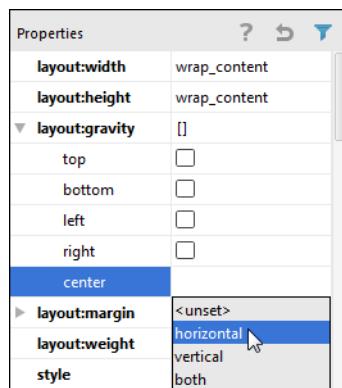
Each view you place in a layout has various layout properties that enable you to customize the view's size and positioning within the layout. When you select a view in the layout editor or Component Tree, the Properties window lists the layout and style properties at the top, followed by the view-specific properties in alphabetical order (Fig. 2.23).



**Fig. 2.23** | Properties window showing layout and style properties at the top.

In this app, we'd like to center the TextView horizontally within the LinearLayout. To do this, you'll set its **layout:gravity** property to center horizontally as follows:

1. With the TextView selected, expand the layout:gravity property's node in the Properties window.
2. Click the value field to the right of the center option that appears, then select the horizontal option (Fig. 2.24).



**Fig. 2.24** | Setting the layout:gravity for the TextView.

In the layout XML file, layout properties have attribute names that begin with `layout_`. The preceding `layout:gravity` property setting is represented in XML as:

```
android:layout_gravity="center_horizontal"
```

### 2.5.10 Setting the `TextView`'s `layout:weight` Property

A `LinearLayout` can proportionally size its children based on their `layout:weights`, which specify the view's relative size with respect to the layout's other views. By default, the `layout:weight` is 0 for each view you add to a `LinearLayout`, indicating that the view should not be proportionally sized.

In this app, we'd like the `TextView` and `ImageView` to each occupy half of the `LinearLayout`'s vertical space. You accomplish this by setting each view's `layout:weight` to the same value. The `LinearLayout` uses the ratio of each view's `layout:weight` to the total `layout:weight` to allocate space to the views. In this app, you'll set the `layout:weight` to 1 for both the `TextView` and `ImageView` (Section 2.5.11)—the total `layout:weight` will be 2 and each view will occupy 1/2 the layout's height.

If you wanted the `TextView` to occupy one-third of the `LinearLayout`'s height, you could set its `layout:weight` to 1 and the `ImageView`'s `layout:weight` to 2. In this case, the total `layout:weight` is 3, so the `TextView` would occupy 1/3 the height and the `ImageView` 2/3 the height.

Set the `TextView`'s `layout:weight` to 1. The layout editor displays a light bulb (💡) icon to the left of the `layout:height` property—if it does not do so immediately, click the `layout:height` property in the **Properties** window. These icons—generated by a tool in the IDE known as *Android Lint*—warn you of potential problems and help you fix them. When you click the light bulb, the IDE displays the message, “Use a `layout_height` of `0dp` instead of `wrap_content` for better performance.” Click the message to apply the recommendation. This change enables the `LinearLayout` to calculate its children's sizes more efficiently. The layout editor window should now appear as shown in Fig. 2.25.



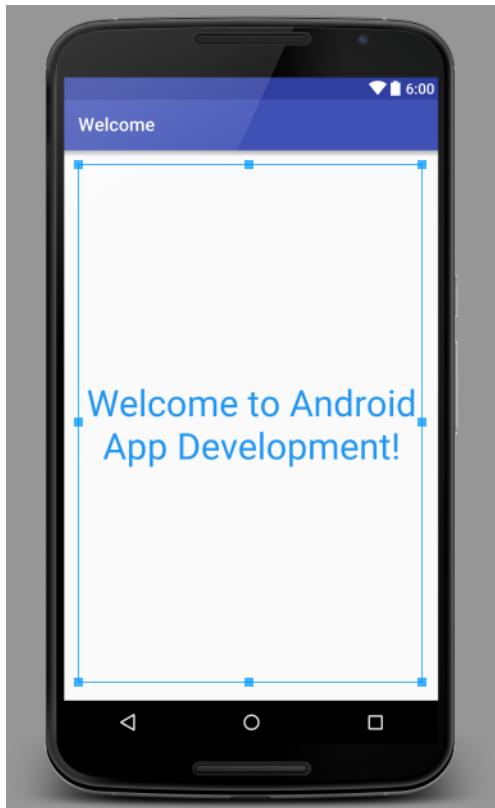
#### Error-Prevention Tip 2.2

*Android Lint checks your project for common errors, and makes suggestions for better security, enhanced performance, improved accessibility, internationalization and more. Some checks occur as you build your apps and write code. You also can select Analyze > Inspect Code... to perform additional checks on specific files or your entire project. For more information, visit <http://developer.android.com/tools/help/lint.html>. For Android Lint's configuration options and output, see <http://developer.android.com/tools/debugging/improving-w-lint.html>.*

### 2.5.11 Adding an `ImageView` to Display the Image

Next, you'll add an `ImageView` to the GUI to display the image you added to the project in Section 2.5.1. You'll do this by dragging an `ImageView` from the **Palette**'s **Widgets** section onto the canvas below the `TextView`. When you drag a view onto the canvas, the layout editor displays orange guide lines, green guide lines and a tooltip:

- The *orange guide lines* show the bounds of each existing view in the layout.
- The *green guide lines* indicate where the new view will be placed with respect to the existing views—by default, new views are added at the bottom of a vertical



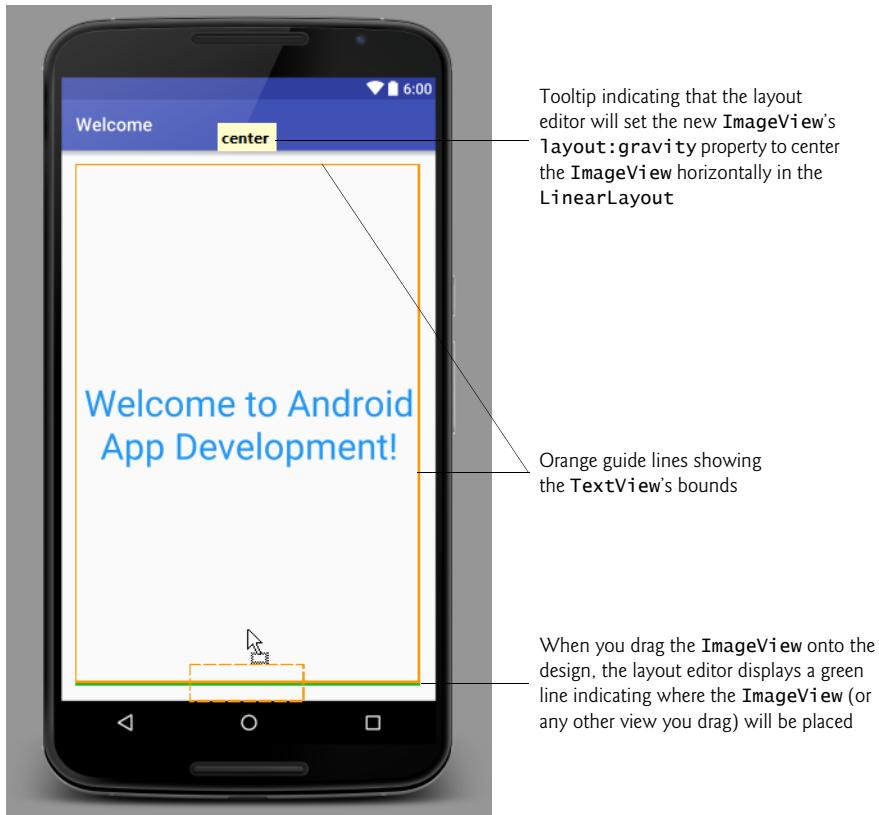
**Fig. 2.25** | Layout editor window after configuring the TextView.

LinearLayout, unless you position the mouse above the orange box that bounds the layout's topmost view.

- The *tooltip* displays how the view will be configured if you drop it at the current position.

To add and configure the ImageView:

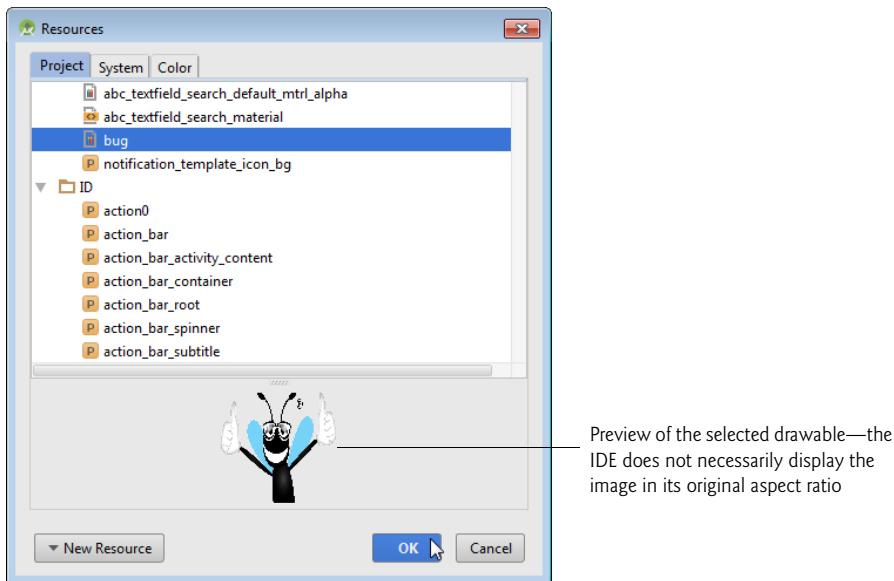
1. From the Palette's **Widgets** section, drag an ImageView onto the canvas as shown in Fig. 2.26. *Before releasing the mouse*, ensure that **center** appears in the tooltip at the top of the design—this indicates that the layout editor will set the ImageView's `layout:gravity` property to center the ImageView horizontally in the LinearLayout. When you drop the ImageView by releasing the mouse, the layout editor assumes that the ImageView's `layout:weight` should be the same as the TextView's and sets the `layout:weight` to 1. It also sets the `layout_height` to 0dp as we did for the TextView. The new ImageView appears below the TextView in the design and below `welcomeTextView` in the **Component Tree**. The ImageView's properties are displayed in the **Properties** window.



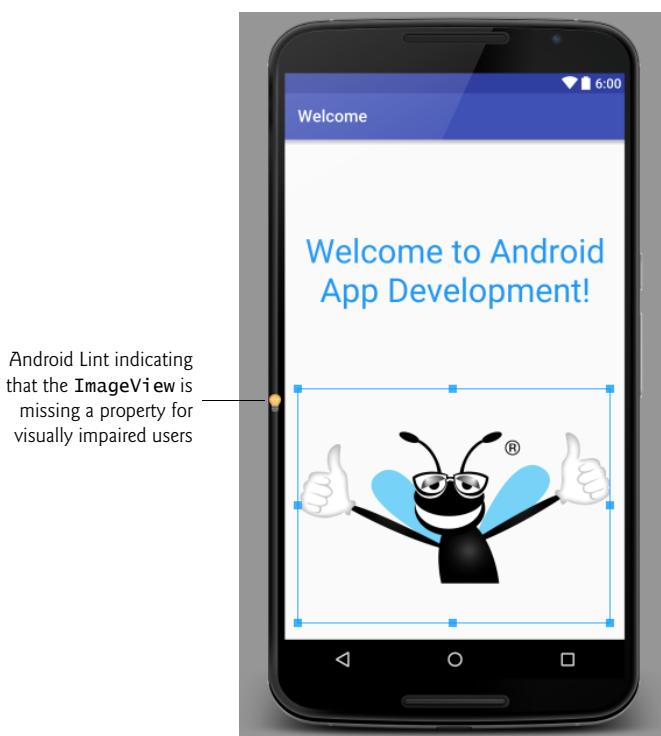
**Fig. 2.26** | Dragging and dropping an ImageView onto the GUI.

2. In the **Properties** window, locate the ImageView's `src` property (which specifies the image to display), then click its value field's ellipsis button to display the **Resources** dialog (Fig. 2.27). When the dialog opens, type `bug` to search the list of resources for the image you added in Section 2.5.1, then click **OK**. For every image you place in a `drawable` folder, the IDE generates a unique resource ID (i.e., a resource name) that you can use to reference that image. An image's resource ID is the image's file name without the file-name extension—`bug` for the `bug.png` file.
3. Double-click the ImageView in the layout editor and set its `id:` to `bugImageView`.

The GUI should now appear as in Fig. 2.28. If you select the ImageView in the layout editor, Android Lint displays a light bulb ( ) next to the ImageView—clicking this displays a message indicating that a property is missing for visually impaired users. You'll correct this in Section 2.7.



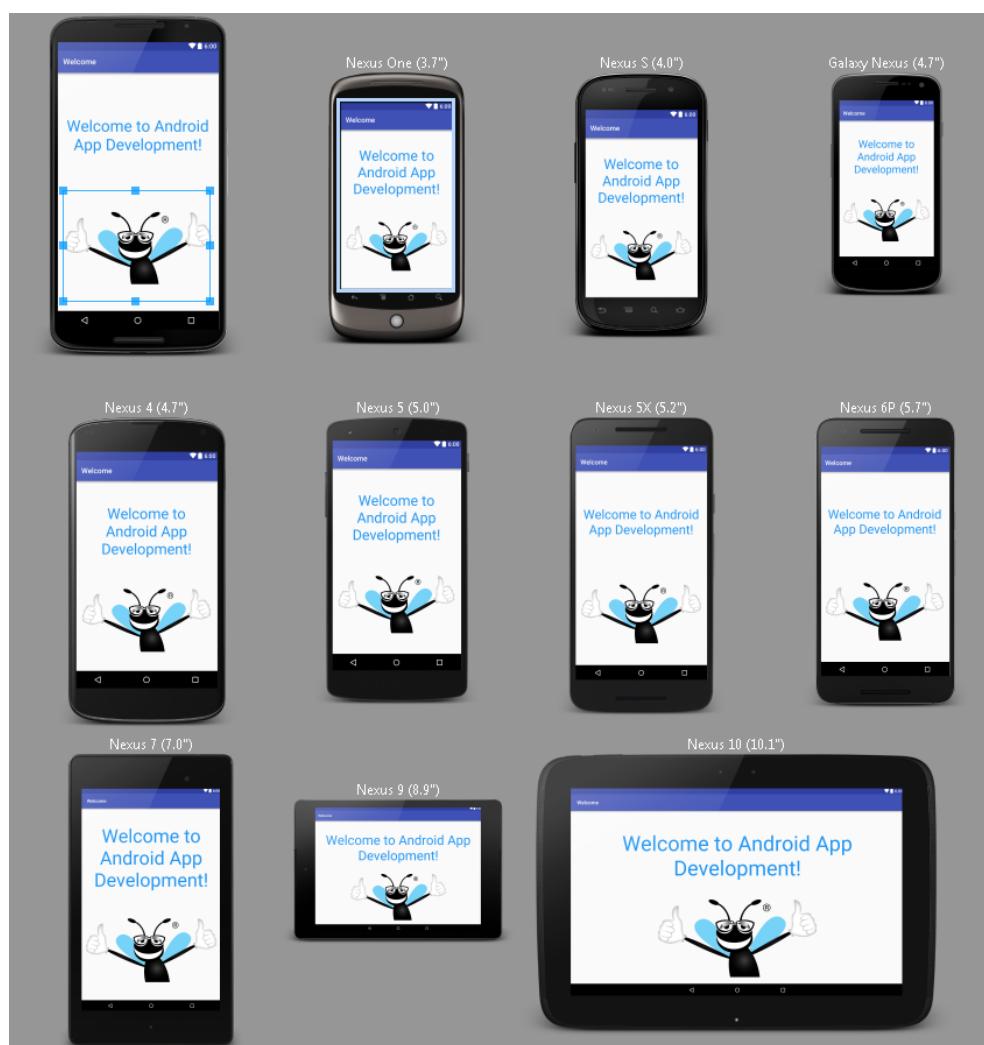
**Fig. 2.27** | Selecting the **bug** image resource from the **Resources** dialog.



**Fig. 2.28** | Preview of the completed design.

### 2.5.12 Previewing the Design

Android Studio also enables you to preview your design in landscape orientation and to preview your design for multiple devices. To toggle the design between portrait and landscape orientations, simply click the **Go to next state** button (☞) in the toolbar at the top of the layout editor. This helps you determine whether your design adjusts appropriately for each orientation. To preview the design for multiple devices, click the virtual device drop-down (Fig. 2.11) at the top of the layout editor, then select **Preview All Screen Sizes**. This displays miniature screens (Fig. 2.29) for many devices listed in the virtual device drop-down—some in portrait and some in landscape. These help you quickly determine whether your design works appropriately on various devices.

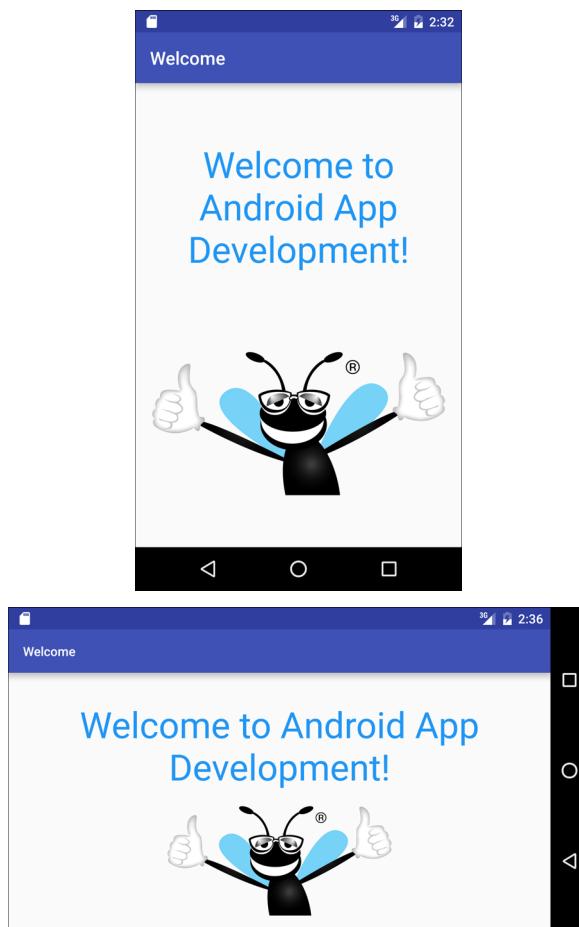


**Fig. 2.29** | Previewing various devices for the **Welcome** app's design.

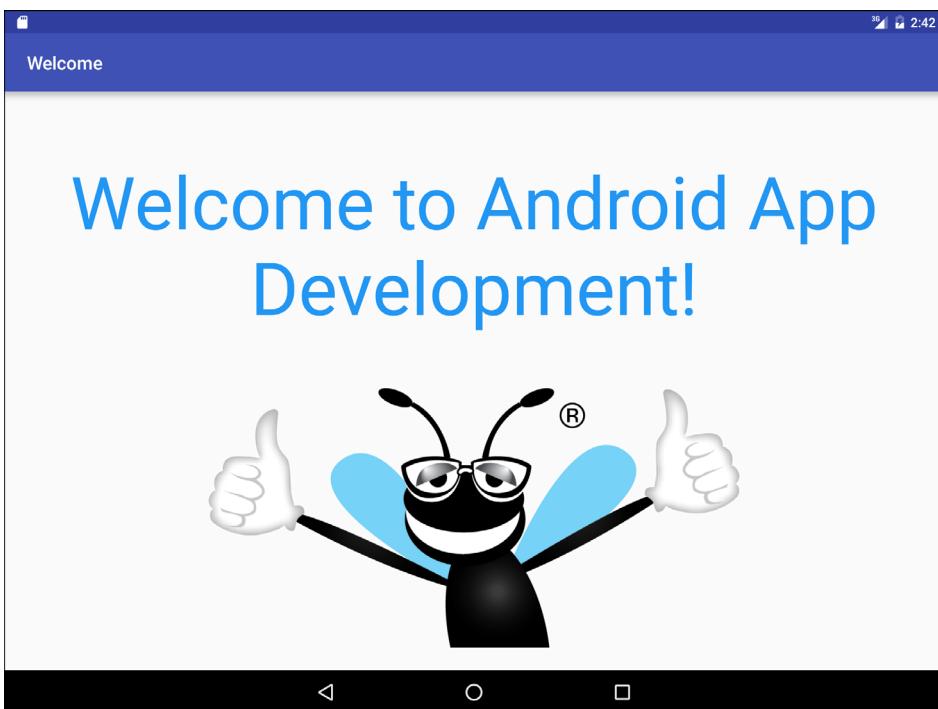
You can return to displaying one device by clicking the virtual device drop-down and selecting **Remove Previews**. You also can preview your design for a particular device by selecting that device in the virtual device drop-down.

## 2.6 Running the Welcome App

You're now ready to run the **Welcome** app. Perform the steps shown in Section 1.9.3 to run the app on the AVDs you configured previously for both the Nexus 6 phone and Nexus 9 tablet. Figures 2.30–2.31 show the app running in the Nexus 6 AVD (in portrait and landscape) and the Nexus 9 AVD (in landscape), respectively. You can toggle an AVD between portrait and landscape orientations by typing *Ctrl + F11* or *control + F11*. Typically, for apps that run on both phones and tablets, you'll also provide a tablet layout that makes better use of the screen's available space, as we'll demonstrate in later chapters. If you have an Android device, you can follow the steps in Section 1.9.4 to run the app on your device.



**Fig. 2.30** | **Welcome** app running in the Nexus 6 AVD.



**Fig. 2.31** | Welcome app running in the Nexus 9 AVD.

## 2.7 Making Your App Accessible

Android contains *accessibility* features to help people with certain disabilities use their devices. For people with visual disabilities, Android's TalkBack can speak screen text or text that you provide (when designing your GUI or programmatically) to help the user understand the purpose of a view. Android also provides *Explore by Touch*, which enables the user to hear TalkBack speak what's on the screen where the user touches.

When TalkBack is enabled and the user touches a view for which accessibility text is specified, the device vibrates to indicate that the user touched a significant view and TalkBack speaks the view's accessibility text. All standard Android views support accessibility. For those that display text, TalkBack speaks that text by default—e.g., when the user touches a `TextView`, TalkBack speaks the `TextView`'s text. You enable TalkBack in the `Settings` app under `Accessibility`. From that page, you also can enable other Android accessibility features such as a *larger default text size* and the ability to use *gestures that magnify areas of the screen*. TalkBack is *not* currently supported on AVDs, so you must run this app on a device to hear TalkBack speak the text. When you enable TalkBack, Android walks you through a tutorial on using TalkBack with Explore by Touch.

### *Enabling TalkBack for the `ImageViews`*

In the `Welcome` app, we don't need more descriptive text for the `TextView`, because TalkBack will read the `TextView`'s content. For an `ImageView`, however, there is no text for

TalkBack to speak unless you provide it. It's considered good practice in Android to ensure that *every* view can be used with TalkBack by providing text for the **contentDescription** property of any view that does not display text. For that reason, the IDE warned us that something was wrong by displaying a light-bulb icon (💡—as you saw in Fig. 2.28) in the layout editor next to the `ImageView`. If you click the light bulb, you'll see the message, “[Accessibility] Missing contentDescription attribute on image.” The text you provide should help the user understand the purpose of the component. For an `ImageView`, the text should describe the image.

To add the `ImageView`'s **contentDescription** (and eliminate the warning):

1. Select the `bugImageView` in the layout editor.
2. In the **Properties** window, click the ellipsis button to the right of the **contentDescription** property to open the **Resources** dialog.
3. Click **New Resource**, then select **New String Value...** to display the **New String Value Resource** dialog.
4. In the **Resource name** field specify `deitel_logo` and in the **Resource value** field specify “Deitel double-thumbs-up bug logo”, then press **OK**. The new string resource is chosen automatically as the **contentDescription** value.

After you set the `ImageView`'s **contentDescription**, the layout editor removes the warning light bulb.

### **Testing the App with TalkBack Enabled**

Run this app on a device with TalkBack enabled, then touch the `TextView` and `ImageView` to hear TalkBack speak the corresponding text.

### **Dynamically Created Views**

Some apps dynamically create views in response to user interactions. For such views, you can programmatically set the accessibility text. For more information on this and Android's other accessibility features, and for a checklist to follow when developing accessible apps, visit:

```
http://developer.android.com/design/patterns/accessibility.html  
http://developer.android.com/guide/topics/ui/accessibility
```

## **2.8 Internationalizing Your App**

To reach the largest possible audience, you should consider designing your apps so that they can be customized for various locales and spoken languages. Then, if you intend to offer your app, for example, in France, you would translate its resources (text, audio files, etc.) into French. You might also choose to use different colors, graphics and sounds based on the *locale*. For each locale, you'll have a separate, customized set of resources. When the user launches the app, Android automatically finds and loads the resources that match the device's locale settings. Designing an app so it can be customized is known as *internationalization*. Customizing an app's resources for each locale is known as *localization*.

### **2.8.1 Localization**

A key benefit of defining your string values as string resources (as we did in this app) is that you can easily *localize* your app by creating additional XML resource files for those

string resources in other languages. In each file, you use the same string-resource names, but provide the *translated* string. Android can then choose the appropriate resource file based on the device user's preferred language.

### 2.8.2 Naming the Folders for Localized Resources

The XML resource files containing localized strings are placed on disk in subfolders of the project's `res` folder. Android uses a special folder-naming scheme to automatically choose the correct localized resources—for example, the folder `values-fr` would contain a `strings.xml` file for French and the folder `values-es` would contain a `strings.xml` file for Spanish. You also can name these folders with region information—`values-en-rUS` would contain a `strings.xml` file for United States English and `values-en-rGB` would contain a `strings.xml` file for United Kingdom English. If localized resources are not provided for a given locale, Android uses the app's *default* resources—that is, those in the `res` folder's `values` subfolder. We discuss these alternative-resource naming conventions in more detail in later chapters.

### 2.8.3 Adding String Translations to the App's Project

Android Studio provides a **Translations Editor** for quickly and easily adding translations for existing strings in your app. Follow these steps to add translated strings to the project:

1. In the **Project** window, expand the `values` node, then open the `strings.xml` file.
2. In the editor's upper-right corner, click the **Open editor** link to open the **Translations Editor**.
3. In the upper-left corner of the **Translations Editor**, click the **Add Locale** button () , then select **Spanish (es)**—you can search for this entry by typing part of the language name or its abbreviation (es). After you select the locale in the list, a new `strings.xml (es)` file will be created and be placed in the `strings.xml` node in the **Project** window (the file is stored in a `values-es` folder on disk). The **Translations Editor** also displays a new column for the Spanish translations.
4. To add a Spanish translation for a given **String** resource, click the cell for the resource's **Spanish (es)** translation, then in the **Translation:** field at the bottom of the window enter the Spanish text. If a string should not be translated (for example, a string that's never displayed to the user), check the **Untranslatable** checkbox for that **String** resource. For the **Welcome** app, use the translations in Section 2.8.4.

Repeat the preceding steps for each language you wish to support.

### 2.8.4 Localizing Strings

In this app, the GUI contains one `TextView` that displays a string and one content-description string for the `ImageView`. These strings were defined as string resources in the `strings.xml` file. You can now provide the translated strings that will be stored in the new version of the `strings.xml` file. For this app, you'll replace the strings

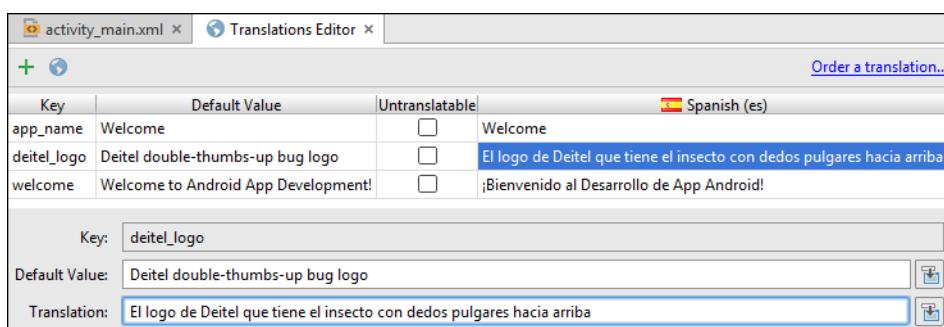
```
"Welcome to Android App Development!"  
"Deitel double-thumbs-up bug logo"
```

with the Spanish strings

```
"¡Bienvenido al Desarrollo de App Android!"  
"El logo de Deitel que tiene el insecto con dedos pulgares  
hacia arriba"
```

In the Translation Editor window:

1. Click the cell for the `welcome` resource **Spanish (es)** translation, then in the **Translation:** field at the bottom of the window enter the Spanish string "`¡Bienvenido al Desarrollo de App Android!`". If you cannot type special Spanish characters and symbols on your keyboard, you can copy the Spanish strings from our `res/values-es/strings.xml` file in the final version of the **Welcome** app (located in the **WelcomeInternationalized** folder with the chapter's examples), then paste the Spanish string into the **Translation:** field.
2. Next, click the cell for the `deitel_logo` resource's value and enter in the **Translation:** field "`El logo de Deitel que tiene el insecto con dedos pulgares hacia arriba`".
3. We chose not to translate the resource `app_name`, though we could have. The window should appear as in Fig. 2.32.
4. Save the Spanish `strings.xml` file by selecting **File > Save All** or clicking the **Save All** toolbar button (≡).



**Fig. 2.32** | Translations Editor window with the Spanish strings.

### 2.8.5 Testing the App in Spanish on an AVD

To test the app in Spanish on an AVD, you can use the **Custom Locale** app that's installed on the AVD.

1. Click the home (○) icon on your AVD.
2. Click the launcher (●) icon, then locate and click the **Custom Locale** app's icon to open it.
3. Drag the mouse to scroll to the `es - español` option, then click it and click the **SELECT 'ES'** button to change the AVD's locale.

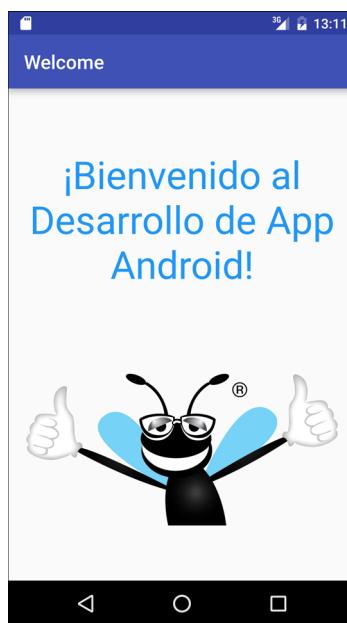
The emulator or device changes its language setting to Spanish.

Next, run the **Welcome** app, which installs and launches the localized app (Fig. 2.33). When the app begins executing, Android checks the AVD's (or device's) language settings, determines that the AVD (or device) is set to Spanish and uses the Spanish `welcome` and `deitel_logo` string resources defined in `res/values-es/strings.xml`. Notice, however, that the app's name still appears in *English* in the app bar at the top of the app. This is because we did *not* provide a localized version of the `app_name` string resource in the `res/values-es/strings.xml` file. If Android cannot find a localized version of a string resource, it uses the default version in the `res/values/strings.xml` file.

### **Returning the AVD to English**

To return your AVD to English:

1. Click the home (○) icon on your AVD.
2. Click the launcher (●) icon, then locate and click the **Custom Locale** app's icon to open it.
3. Drag the mouse to scroll to the **en-US - en-us** option, then click it and click the **SELECT 'EN-US'** button to change the AVD's locale.



**Fig. 2.33** | **Welcome** app running in Spanish in the Nexus 6 AVD.

### **2.8.6 Testing the App in Spanish on a Device**

To test on a device you must change the language settings for your device. To do so:

1. Touch the home (○) icon on your device.
2. Touch the launcher (●) icon, then locate and touch the **Settings** app (⚙️) icon.

3. In the **Settings** app, scroll to the **Personal** section, then touch **Language & input**.
4. Touch **Language** (the first item in the list), then select **Español (España)** from the list of languages.

The device changes its language setting to Spanish and returns to the **Language & input** settings, which are now displayed in Spanish. Run the app from the IDE to install and run the localized version on your device.

### *Returning Your Device to English*

To return your AVD (or Device) to English:

1. Touch the home (○) icon on the emulator or on your device.
2. Touch the launcher (☰) icon, then locate and touch the **Settings** app (⚙️) icon—the app is now called **Ajustes** in Spanish.
3. Touch the item **Idioma e introducción de texto** to access the language settings.
4. Touch the item **Idioma**, then in the list of languages select **English (United States)**.

### 2.8.7 TalkBack and Localization

TalkBack currently supports English, Spanish, Italian, French and German. If you run the **Welcome** app on a device with Spanish specified as the device’s language and TalkBack enabled, TalkBack will speak the app’s Spanish strings as you touch each view.

When you first switch your device to Spanish and enable TalkBack, Android will automatically download the Spanish text-to-speech engine. If TalkBack does *not* speak the Spanish strings, then the Spanish text-to-speech engine has not finished downloading and installing yet. In this case, you should try executing the app again later.

### 2.8.8 Localization Checklist

For more information on localizing your app’s resources, be sure to check out the *Android Localization Checklist* at:

<http://developer.android.com/distribute/tools/localization-checklist.html>

### 2.8.9 Professional Translation

App-development companies often have translators on staff or hire other companies to perform translations. In fact, in the Google Play Developer Console—which you use to publish your apps in the Google Play store—you can find translation-services companies, and in the **Translations Editor** window there is an **Order translations...** link. For more information on the Google Play Developer Console, see Chapter 10 and

<http://developer.android.com/distribute/googleplay/developer-console.html>

For more information regarding translation, see

<https://support.google.com/110n/answer/6227218>

## 2.9 Wrap-Up

In this chapter, you used Android Studio to build the **Welcome** app that displays a welcome message and an image without writing any code. You created a simple GUI using the IDE’s layout editor and configured view properties using the **Properties** window.

In the layout XML file, you changed the default `RelativeLayout` to a `LinearLayout`, which you then configured to arrange views vertically. The app displayed text in a `TextView` and a picture in an `ImageView`. You modified the `TextView` from the default GUI to display the app’s text centered in the GUI, with a larger font size and in one of the standard theme colors. You also used the layout editor’s **Palette** of GUI controls to drag and drop the `ImageView` onto the GUI. Following good practice, you defined all strings and numeric values in resource files in the project’s `res` folder.

You learned that Android has accessibility features to help people with certain disabilities use their devices. We showed how to enable Android’s TalkBack to allow a device to speak screen text or speak text that you provide to help the visually impaired user understand the purpose and contents of a view. We discussed Android’s Explore by Touch feature, which enables the user to touch the screen to hear TalkBack speak what’s on the screen near the touch. For the app’s `ImageViews`, you provided content descriptions that could be used with TalkBack and Explore by Touch.

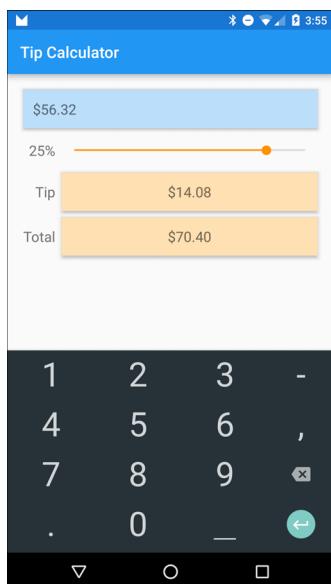
Finally, you learned how to use Android’s internationalization features to reach the largest possible audience for your apps. You localized the **Welcome** app with Spanish strings for the `TextView`’s text and the `ImageViews`’ accessibility strings, then tested the app on an AVD configured for Spanish.

Android development is a combination of GUI design and Java coding. In the next chapter, you’ll develop a simple **Tip Calculator** app by using the layout editor to develop the GUI visually and Java programming to specify the app’s behavior.

# 3

# Tip Calculator App

Introducing GridLayout, EditText, SeekBar, Event Handling, NumberFormat, Customizing the App's Theme and Defining App Functionality with Java



## Objectives

In this chapter you'll:

- Change the default GUI theme.
- Customize the GUI theme's colors.
- Design a GUI using a GridLayout.
- Use the IDE's **Component Tree** window to add views to a GridLayout.
- Use TextViews, an EditText and a SeekBar.
- Use Java object-oriented programming capabilities, including classes, objects, interfaces, anonymous inner classes and inheritance to add functionality to an app.
- Programmatically change the text in a TextView.
- Use event handling to respond to user interactions with an EditText and a SeekBar.
- Specify that the keypad should display by default when the app executes.
- Specify that the app supports only portrait orientation.

**Outline**

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|------------|---|------------|---|
| <b>3.1</b> | Introduction  | 3.4.3      | Changing to a GridLayout  |
| <b>3.2</b> | Test-Driving the Tip Calculator App   | 3.4.4      | Adding the TextViews, EditText and SeekBar                              |
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| 3.3.6      | Formatting Numbers as Locale-Specific Currency and Percentage Strings                                 | 3.6.1      | package and import Statements   |
| 3.3.7      | Implementing Interface TextWatcher for Handling EditText Text Changes                                 | 3.6.2      | MainActivity Subclass of AppCompatActivity                              |
| 3.3.8      | Implementing Interface OnSeekBarChangeListener for Handling SeekBar Thumb Position Changes            | 3.6.3      | Class Variables and Instance Variables                                  |
| 3.3.9      | Material Themes   | 3.6.4      | Overriding Activity Method onCreate                                     |
| 3.3.10     | Material Design: Elevation and Shadows  | 3.6.5      | MainActivity Method calculate   |
| 3.3.11     | Material Design: Colors   | 3.6.6      | Anonymous Inner Class That Implements Interface OnSeekBarChangeListener |
| 3.3.12     | AndroidManifest.xml   | 3.6.7      | Anonymous Inner Class That Implements Interface TextWatcher             |
| 3.3.13     | Searching in the Properties Window  | <b>3.7</b> | AndroidManifest.xml   |
| <b>3.4</b> | Building the GUI  | 3.7.1      | manifest Element  |
| 3.4.1      | GridLayout Introduction   | 3.7.2      | application Element   |
| 3.4.2      | Creating the TipCalculator Project  | 3.7.3      | activity Element  |
|            |   | 3.7.4      | intent-filter Element   |
|            |   | <b>3.8</b> | Wrap-Up   |

## 3.1 Introduction

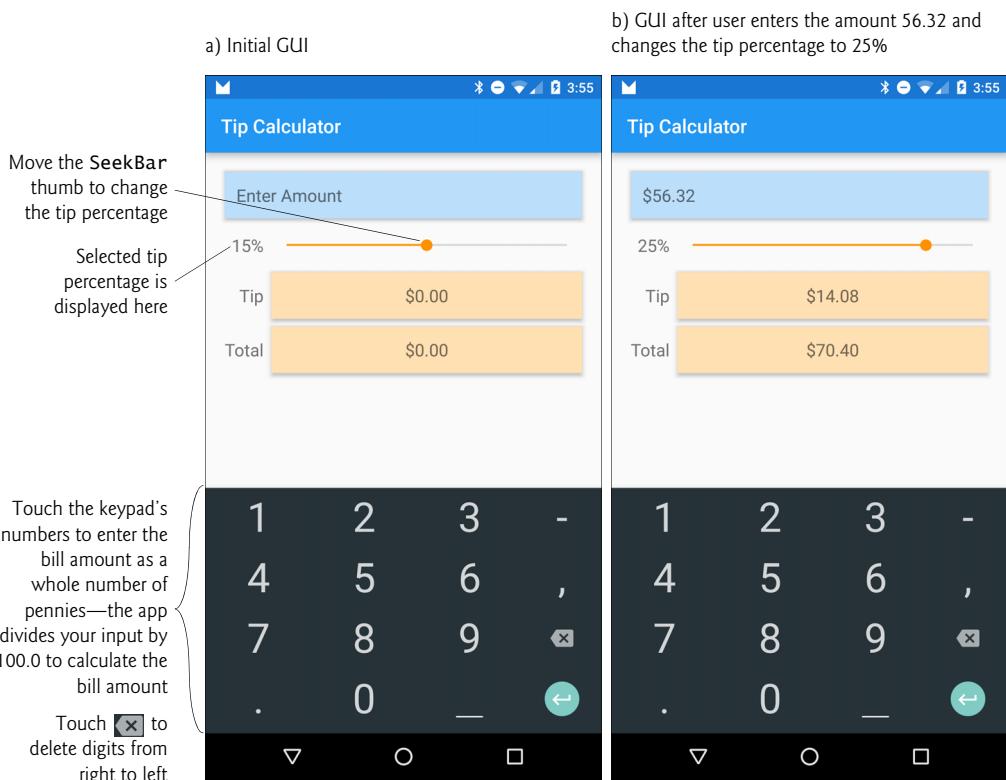
The **Tip Calculator** app (Fig. 3.1(a)) calculates and displays the tip and total for a restaurant bill amount. As you touch the numeric keypad to enter the bill amount’s digits, the app calculates and displays the tip and total bill amounts for the current tip percentage (15% by default). You specify a tip percentage from 0% to 30% by moving the SeekBar thumb—this updates the displayed tip percentage and recalculates the tip and total. All numeric values are displayed using *locale-specific* formatting. Figure 3.1(b) shows the app after the user enters the amount 56.32 and changes the tip percentage to 25%.

You’ll begin by test-driving the app. Then we’ll overview the technologies you’ll use to create the app. You’ll build the app’s GUI using Android Studio’s layout editor and the **Component Tree** window. Finally, we’ll present the complete Java code for the app and do a detailed code walkthrough.

### Note Regarding the Keyboard in Our Screen Captures

The keypad in Fig. 3.1 may differ, based on your AVD’s or device’s Android version or whether you’ve installed and selected a custom keyboard on your device. We configured our AVD to display the *dark keyboard* for better contrast in our screen captures. To do so:

1. Touch the home (○) icon on your AVD or device.



**Fig. 3.1** | Entering the bill total and calculating the tip.

2. On the home screen, touch the launcher (⋮) icon, then open the **Settings** app.
3. In the **Personal** section, touch **Language and Input**.
4. On an AVD, touch **Android Keyboard (AOSP)**. On a device touch **Google Keyboard**—we assume you’re using the standard Android keyboard.
5. Touch **Appearance & layouts**, then touch **Theme**.
6. Touch **Material Dark** to change to the keyboard with the dark background.

## 3.2 Test-Driving the Tip Calculator App

### *Opening and Running the App*

Perform the steps in Sections 1.9.1 and 1.9.3 to open the **Tip Calculator** app project in Android Studio and run the app on the Nexus 6 AVD. If you prefer, perform the steps in Section 1.9.4 to run the app on an Android phone.

### *Entering a Bill Total*

Enter the bill total 56.32 by touching numbers on the numeric keypad. If you make a mistake, press the keypad’s delete button (⌫) to erase the last digit you entered. Even though the keypad contains a decimal point, the app is configured so that you may enter only the

digits 0 through 9—other input buttons on the keypad are ignored and an Android device will vibrate to indicate when you touch an invalid input button. Each time you touch a digit or delete a digit, the app reads what you've entered so far, and

- converts it to a number
- divides the number by 100.0 and displays the new bill amount
- recalculates the tip and total amounts, based on the current tip percentage (15% by default) and
- displays in the **Tip** and **Total** **TextViews** the new tip and total amounts.

If you delete all the digits, the app redisplays **Enter Amount** in the blue **TextView** and displays 0.00 in the orange **TextViews**. The app divides the value by 100.0 and displays the result in the blue **TextView**. The app then calculates and updates the tip and total amounts in the orange **TextViews**.

All monetary amounts are displayed in locale-specific currency formats and the tip percentage is displayed in a locale-specific percentage format. For the U.S. locale, as you enter the four digits 5, 6, 3 and 2, the bill total is displayed successively as **\$0.05**, **\$0.56**, **\$5.63** and **\$56.32**, respectively.

### Selecting a Tip Percentage

Use the Seekbar—often called a *slider* in other GUI technologies—to specify the tip percentage. Drag the Seekbar's *thumb* until the percentage reads 25% (Fig. 3.1(b)). As you drag the thumb, the tip and total update continuously. By default, the Seekbar allows you to select values from 0 to 100, but we specified a maximum value of 30 for this app.

## 3.3 Technologies Overview

This section introduces the IDE and Android features you'll use to build the **Tip Calculator** app. We assume that you're already familiar with Java object-oriented programming—we present Java in our book *Java SE 8 for Programmers* (<http://bit.ly/JavaSE8FP>). You'll

- use various Android classes to create objects
- call methods on classes and objects
- define and call your own methods
- use inheritance to create a class that defines the **Tip Calculator**'s functionality and
- use event handling, anonymous inner classes and interfaces to process the user's GUI interactions.

### 3.3.1 Class Activity

Android apps have four types of executable components—*activities*, *services*, *content providers* and *broadcast receivers*. In this chapter, we'll discuss activities, which are defined as subclasses of **Activity** (package **android.app**). An app can have many activities, one of which is the first you see after launching the app. You interact with an **Activity** through views—GUI components that inherit from class **View** (package **android.view**).

Before Android 3.0, a separate **Activity** was typically associated with each screen of an app. As you'll see, starting in Chapter 4, an **Activity** can manage multiple **Fragments**.

On a phone, each **Fragment** typically occupies the entire screen and the **Activity** switches between the **Fragment**s, based on user interactions. On a tablet, activities typically display multiple **Fragment**s per screen to take advantage of the larger screen size.

### 3.3.2 Activity Lifecycle Methods

Throughout its life, an **Activity** can be in one of several *states*—*active* (i.e., *running*), *paused* or *stopped*. The **Activity** transitions between these states in response to various *events*:

- An *active* **Activity** is *visible* on the screen and “has the focus”—that is, it’s in the *foreground*. You can interact with the **Activity** currently in the foreground.
- A *paused* **Activity** is *visible* on the screen but *does not* have the focus—such as when an alert dialog is displayed. You cannot interact with the *paused* activity until it becomes active—for example, after the user dismisses an alert dialog.
- A *stopped* activity is *not visible* on the screen—it’s in the *background* and is likely to be killed by the system when its memory is needed. An **Activity** is *stopped* when another **Activity** enters the *foreground* and becomes *active*. For example, when you answer a phone call, the phone app becomes *active* and the app you previously were using is *stopped*.

As an **Activity** transitions among these states, the Android runtime calls various **Activity** *lifecycle methods*—all of which are defined by the **Activity** class in package `android.app`. You’ll override the **onCreate** method in *every* activity. This method is called by the Android runtime when an **Activity** is *starting*—that is, when its GUI is about to be displayed so you can interact with the **Activity**. Other lifecycle methods include **onStart**, **onPause**, **onRestart**, **onResume**, **onStop** and **onDestroy**. We’ll discuss most of these in later chapters. Each activity lifecycle method you override *must* call the superclass’s version; otherwise, an *exception* will occur. This is required because each lifecycle method in superclass **Activity** contains code that must execute in addition to the code you define in your overridden lifecycle methods. For more on the **Activity** lifecycle see

<http://developer.android.com/reference/android/app/Activity.html>

### 3.3.3 AppCompat Library and Class **AppCompatActivity**

A big challenge developers face when using new Android features is backward compatibility with earlier Android platforms. Google now introduces many new Android features via the *Android Support Library*—a set of libraries that enable you to use newer Android features in apps targeting current and past Android platforms.

One such library is the **AppCompat** library, which enables apps to provide an app bar (formerly called an action bar) and more on devices running Android 2.1 (API 7) and higher—app bars were originally introduced in Android 3.0 (API 11). Android Studio’s app templates have been updated to use the **AppCompat** library, enabling the new apps you create to run on almost all Android devices.

Android Studio’s **Empty Activity** app template defines the app’s **MainActivity** class as a subclass of **AppCompatActivity** (package `android.support.v7.app`)—an indirect subclass of **Activity** that supports using newer Android features in apps running on current and older Android platforms.



### Software Engineering Observation 3.1

*By creating apps with the AppCompat library from the start, you avoid having to reimplement your code if you decide to support older Android versions to target a wider potential audience for your app.*



### Software Engineering Observation 3.2

*Some Android features are not available in earlier Android versions, even if you use the AppCompat libraries. For example, Android's printing capabilities are available only in Android 4.4 and higher. If you use such features in your app, you must either restrict the app to the supported platforms or disable those features on Android versions that do not support them.*

For more details on Android Support Libraries, including when to use them and how to set them up, visit:

<http://developer.android.com/tools/support-library>

### 3.3.4 Arranging Views with a GridLayout

Recall that you arrange a GUI's views in layouts. We'll use a **GridLayout** (package `android.widget`) to arrange views into cells in a rectangular grid. Cells can occupy *multiple* rows and columns, allowing for complex layouts. Normally, **GridLayout** requires API level 14 or higher. However, the *Android Support Library* provides alternate versions of **GridLayout** and many other views and layouts so that you can use them in older Android versions. For more information on this library and how to use it in your apps, visit

<http://developer.android.com/tools/support-library/index.html>

We'll cover more layouts and views in later chapters—for a complete list, visit

<http://developer.android.com/reference/android/widget/package-summary.html>

### 3.3.5 Creating and Customizing the GUI with the Layout Editor and the Component Tree and Properties Windows

You'll create **TextViews**, an **EditText** and a **SeekBar** using the layout editor (that you used in Chapter 2) and **Component Tree** window, then customize them with the IDE's **Properties** window.

An **EditText**—often called a *text box* or *text field* in other GUI technologies—is a *sub-class* of **TextView** (presented in Chapter 2) that can display text *and* accept text input from the user. You'll specify an **EditText** for numeric input, allow users to enter only digits and restrict the maximum number of digits that can be entered.

A **SeekBar** represents an integer in the range 0–100 by default and allows the user to select a number in that range by moving the **SeekBar**'s thumb. You'll customize the **SeekBar** so the user can choose a tip percentage from the more limited range 0 to 30.

### 3.3.6 Formatting Numbers as Locale-Specific Currency and Percentage Strings

You'll use class **NumberFormat** (package `java.text`) to create *locale-specific* currency and percentage strings—an important part of *internationalizing* your apps. You also can add

accessibility strings and internationalize the app’s other text using the techniques you learned in Sections 2.7–2.8.

### 3.3.7 Implementing Interface TextWatcher for Handling EditText Text Changes

To respond to events when the user changes the text in this app’s `EditText`, you’ll use an *anonymous inner class* to implement the `TextWatcher` interface (from package `android.text`). In particular, you’ll use method `onTextChanged` to display the currency-formatted bill amount and to calculate the tip and total as the user enters each digit. If you’re not familiar with *anonymous inner classes*, visit

<http://bit.ly/AnonymousInnerClasses>

### 3.3.8 Implementing Interface OnSeekBarChangeListener for Handling SeekBar Thumb Position Changes

You’ll use another anonymous inner class to implement the `SeekBar.OnSeekBarChangeListener` interface (from package `android.widget`) to respond to the user moving the `SeekBar`’s *thumb*. In particular, you’ll use method `onProgressChanged` to display the selected tip percentage and to calculate the tip and total as the user moves the `SeekBar`’s thumb.

### 3.3.9 Material Themes

A theme gives an app a look-and-feel that’s consistent with Android. Projects that you create for Android 5 and higher use themes that adhere to Google’s material design guidelines. There are several predefined material design themes:

- The “light” theme has a white app bar, a white app background and text that is black or shades of dark gray.
- The “light” theme with a dark app bar is the same as above, but the app bar is black with white text by default.
- The “dark” has a black app bar, a dark gray app background and text that is white or shades of light gray.

For each of these themes, there is

- a `Theme.Material` version (e.g., `Theme.Material.Light`) for apps that do not use any AppCompat libraries and run on Android 5 and higher, and
- a `Theme.AppCompat` version (e.g., `Theme.AppCompat.Light`) for apps that use AppCompat libraries and run on Android 2.1 and higher.

When designing a GUI, you can choose from the predefined themes, or even create your own new ones. For this chapter, we’ll use `Theme.AppCompat.Light.DarkActionBar`, which is the default theme in Android Studio’s app templates. Apps that use the AppCompat libraries must use one of the AppCompat themes; otherwise, some views will not render correctly. For more information about each theme and to see sample screen captures, visit

<http://www.google.com/design/spec/style/color.html#color-themes>  
<http://developer.android.com/training/material/theme.html>



### Performance Tip 3.1

Many of today's Android phones use AMOLED displays. On such displays, a black pixel is turned off and does not consume power. Apps that use mostly black themes can reduce power consumption by approximately 40% (<http://bit.ly/AndroidAMOLEDDisplay>).

### 3.3.10 Material Design: Elevation and Shadows

Google's material design guidelines recommend that objects in your user interfaces cast shadows just as real-world objects do. When you set a view's **elevation** property, Android automatically casts a shadow for that view. Larger elevation values result in more pronounced shadows. For this app, we'll set the elevation of the blue and orange TextViews that display monetary amounts.

The material design guidelines contain elevation recommendations for various on-screen components—for example, a dialog's recommended elevation is 24dp and a menu's is 8dp. For other recommended elevations, see:

<http://www.google.com/design/spec/what-is-material/elevation-shadows.html>

### 3.3.11 Material Design: Colors

App developers often customize a theme's colors to match a company's branding. If you need to customize theme colors, Google's material design guidelines for color<sup>1</sup> recommend that you choose a color palette consisting of a primary color—with no more than three hues (shades)—and an accent color. The primary colors typically are used to color the status bar and the app bar at the top of the screen and also can be used in your GUI. The accent color is used to tint various views in your GUI, such as SeekBars, CheckBoxes and RadioButtons. Once you choose a palette, you can use Android Studio's **Theme Editor** (Section 3.5.2) to modify a theme's colors.

You can find recommended sample color swatches from the material design color palette at

<http://www.google.com/design/spec/style/color.html#color-color-palette>

For palette color recommendations, visit

<http://www.materialpalette.com/>

This site enables you to click two colors from Google's material design color palette, then it recommends three shades of the primary color, one secondary color and colors for your app's text and icons.

In this app, we'll use color swatches displayed in the Android Studio **Theme Editor** to select

- a blue *primary color* for app bar's background color
- a darker blue *dark primary color* for the status bar that appears above the app bar, and
- an orange *accent color* used to tint the SeekBar.

1. <http://www.google.com/design/spec/style/color.html>.

For the amount `TextView`'s light blue color and the tip and total `TextViews`' light orange color, we used Google's material design color palette to choose lighter shades of the primary and accent colors.

### 3.3.12 `AndroidManifest.xml`

The `AndroidManifest.xml` file is created by the IDE when you create a new app project. This file contains many of the settings that you specify in the **Create New Project** dialog—the app's name, package name and **Activity** name(s) and more. You'll edit this file's XML to add a new setting that forces the *soft keyboard* to be displayed when the app begins executing. You'll also specify that the app supports only *portrait orientation*—that is, the device's longer dimension is vertical.

### 3.3.13 Searching in the Properties Window

The **Properties** window allows you to search for properties by their names or portions of their names, which can help you find and set properties faster. To do so, click the **Properties** window's title bar and begin typing. At the top of the property list, a **Search for** tooltip appears showing what you've typed so far, and Android Studio highlights parts of every property name in the list that matches all or part of what you've typed. Then you can scroll through the list looking at the property names containing highlights.

The window will also scroll to the specific property that best matches what you type. For example, when searching a `TextView`'s properties, if you type "text co" or "textco", the **Properties** window will highlight portions of many properties, but it specifically scrolls to and highlights the `textColor` property.

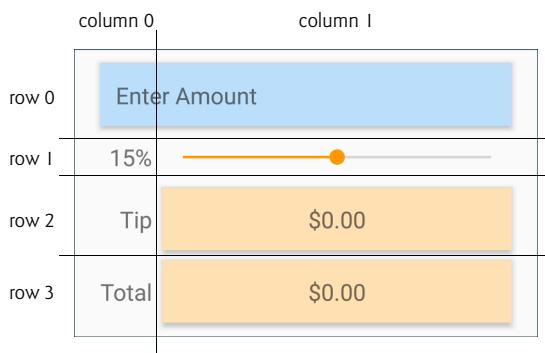
## 3.4 Building the GUI

In this section, we'll show the precise steps for building the **Tip Calculator**'s GUI, including how to customize the Material theme's primary and accent colors.

### 3.4.1 `GridLayout` Introduction

This app uses a `GridLayout` (package `android.widget`) to arrange views into four *rows* and two *columns*, each indexed from 0 like the elements in an array. You can specify a `GridLayout`'s number of rows and columns in the **Properties** window. Each cell can be *empty* or can hold one or more *views*, including layouts *containing* other views. A row's *height* is determined by the row's *tallest* view. Similarly, a column's *width* is defined by the column's *widest* view. Figure 3.2 shows the **Tip Calculator**'s `GridLayout` labeled by its rows and columns—we drew horizontal lines to delineate the rows and a vertical line to delineate the columns. Views can span *multiple* rows and/or columns—for example, the **Enter Amount** `TextView` in Fig. 3.2 spans both columns in row 0.

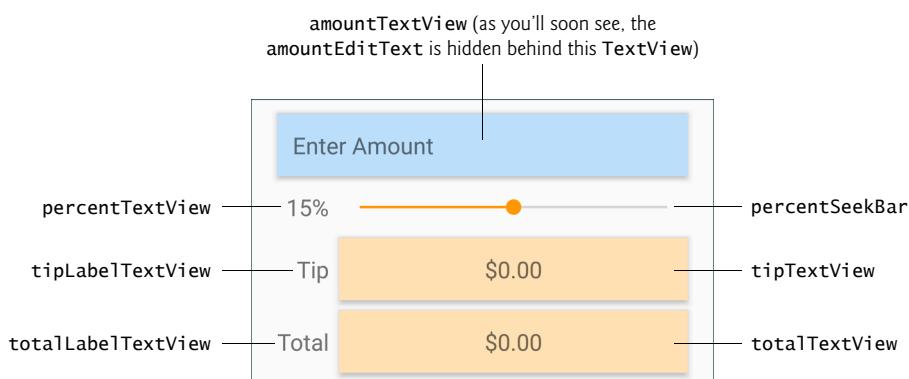
When you drag a view onto a `GridLayout` in the **Component Tree**, the view occupies the next available grid cell—cells populate the `GridLayout` left-to-right until a given row is full, then the next view appears in the first column of the next row. As you'll see, you also can specify the exact row and column in which to place a view. We'll discuss other `GridLayout` features as we present the GUI-building steps.



**Fig. 3.2** | Tip Calculator GUI's GridLayout labeled by its rows and columns.

### *id* Property Values for This App's Views

Figure 3.3 shows the views' *id* property values. For clarity, our naming convention is to use the view's class name in the *id* property and the corresponding Java variable name. In the first row, there are actually *two* components in the *same* grid cell—the `amountTextView` (which initially displays **Enter Amount**) *hides* the `amountEditText` that receives the user input. As you'll soon see, we restrict the user's input to whole-number values entered as integer digits, so the user enters the bill amount \$34.56 as 3456. This ensures the user *cannot* enter invalid input. However, this amount should be displayed as *currency*. As the user enters each digit, we divide the amount by 100.0 and display in the `amountTextView` the locale-specific, currency-formatted amount.



**Fig. 3.3** | Tip Calculator views labeled with their *id* property values.

### 3.4.2 Creating the TipCalculator Project

Follow the steps in Section 2.3 to create a new project using the **Empty Activity** template. Specify the following values in the **Create New Project** dialog's **New Project** step:

- Application name: **Tip Calculator**
- Company Domain: **deitel.com** (or specify your own domain name)

For the remaining steps in the **Create New Project** dialog, use the same settings as in Section 2.3. Also, follow the steps in Section 2.5.2 to add an app icon to your project.

Once the project is open in Android Studio, in the layout editor, select **Nexus 6** from the virtual-device drop-down list (Fig. 2.11). Once again, we'll use this device as the basis for our design. Also, delete the **Hello world!** **TextView**.

### 3.4.3 Changing to a GridLayout

Recall that the default layout for an **Empty Activity** is a **RelativeLayout**. Here, you'll change that to a **GridLayout**:

1. Click the **Text** tab at the bottom of the layout editor to switch from the **Design** view to the layout's XML text.
2. At the top of the XML, change **RelativeLayout** to **GridLayout**.
3. Switch back to the layout editor's **Design** tab.

#### *Specifying Two Columns and Default Margins for the GridLayout*

Recall that the GUI in Fig. 3.2 consists of two columns. To specify this, select **GridLayout** in the **Component Tree** window, then change its **columnCount** property to 2—this property appears near the top of the **Properties** window with the other layout properties. You do not need to set the **rowCount**—it will be increased as we build the GUI.

By default, there are *no margins*—spacing that separates views—around a **GridLayout**'s cells. The material design guidelines recommend 8dp minimum spacing between views:

<http://developer.android.com/design/style/metrics-grids.html>

**GridLayout** can enforce this recommended spacing. With the **GridLayout** selected in the **Component Tree**, in the **Properties** window, check the **GridLayout**'s **useDefaultMargins** property (which sets it to **true**) to use the recommended margins around the layout's cells.

### 3.4.4 Adding the TextViews, EditText and SeekBar

You'll now build the GUI in Fig. 3.2. You'll start with the basic layout and views in this section. In Section 3.4.5, you'll customize the views' properties to complete the design. Then, in Section 3.5, you'll change the default theme and customize two of its colors. As you add each view to the GUI, immediately set its **id** property using the names in Fig. 3.3. You'll add views to the **GridLayout** using the **Component Tree** window. If you drop a view in the wrong location in the **Component Tree**, you can drag it to the correct location.

You may also drag views directly onto the layout editor. For a **GridLayout**, the layout editor displays a grid of green guidelines to help you position the view. As you drag a view over the grid, the layout editor displays a tooltip indicating the row and column in which the view will be placed if you drop the view at that location.



#### Error-Prevention Tip 3.1

*The cells in the layout editor's grid of green guidelines are small. If you drop a view in the wrong location, the layout editor might change the GridLayout's rowCount and columnCount property values and incorrectly set the view's layout:row and layout:column property values, causing your GUI to lay out incorrectly. If so, reset the GridLayout's rowCount and columnCount, based on your design, and change the view's layout:row and layout:column property values to the correct row and column for your design.*

### Step 1: Adding Views to the First Row

The first row consists of the `amountTextView` and the `amountEditText`—both occupy the same cell and span two columns. Each time you drop a view onto the `GridLayout` in the **Component Tree** window, the view is placed in the layout's *next open cell*, unless you specify otherwise by setting the view's `layout:row` and `layout:column` properties. You'll do that in this step so that the `amountEditText` and `amountTextView` appear in the same cell with the `amountTextView` in the foreground.

This app's `TextViews` use the *medium*-sized font from the app's theme. The layout editor's **Palette** provides preconfigured `TextViews` named **Plain Text**, **Large Text**, **Medium Text** and **Small Text** (in the **Widgets** section) for various text sizes. The **Plain Text** `TextView` uses the theme's default font size. For the others, the IDE configures the `TextView`'s `textAppearance` property using the Material theme's styles for the corresponding font sizes.

Perform the following steps to add to the `GridLayout` an `EditText` and a `TextView` for receiving and displaying the bill amount:

1. This app allows you to enter only *nonnegative integers*, which the app divides by 100.0 to display the bill amount. The **Palette**'s **Text Fields** section provides *preconfigured* `EditTexts` for various forms of input, including person names, passwords, e-mail addresses, phone numbers, times, dates and numbers. When the user interacts with an `EditText`, an appropriate keyboard is displayed, based on the `EditText`'s *input type*. From the **Palette**'s **Text Fields** section, drag and drop a **Number EditText** onto the `GridLayout` node in the **Component Tree** window—this creates an `EditText` with the `id editText` in the `GridLayout`. Change the `id` to `amountEditText`. The `EditText` is placed in the *first* column of the `GridLayout`'s *first* row. Set the `EditText`'s `layout:column` to 0 and the `layout:columnSpan` to 2—these settings ensure that the `TextView` spans both columns of row 0.
2. Drag a **Medium Text** `TextView` from the **Palette**'s **Widgets** section over the `amountEditText` in the **Component Tree** window—a horizontal black line appears below `amountEditText`, indicating that the `TextView` will be placed after `amountEditText`. The IDE creates a new `TextView` named `textView` and nests it in the `GridLayout` node. The default text "Medium Text" appears in the layout editor. You'll change this in *Step 5* (Section 3.4.5). Change the `TextView`'s `id` to `amountTextView`, then set the `layout:row` to 0, the `layout:column` to 0 and the `layout:columnSpan` to 2—these settings ensure that the `TextView` spans both columns of row 0, as you'll see once we change the `TextView`'s background color.

### Step 2: Adding Views to the Second Row

Next, add the `percentTextView` and `percentSeekBar` to the `GridLayout` for displaying and selecting the tip percentage (be sure to set each view's `id` to the name we specify):

1. Drag a **Medium TextView** (`percentTextView`) from the **Palette**'s **Widgets** section over the `amountTextView` in the `GridLayout` node in the **Component Tree** window. The new view becomes the first view in row 1 (the second row).
2. Drag a **SeekBar** (`percentSeekBar`) from the **Palette**'s **Widgets** section over the `percentTextView` in the `GridLayout` node in the **Component Tree** window. The new view becomes the second view in row 1.

### Step 3: Adding Views to the Third Row

Next, add the `tipLabelTextView` and the `tipTextView` to the `GridLayout` for displaying the tip amount:

1. Drag a **Medium TextView** (`tipLabelTextView`) over the `percentSeekBar` in the `GridLayout` node. The new view becomes the first view in row 2 (the third row).
2. Drag a **Medium TextView** (`tipTextView`) over the `tipLabelTextView` in the `GridLayout` node. The new view becomes the second view in row 2.

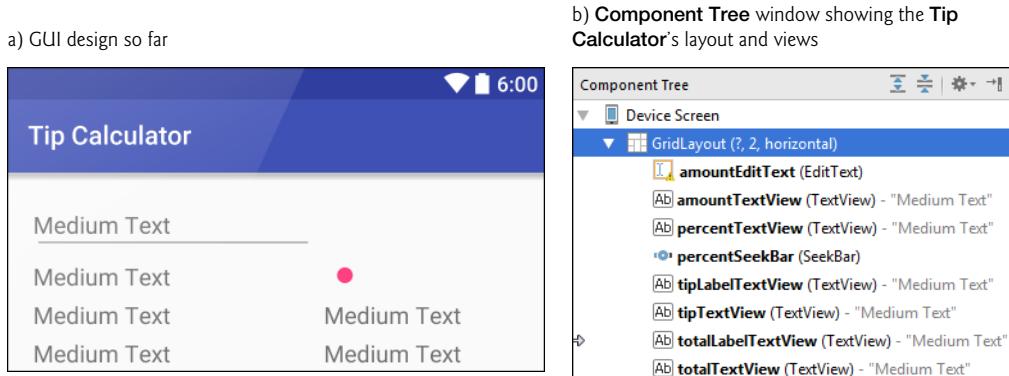
### Step 4: Adding Views to the Fourth Row

Next, add the `totalLabelTextView` and the `totalTextView` to the `GridLayout` for displaying the tip amount:

1. Drag a **Medium TextView** (`totalLabelTextView`) over the `tipTextView` in the `GridLayout` node. This becomes the first view in row 3 (the fourth row).
2. Drag a **Medium TextView** (`totalTextView`) over the `totalLabelTextView` in the `GridLayout` node. This becomes the second view in row 3.

### Reviewing the Layout So Far

The GUI and **Component Tree** window should now appear as shown in Fig. 3.4. The warning symbols shown in the layout editor and the **Component Tree** window will go away as you complete the GUI design in Section 3.4.5.



**Fig. 3.4** | GUI and the Component Tree window after adding the views to the GridLayout.

### A Note Regarding the EditText's Virtual Keyboard

When the virtual keyboard is displayed, the device's back button (⌫) changes to a down button (⌄) that enables you to dismiss the keyboard. If you do so, the down button (⌄) changes to a back button (⌫) that you can touch to return to the previous Activity—possibly a prior app or the device's home screen.

Normally, you'd touch the `EditText` to redisplay the virtual keyboard. In this app, however, the `EditText` is hidden behind a `TextView`. If you were to dismiss this app's keyboard, you'd have to leave the app and return to it to redisplay the keyboard. We could programmatically force the keyboard to stay on the screen, but this would prevent the back

button from ever being displayed in this app. This, in turn, would prevent you from returning to the previous Activity—a basic Android feature that every user expects.

We used an Android virtual keyboard to demonstrate how to choose the keyboard displayed for a given `EditText`. Another approach would be to provide Buttons representing the digits 0–9 that always remain on the screen. We could handle their click events and use `String` manipulation rather than an `EditText` to keep track of the user input.

### 3.4.5 Customizing the Views

You'll now customize additional view properties. As you did in Section 2.5, you'll also create several `String`, dimension and color resources.

#### *Step 5: Specifying Literal Text*

Next, you'll specify the literal text for the `amountTextView`, `percentTextView`, `tipLabelTextView` and `totalLabelTextView`. When a `TextView`'s `text` property is empty, its **hint** property's value (if you specify one) is displayed—this property is commonly used with an `EditText` (a subclass of `TextView`) to help the user understand the `EditText`'s purpose. We're using it similarly in the `amountTextView` to tell the user to enter a bill amount:

1. In the **Component Tree**, select `amountTextView` and locate its `hint` property in the **Properties** window.
2. Click the ellipsis (...) button to the right of the property's value to display the **Resources** dialog.
3. In the dialog, click **New Resource**, then select **New String Value...** to display the **New String Value Resource** dialog and set the **Resource name** to `enter_amount` and **Resource value** to "Enter Amount". Leave the other settings and click **OK** to create the new `String` resource and set it as `amountTextView`'s `hint`.

Repeat these steps to set the `text` property for the `percentTextView`, `tipLabelTextView` and `totalLabelTextView` using the values shown in Fig. 3.5.

| View                            | Resource name               | Resource Value |
|---------------------------------|-----------------------------|----------------|
| <code>percentTextView</code>    | <code>tip_percentage</code> | 15%            |
| <code>tipLabelTextView</code>   | <code>tip</code>            | Tip            |
| <code>totalLabelTextView</code> | <code>total</code>          | Total          |

**Fig. 3.5** | String resource values and names.

#### *Step 6: Right Aligning the `TextViews` in the Left Column*

In Fig. 3.2, the `percentTextView`, `tipLabelTextView` and `totalLabelTextView` are right aligned. You can accomplish this for all three `TextViews` at once as follows:

1. Select the `percentTextView`.
2. Hold *Ctrl* on Windows/Linux or *Command* on Mac and click the `tipLabelTextView` and `totalLabelTextView`. Now all three `TextViews` are selected.
3. Expand the `layout:gravity` property's node and check the `right` checkbox.

### Step 7: Configuring the amountEditText

In the final app, the `amountEditText` is *hidden* behind the `amountTextView` and is configured to allow only *digits* to be entered by the user. Select the `amountEditText` and set the following properties:

1. Set the **`digits`** property to 0123456789—this allows *only* digits to be entered, even though the numeric keypad contains other characters, such as minus (-), comma (,), and period (.).
2. Set the **`maxLength`** property to 6. This restricts the bill amount to a maximum of *six* digits—so the largest supported bill amount is 9999.99.

### Step 8: Configuring the amountTextView

To complete the `amountTextView`'s formatting, select it and set the following properties:

1. Delete the default value of the `text` property ("Medium Text")—we'll programmatically display text here, based on the user's input.
2. Expand the `layout:gravity` property's node and set the `fill` to `horizontal`. This indicates that the `TextView` should occupy all remaining horizontal space in this `GridLayout` row.
3. Set the **`background`** property (which specifies the view's background color) to a new color resource named `amount_background` with the value `#BBDEFB`—a light blue color chosen from Google's material design color palette.
4. Add padding around the `TextView`. A view's **`padding`** specifies extra space around a view's content. The `all` property specifies that the padding amount should be applied to the top, right, bottom and left of the view's contents. You may also set the padding for each of these individually. Expand the `padding` property's node, click the `all` property, then click the ellipsis button. Create a new dimension resource named `textview_padding` with the value `12dp`. You'll use this resource again shortly.
5. Finally, add a shadow to the view by setting the `elevation` property to a new dimension resource named `elevation` with the value `4dp`. We chose this value for demonstration purposes to emphasize the shadow effect.

### Step 9: Configuring the percentTextView

Notice that the `percentTextView` is aligned higher than the `percentSeekBar`. This looks better if it's *vertically centered*. To do this, expand the `layout:gravity` property's node, then set the `center` value to `vertical`. Recall that you previously set the `layout:gravity` to `right`. The combination of these settings appears in the layout XML as

```
    android:layout_gravity="center_vertical|right"
```

A *vertical bar* (|) is used to separate multiple `layout:gravity` values—in this case indicating that the `TextView` should be *centered vertically* and *right aligned* within the grid cell.

### Step 10: Configuring the percentSeekBar

Select `percentSeekBar` and configure the following properties:

1. By default, a `SeekBar`'s range is 0 to 100 and its current value is indicated by its **`progress`** property. This app allows tip percentages from 0 to 30 and specifies a

default of 15 percent. Set the `SeekBar`'s `max` property to 30 and the `progress` property to 15.

2. Expand the `layout:gravity` property's node and set the `fill` to `horizontal` so the `SeekBar` occupies all horizontal space in the `SeekBar`'s `GridLayout` column.
3. Set the `layout:height` property to a new dimension resource (`seekbar_height`) with the value `40dp` to increase vertical space in which the `SeekBar` is displayed.

#### *Step 11: Configuring the `tipTextView` and `totalTextView`*

To complete the formatting of the `tipTextView` and `totalTextView`, select both and set the following properties:

1. Delete the default value of the `text` property ("Medium Text")—we'll programmatically display the calculated tip and total.
2. Expand the `layout:gravity` property's node and set the `fill` to `horizontal` so each `TextView` occupies all horizontal space in the `TextViews`' `GridLayout` column.
3. Set the `background` property to a new color resource named `result_background` with the value `#FFEB3B`—a light orange color chosen from Google's material design color palette.
4. Set the `gravity` property to `center` so the calculated tip and total amounts will be centered within these `TextViews`.
5. Expand the `padding` property's node, click the ellipsis button for the `all` value, then select the dimension resource named `textview_padding` that you created previously for the `amountTextView`.
6. Finally, add a shadow to each view by setting the `elevation` property to the `elevation` dimension resource you created earlier.

## 3.5 Default Theme and Customizing Theme Colors

Each app has a theme that defines the default look-and-feel of the standard views you use. The theme is specified in the app's `AndroidManifest.xml` file (Section 3.7). You can customize aspects of the theme, such those that define an app's color scheme, by defining **style resources** in the `styles.xml` file located in the in the app's `res/values` folder.

### 3.5.1 parent Themes

The `style.xml` resource file contains a `style` with the name "AppTheme" that's referenced from the app's `AndroidManifest.xml` file to specify the app's theme. This `style` also specifies a `parent` theme, which is similar to a superclass in Java—the new `style` inherits its `parent` theme's attributes and their default values. Just as in a Java subclass, a `style` can override `parent` theme attributes with values customized for specific apps. A company might do this, for example, to use the company's branding colors. We'll use this concept in Section 3.5.2 to customize three colors used in the app's theme.

As we mentioned previously, Android Studio's app templates now include support for the `AppCompat` libraries that enable you to use newer Android features in older Android versions. By default, Android Studio sets the `parent` theme to

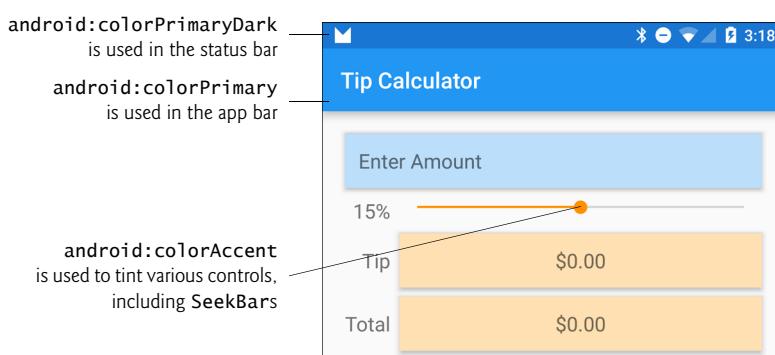
`Theme.AppCompat.Light.DarkActionBar`

one of several predefined themes from the AppCompat library—apps that use this theme have a light background, except for the dark app bar at the top of the app. Each AppCompat theme uses Google’s material design recommendations to style your apps’ GUIs.

### 3.5.2 Customizing Theme Colors

Section 3.3.11 discussed where a theme’s primary, dark primary and accent colors are applied in an app’s on-screen elements. In this section, you’ll use the new Android Studio **Theme Editor** to change the app’s primary, dark primary and accent colors, thus overriding the values of the `android:colorPrimary`, `android:colorPrimaryDark` and `android:colorAccent` theme attributes shown in Fig. 3.6. These are three of many theme attributes you can override. For the complete list, visit:

<http://developer.android.com/reference/android/R.attr.html>



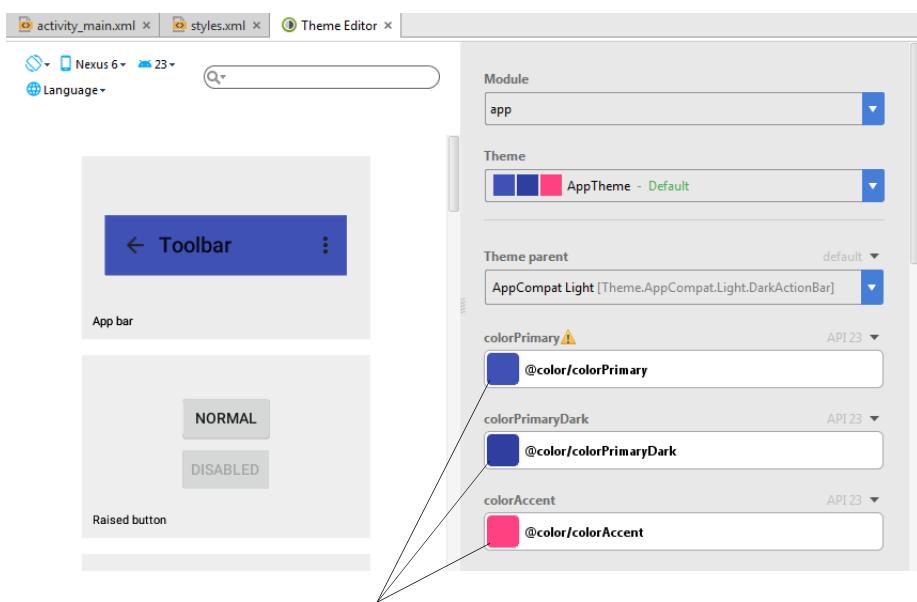
**Fig. 3.6** | Theme attributes for the primary, primary dark and accent colors.

#### Modifying the Theme’s Primary, Dark Primary and Accent Colors

To customize the colors:

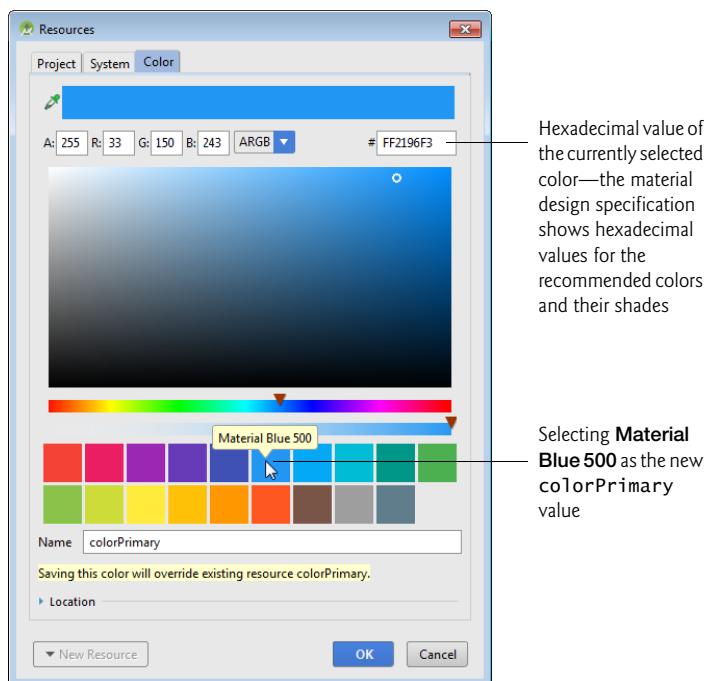
1. Open `styles.xml`. In the editor’s upper-right corner, click the **Open editor** link to display the **Theme Editor** (Fig. 3.7) showing the current colors for `colorPrimary` (dark blue), `colorPrimaryDark` (a darker shade of `colorPrimary`) and `colorAccent` (bright pink)—these are the default colors specified in Android Studio’s **Empty Activity** app template. For this app, we’ll change `colorPrimary` and `colorPrimaryDark` to lighter blues and change `colorAccent` to orange.
2. Customize the app’s `colorPrimary` value by clicking its color swatch (Fig. 3.7) to display the **Resources** dialog (Fig. 3.8). In the dialog, click the **Material Blue 500** color swatch, then click **OK** to change `colorPrimary`’s value—hovering the mouse cursor over a color swatch displays its color name in a tooltip. The number **500** represents a particular shade of the **Material Blue** color. Shades of each color range from **50** (a light shade) to **900** (a dark shade)—you can view samples of each color’s shades at

<https://www.google.com/design/spec/style/color.html#color-color-palette>



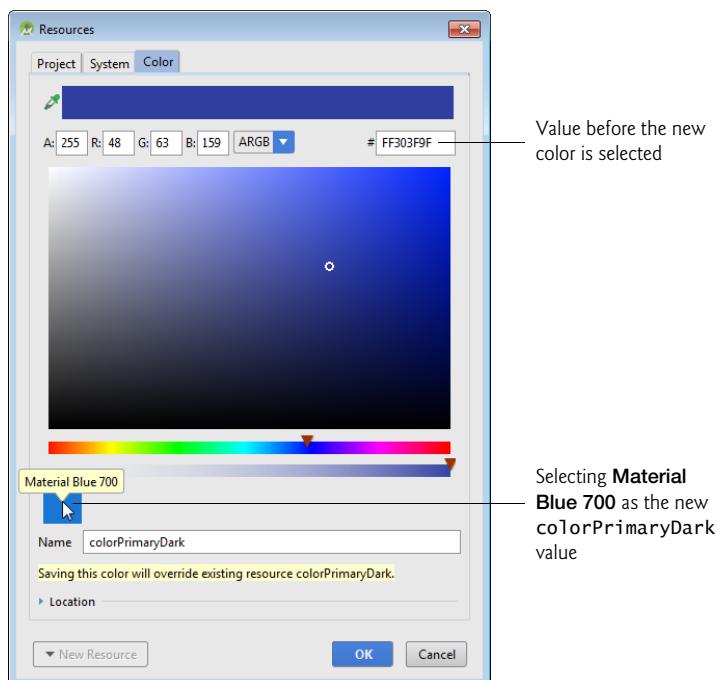
Color swatches for the theme's `colorPrimary`, `colorPrimaryDark` and `colorAccent` attributes

**Fig. 3.7** | Theme Editor shows styled view previews on the left and theme attributes on the right.



**Fig. 3.8** | Selecting the **Material Blue 500** color swatch for `colorPrimary`.

3. Next, click the `colorPrimaryDark` color swatch in the **Theme Editor** to display the **Resources** dialog. The **Theme Editor** recognizes the new `colorPrimary` value and automatically displays a color swatch containing the recommended darker `colorPrimary` shade you should use for `colorPrimaryDark`—in this case, **Material Blue 700**. Click that color swatch (Fig. 3.9), then click **OK**.



**Fig. 3.9** | Selecting the **Material Blue 700** color swatch for `colorPrimaryDark`.

4. Next, click the `colorAccent` color swatch in the **Theme Editor** to display the **Resources** dialog. Again, the **Theme Editor** recognizes that you changed the `colorPrimary` value and displays swatches for various complementary accent colors. In the dialog, click the **Orange accent 400** color swatch, then click **OK** to change `colorAccent`'s value (Fig. 3.10), then click **OK**.

You've now completed the app's design, which should appear as shown in Fig. 3.11.

### 3.5.3 Common View Property Values as Styles

As you'll see in later apps, **style** resources can define common property values that should be applied to multiple views. You apply a **style** resource to a given view by setting its **style property**. Any subsequent changes you make to a **style** are automatically applied to all views using the **style**. For example, consider the `tipTextView` and `totalTextView` that we configured identically in Step 11 of Section 3.4.5. We could have defined a **style** resource specifying the `layout:gravity`, `background`, `gravity`, `padding` and `elevation` properties' values, then set both **TextViews**' **style** properties to the same **style** resource.

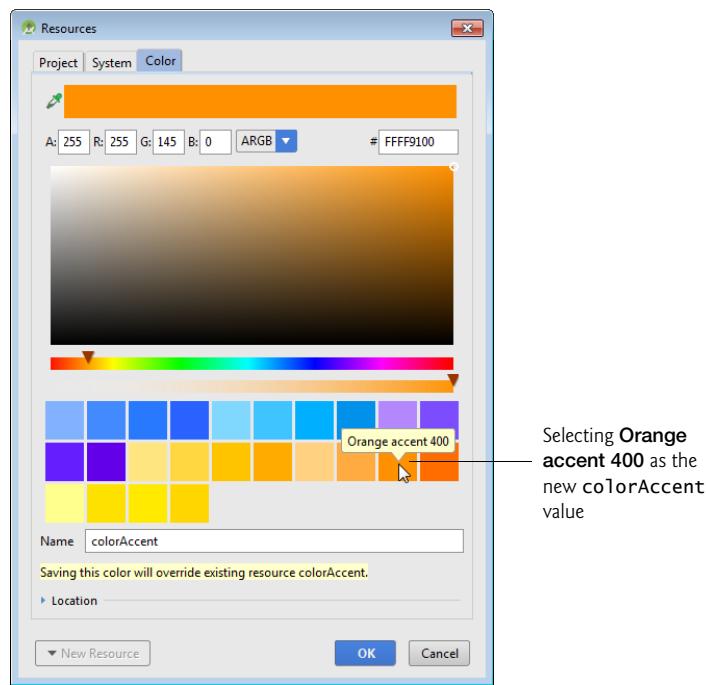


Fig. 3.10 | Selecting the **Orange accent 400** color swatch for `colorAccent`.

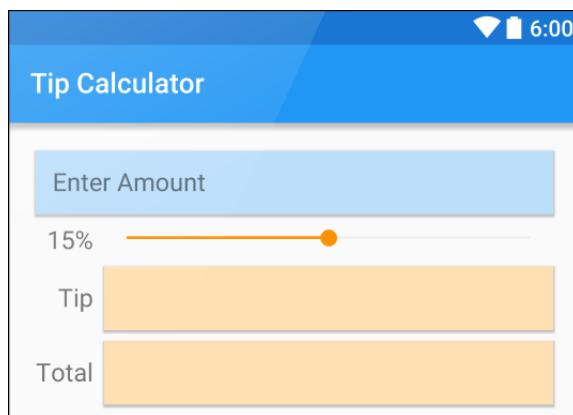


Fig. 3.11 | Completed design.

## 3.6 Adding the App's Logic

Class `MainActivity` (Figs. 3.12–3.18) implements the **Tip Calculator** app's logic. It calculates the tip and total bill amounts, then displays them in locale-specific currency format. To view the file, in the Project window, expand the `app/Java/com.deitel.tipcalcula-`

tor node and double click `MainActivity.java`. You'll need to enter most of the code in Figs. 3.12–3.18.

### 3.6.1 package and import Statements

Figure 3.12 shows the package statement and `import` statements in `MainActivity.java`. The `package` statement in line 3 was inserted when you created the project. When you open a Java file in the IDE, the `import` statements are collapsed—one is displayed with a  to its left. You can click the  to see the complete list of `import` statements.

---

```

1 // MainActivity.java
2 // Calculates a bill total based on a tip percentage
3 package com.deitel.tipcalculator;
4
5 import android.os.Bundle; // for saving state information
6 import android.support.v7.app.AppCompatActivity; // base class
7 import android.text.Editable; // for EditText event handling
8 import android.text.TextWatcher; // EditText listener
9 import android.widget.EditText; // for bill amount input
10 import android.widget.SeekBar; // for changing the tip percentage
11 import android.widget.SeekBar.OnSeekBarChangeListener; // SeekBar Listener
12 import android.widget.TextView; // for displaying text
13
14 import java.text.NumberFormat; // for currency formatting
15

```

---

**Fig. 3.12** | `MainActivity`'s package and `import` statements.

Lines 5–14 import the classes and interfaces the app uses:

- Class `Bundle` of package `android.os` (line 5) stores key–value pairs of information—typically representing an app's state or data that needs to be passed between activities. When another app is about to appear on the screen—e.g., when the user *receives a phone call* or *launches another app*—Android gives the currently executing app the opportunity to *save its state* in a `Bundle`. The Android runtime might subsequently kill the app—e.g., to reclaim its memory. When the app returns to the screen, the Android runtime passes the `Bundle` of the previously saved state to `Activity` method `onCreate` (Section 3.6.4). Then, the app can use the saved state to return the app to the state it was in when another app became active. We'll use `Bundles` in Chapter 8 to pass data between activities.
- Class `AppCompatActivity` of package `android.support.v7.app` (line 6) provides the basic *lifecycle methods* of an app—we'll discuss these shortly. `AppCompatActivity` is an indirect subclass of `Activity` (package `android.app`) that supports using newer Android features apps running on current and older Android platforms.
- Interface `Editable` of package `android.text` (line 7) allows you to modify the content and markup of text in a GUI.
- You implement interface `TextWatcher` of package `android.text` (line 8) to respond to events when the user changes the text in an `EditText`.

- Package `android.widget` (lines 9, 10 and 12) contains the *widgets* (i.e., views) and layouts that are used in Android GUIs. This app uses `EditText` (line 9), `SeekBar` (line 10) and `TextView` (line 12) widgets.
- You implement interface `SeekBar.OnSeekBarChangeListener` of package `android.widget` (line 11) to respond to the user moving the `SeekBar`'s *thumb*.
- Class `NumberFormat` of package `java.text` (line 14) provides numeric formatting capabilities, such as *locale-specific* currency and percentage formats.

### 3.6.2 MainActivity Subclass of AppCompatActivity

Class `MainActivity` (Figs. 3.13–3.18) is the **Tip Calculator** app's `Activity` subclass. When you created the **TipCalculator** project, the IDE generated this class as a subclass of `AppCompatActivity` (an indirect subclass of `Activity`) and provided an override of class `Activity`'s inherited `onCreate` method (Fig. 3.15). Every `Activity` subclass *must* override this method. We'll discuss `onCreate` shortly.

---

```
16 // MainActivity class for the Tip Calculator app
17 public class MainActivity extends Activity {
18
```

---

**Fig. 3.13** | Class `MainActivity` is a subclass of `Activity`.

### 3.6.3 Class Variables and Instance Variables

Figure 3.14 declares class `MainActivity`'s variables. The `NumberFormat` objects (lines 20–23) are used to format currency values and percentages, respectively. `NumberFormat`'s `static` method `getCurrencyInstance` returns a `NumberFormat` object that formats values as currency using the device's locale. Similarly, `static` method `getPercentInstance` formats values as percentages using the device's locale.

---

```
19 // currency and percent formatter objects
20 private static final NumberFormat currencyFormat =
    NumberFormat.getCurrencyInstance();
21 private static final NumberFormat percentFormat =
    NumberFormat.getPercentInstance();
22
23
24
25 private double billAmount = 0.0; // bill amount entered by the user
26 private double percent = 0.15; // initial tip percentage
27 private TextView amountTextView; // shows formatted bill amount
28 private TextView percentTextView; // shows tip percentage
29 private TextView tipTextView; // shows calculated tip amount
30 private TextView totalTextView; // shows calculated total bill amount
31
```

---

**Fig. 3.14** | `MainActivity` class's instance variables.

The bill amount entered by the user into `amountEditText` will be read and stored as a `double` in `billAmount` (line 25). The tip percentage (an integer in the range 0–30) that the user sets by moving the `SeekBar` *thumb* will be divided by 100.0 to create a `double` for

use in calculations, then stored in `percent` (line 26). For example, if you select 25 with the `SeekBar`, `percent` will store 0.25, so the app will multiply the bill amount by 0.25 to calculate the 25% tip.



### Software Engineering Observation 3.3

*For precise monetary calculations, use class `BigDecimal` (package `java.math`)—rather than type `double`—to represent the monetary amounts and perform calculations.*

Line 27 declares the `TextView` that displays the currency-formatted bill amount. Line 28 declares the `TextView` that displays the tip percentage, based on the `SeekBar` `thumb`'s position (see the 15% in Fig. 3.1(a)). The variables in line 29–30 will refer to the `TextViews` in which the app displays the calculated tip and total.

#### 3.6.4 Overriding Activity Method `onCreate`

The `onCreate` method (Fig. 3.15)—which is *autogenerated* with lines 33–36 when you create the app's project—is called by the system when an `Activity` is *started*. Method `onCreate` typically initializes the `Activity`'s instance variables and views. This method should be as simple as possible so that the app *loads quickly*. In fact, if the app takes longer than five seconds to load, the operating system will display an **ANR (Application Not Responding) dialog**—giving the user the option to *forcibly terminate the app*. You'll learn how to prevent this problem in Chapter 9.

```

32    // called when the activity is first created
33    @Override
34    protected void onCreate(Bundle savedInstanceState) {
35        super.onCreate(savedInstanceState); // call superclass's version
36        setContentView(R.layout.activity_main); // inflate the GUI
37
38        // get references to programmatically manipulated TextViews
39        amountTextView = (TextView) findViewById(R.id.amountTextView);
40        percentTextView = (TextView) findViewById(R.id.percentTextView);
41        tipTextView = (TextView) findViewById(R.id.tipTextView);
42        totalTextView = (TextView) findViewById(R.id.totalTextView);
43        tipTextView.setText(currencyFormat.format(0)); // set text to 0
44        totalTextView.setText(currencyFormat.format(0)); // set text to 0
45
46        // set amountEditText's TextWatcher
47        EditText amountEditText =
48            (EditText) findViewById(R.id.amountEditText);
49        amountEditText.addTextChangedListener(amountEditTextWatcher);
50
51        // set percentSeekBar's OnSeekBarChangeListener
52        SeekBar percentSeekBar =
53            (SeekBar) findViewById(R.id.percentSeekBar);
54        percentSeekBar.setOnSeekBarChangeListener(seekBarListener);
55    }
56

```

**Fig. 3.15** | Overriding Activity method `onCreate`.

### ***onCreate's Bundle Parameter***

During the app’s execution, the user could change the device’s configuration—for example, by *rotating the device, connecting to a Bluetooth keyboard or sliding out a hard keyboard*. For a good user experience, the app should continue operating smoothly through such configuration changes. When the system calls `onCreate`, it passes a `Bundle` argument containing the Activity’s saved state, if any. Typically, you save state in Activity methods `onPause` or `onSaveInstanceState` (demonstrated in later apps). Line 35 calls the super-class’s `onCreate` method, which is *required* when overriding `onCreate`.

### ***Generated R Class Contains Resource IDs***

As you build your app’s GUI and add *resources* (such as `strings.xml` file or views in the `activity_main.xml` file) to your app, the IDE generates a class named `R` that contains *nested classes* representing each type of resource in your project’s `res` folder. The nested classes are declared `static`, so that you can access them in your code with `R.ClassName`. Within class `R`’s nested classes, the IDE creates `static final int` constants that enable you to refer to your app’s resources programmatically (as we’ll discuss momentarily). Some of the nested classes in class `R` include

- class `R.drawable`—contains constants for any *drawable* items, such as *images*, that you put in the various `drawable` folders in your app’s `res` folder
- class `R.id`—contains constants for the *views* in your *XML layout files*
- class `R.layout`—contains constants that represent each *layout file* in your project (such as, `activity_main.xml`), and
- class `R.string`—contains constants for each `String` in the `strings.xml` file.

### ***Inflating the GUI***

The call to `setContentView` (line 36) receives the constant `R.layout.activity_main` which indicates the XML file that represents `MainActivity`’s GUI—in this case, the constant represents the `activity_main.xml` file. Method `setContentView` uses this constant to load the corresponding XML document, which Android parses and converts into the app’s GUI. This process is known as **inflating the GUI**.

### ***Getting References to the Widgets***

Once the layout is *inflated*, you can *get references to the individual widgets* so that you can interact with them programmatically. To do so, you use class `Activity`’s `findViewById` method. This method takes an `int` constant representing a specific view’s `Id` and returns a reference to the view. The name of each view’s `R.id` constant is determined by the component’s `Id` property that you specified when designing the GUI. For example, `amountEditText`’s constant is `R.id.amountEditText`.

Lines 39–42 obtain references to the `TextViews` that we change programmatically in the app. Line 39 obtains a reference to the `amountTextView` that’s updated when the user enters the bill amount. Line 40 obtains a reference to the `percentTextView` that’s updated when the user changes the tip percentage. Lines 41–42 obtain references to the `TextViews` where the calculated tip and total are displayed.

### Displaying Initial Values in the TextViews

Lines 43–44 set `tipTextView`'s and `totalTextView`'s text to 0 in a *locale-specific* currency format by calling the `currencyFormat` object's **format** method. The text in each of these `TextViews` will change as the user enters the bill amount.

### Registering the Event Listeners

Lines 47–49 get the `amountEditText` and call its `addTextChangedListener` method to register the `TextWatcher` object that responds to events generated when the user changes the `EditText`'s contents. We define this listener (Fig. 3.18) as an anonymous-inner-class object and assign it to the `amountEditTextWatcher` instance variable. Though we could have defined the anonymous inner class in place of `amountEditTextWatcher` in line 49, we chose to define it later in the class so that the code is easier to read.



### Software Engineering Observation 3.4

*Rather than defining anonymous inner classes in large methods, define them as private final instance variables to make your code easier to debug, modify and maintain.*

Lines 52–53 get a reference to the `percentSeekBar`. Line 54 calls the `SeekBar`'s `setOnSeekBarChangeListener` method to register the `OnSeekBarChangeListener` object that responds to *events* generated when the user moves the `SeekBar`'s thumb. Figure 3.17 defines this listener as an anonymous-inner-class object that's assigned to the instance variable `seekBarListener`.

### Note Regarding Android 6 Data Binding

Android now has a **Data Binding support library** that you can use with Android apps targeting Android 2.1 (API level 7) and higher. You now can include in your layout XML files data-binding expressions that manipulate Java objects and dynamically update data in your apps' user interfaces.

In addition, each layout XML file that contains views with `ids` has a corresponding autogenerated class. For each view with an `id`, the class has a `public final` instance variable referencing that view. You can create an instance of this “Binding” class to replace all calls to `findViewById`, which can greatly simplify your `onCreate` methods in `Activity` and `Fragment` classes with complex user interfaces. Each instance variable's name is the `id` specified in the layout for the corresponding view. The “Binding” class's name is based on the layout's name—for `activity_main.xml`, the class name is `ActivityMainBinding`.

At the time of this writing, the Data Binding library is an early beta release that's subject to substantial changes, both in the syntax of data-binding expressions and in the Android Studio tool support. You can learn more about Android data binding at

<https://developer.android.com/tools/data-binding/guide.html>

### 3.6.5 MainActivity Method `calculate`

Method `calculate` (Fig. 3.16) is called by the `EditText`'s and `SeekBar`'s listeners to update the tip and total `TextViews` each time the user *changes* the bill amount. Line 60 displays the tip percentage in the `percentTextView`. Lines 63–64 calculate the tip and total, based on the `billAmount`. Lines 67–68 display the amounts in currency format.

---

```

57    // calculate and display tip and total amounts
58    private void calculate() {
59        // format percent and display in percentTextView
60        percentTextView.setText(percentFormat.format(percent));
61
62        // calculate the tip and total
63        double tip = billAmount * percent;
64        double total = billAmount + tip;
65
66        // display tip and total formatted as currency
67        tipTextView.setText(currencyFormat.format(tip));
68        totalTextView.setText(currencyFormat.format(total));
69    }
70

```

---

**Fig. 3.16** | MainActivity Method calculate.

### 3.6.6 Anonymous Inner Class That Implements Interface OnSeekBarChangeListener

Lines 72–87 (Fig. 3.17) create the *anonymous-inner-class* object that responds to percentSeekBar’s *events*. The object is assigned to the instance variable seekBarListener. Line 54 (Fig. 3.15) registered seekBarListener as percentSeekBar’s OnSeekBarChangeListener *event-handling* object. For clarity, we define all but the simplest event-handling objects in this manner so that we do not clutter the onCreate method with this code.

---

```

71    // listener object for the SeekBar's progress changed events
72    private final OnSeekBarChangeListener seekBarListener =
73        new OnSeekBarChangeListener() {
74            // update percent, then call calculate
75            @Override
76            public void onProgressChanged(SeekBar seekBar, int progress,
77                boolean fromUser) {
78                percent = progress / 100.0; // set percent based on progress
79                calculate(); // calculate and display tip and total
80            }
81
82            @Override
83            public void onStartTrackingTouch(SeekBar seekBar) { }
84
85            @Override
86            public void onStopTrackingTouch(SeekBar seekBar) { }
87        };
88

```

---

**Fig. 3.17** | Anonymous inner class that implements interface OnSeekBarChangeListener.

#### Overriding Method onProgressChanged of Interface OnSeekBarChangeListener

Lines 75–86 (Fig. 3.17) implement interface OnSeekBarChangeListener’s methods. Method onProgressChanged is called whenever the SeekBar’s thumb position changes. Line 78 calculates the percent value using the method’s progress parameter—an int rep-

resenting the SeekBar's *thumb* position. We divide this by 100.0 to get the percentage. Line 79 calls method calculate to recalculate and display the tip and total.

### **Overriding Methods *onStartTrackingTouch* and *onStopTrackingTouch* of Interface *OnSeekBarChangeListener***

Java requires that you override *every* method in an interface that you implement. This app does not need to know when the user starts moving the SeekBar's thumb (*onStartTrackingTouch*) or stops moving it (*onStopTrackingTouch*), so we simply provide an empty body for each (lines 82–86) to fulfill the interface contract.

### **Android Studio Tools for Overriding Methods**

Android Studio can create for you empty methods that override inherited methods from the class's superclasses or that implement interface methods. When you place the cursor in a class's body, then select the **Code > Override Methods...** menu option, the IDE displays a **Select Methods to Override/Implement** dialog that lists every method you can override in the current class. This list includes all the inherited methods in the class's hierarchy and the methods of any interfaces implemented throughout the class's hierarchy.



#### **Error-Prevention Tip 3.2**

Using Android Studio's **Code > Override Methods...** menu option helps you write code faster and with fewer errors.

### **3.6.7 Anonymous Inner Class That Implements Interface *TextWatcher***

Lines 90–114 of Fig. 3.18 create an *anonymous-inner-class* object that responds to amountEditText's *events* and assign it to the instance variable amountEditTextWatcher. Line 49 (Fig. 3.15) registered this object to *listen* for amountEditText's events that occur when the text changes.

---

```

89     // Listener object for the EditText's text-changed events
90     private final TextWatcher amountEditTextWatcher = new TextWatcher() {
91         // called when the user modifies the bill amount
92         @Override
93         public void onTextChanged(CharSequence s, int start,
94             int before, int count) {
95
96             try { // get bill amount and display currency formatted value
97                 billAmount = Double.parseDouble(s.toString()) / 100.0;
98                 amountTextView.setText(currencyFormat.format(billAmount));
99             }
100            catch (NumberFormatException e) { // if s is empty or non-numeric
101                amountTextView.setText("");
102                billAmount = 0.0;
103            }
104
105            calculate(); // update the tip and total TextViews
106        }
107    }
```

---

**Fig. 3.18** | Anonymous inner class that implements interface *TextWatcher*. (Part 1 of 2.)

---

```

108     @Override
109     public void afterTextChanged(Editable s) { }
110
111     @Override
112     public void beforeTextChanged(
113         CharSequence s, int start, int count, int after) { }
114     ;
115 }
```

---

**Fig. 3.18** | Anonymous inner class that implements interface `TextWatcher`. (Part 2 of 2.)

#### *Overriding Method `onTextChanged` of Interface `TextWatcher`*

The `onTextChanged` method (lines 92–106) is called whenever the text in the `amountEditText` is *modified*. The method receives four parameters. In this example, we use only `CharSequence s`, which contains a copy of `amountEditText`'s text. The other parameters indicate that the `count` characters starting at `start` *replaced* previous text of length `before`.

Line 97 converts the user input from `amountEditText` to a `double`. We allow users to enter only whole numbers in pennies, so we divide the converted value by 100.0 to get the actual bill amount—e.g., if the user enters 2495, the bill amount is 24.95. Line 98 displays the updated bill amount. If an exception occurs, lines 101–102 clear the `amountTextView` and set the `billAmount` to 0.0. Lines 105 calls `calculate` to recalculate and display the tip and total, based on the current bill amount.

#### *Other Methods of the `amountEditTextWatcher` `TextWatcher`*

This app does *not* need to know what changes are about to be made to the text (`beforeTextChanged`) or that the text has already been changed (`afterTextChanged`), so we simply override each of these `TextWatcher` interface methods with an *empty* body (lines 108–113) to fulfill the interface contract.

## 3.7 AndroidManifest.xml

In this section, you'll modify the `AndroidManifest.xml` file to specify that this app's `Activity` supports only a device's portrait orientation and that the virtual keyboard should always be displayed when the `Activity` first appears on the screen or navigates back to the `Activity`. To open the manifest, double click `AndroidManifest.xml` in the `Project` window's `manifests` folder. Figure 3.19 shows the completed manifest with our changes highlighted—the rest of the file was autogenerated by Android Studio when we created the app's project. We'll discuss some aspects of the manifest here. For a list of all the elements a manifest may contain, their attributes and their values, visit

<http://developer.android.com/guide/topics/manifest/manifest-intro.html>

---

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <manifest xmlns:android="http://schemas.android.com/apk/res/android"
3   package="com.deitel.tipcalculator" >
4
```

---

**Fig. 3.19** | `AndroidManifest.xml` contents. (Part 1 of 2.)

---

```
5   <application
6       android:allowBackup="true"
7       android:icon="@mipmap/ic_launcher"
8       android:label="@string/app_name"
9       android:supportsRtl="true"
10      android:theme="@style/AppTheme" >
11      <activity
12          android:name=".MainActivity"
13          android:label="@string/app_name"
14          android:screenOrientation="portrait"
15          android:windowSoftInputMode="stateAlwaysVisible">
16          <intent-filter>
17              <action android:name="android.intent.action.MAIN" />
18
19              <category android:name="android.intent.category.LAUNCHER" />
20          </intent-filter>
21      </activity>
22  </application>
23
24 </manifest>
```

**Fig. 3.19** | `AndroidManifest.xml` contents. (Part 2 of 2.)

### 3.7.1 manifest Element

The **manifest element** (lines 2–24) indicates that this XML file’s contents represent the app’s manifest. This element’s `package` attribute specifies the app’s Java package name that was configured when you created the app’s project (Section 3.4.2). Recall that for apps you submit to the Google Play store, the package name is used as the app’s unique identifier.

### 3.7.2 application Element

The `manifest` element’s nested **application element** (lines 5–21) specifies attributes of the application, including

- **android:allowBackup**—Whether or not the app’s data should be backed up automatically by Android so that the data can be restored to the device or a new device at a later time.
- **android:icon**—The app icon that you touch in the launcher to execute the app.
- **android:label**—The app’s name that’s typically displayed below the icon in the launcher and often displayed in the app bar when the app is executing.
- **android:supportsRtl**—Whether or not the app’s interface can be flipped horizontally to support right-to-left languages like Arabic and Hebrew.
- **android:theme**—The theme that determines the default look-and-feel of the app’s views.

Elements nested in the `application` element define the app’s components, such as its activities.

### 3.7.3 activity Element

The `application` element's nested **activity element** (lines 10–20) describes an Activity. An app can have many activities, one of which is designated as the Activity that's displayed when the user touches the app's icon in the launcher to execute the app. Each `activity` element specifies at least the following attributes:

- **android:name**—The Activity's class name. The notation `".MainActivity"` is shorthand for `"com.deitel.MainActivity"` (where `com.deitel` is the reverse of the domain name you specified when creating the app's project).
- **android:label**—The Activity's name. This is often displayed in the app bar when the Activity is on the screen. For single Activity apps, this name is typically the same as the app's name.

For `MainActivity`, we added the following attributes:

- **android:screenOrientation**—In general, most apps should support *both* portrait and landscape orientations. In *portrait* orientation, the device's longer dimension is vertical. In *landscape orientation*, the device's longer dimension is horizontal. In the **Tip Calculator** app, rotating the device to landscape orientation on a typical phone would cause the numeric keypad to obscure most of the **Tip Calculator**'s GUI. For this reason, we set this property to `"portrait"` to support *only* portrait orientation.
- **android:windowSoftInputMode**—In the **Tip Calculator** app, the soft keypad should be displayed immediately when the app executes and should reappear each time the user returns to the **Tip Calculator** app. For this reason we set this property to `"stateAlwaysVisible"`. This will *not* display the soft keyboard if a hard keyboard is present.

### 3.7.4 intent-filter Element

**Intents** are Android's mechanism for communicating between executable components—such as activities, background services and the operating system. You *state your intent*, then Android uses **intent messaging** to coordinate the executable components to accomplish what you intend to do. This *loose coupling* makes it easy to mix and match parts of different applications. You tell Android what you want to accomplish, then let Android find the installed applications with activities that can handle the task.

#### Inter-App Communication

One example of how Intents are used is *coordinating efforts between separate apps*. Consider how photo sharing can be handled in Android:

- Most social-networking Android apps provide their own photo-sharing capabilities. Each app can advertise in its manifest its specific Activity that uploads a photo to the user's account.
- Other apps can use these photo-sharing capabilities, rather than implementing their own. For example, a photo-editing app can provide a **Share Photo** option. The app can respond to a user's photo-sharing request by *stating its intent* to share a photo—that is, creating a photo-sharing Intent and passing it to Android.

- Android looks at the Intent to determine which installed applications provide activities that can share photos.
- If there's only *one* such app, Android executes that app's photo-sharing Activity.
- If there are *many* such apps, Android displays a list of apps and asks the *user to decide* which app's photo-sharing Activity should execute.

A key benefit of this loosely coupled approach is that the photo-editing app's developer does not need to incorporate support for every possible social-networking site. By issuing a photo-sharing Intent, the app automatically supports *any* app that declares a photo-sharing Activity in its manifest, including those apps the user has already installed and any the user chooses to install in the future. For a list of the items that can be used with Intents, visit

[http://developer.android.com/reference/android/content/  
Intent.html#constants](http://developer.android.com/reference/android/content/Intent.html#constants)

### *Executing Apps*

Another example of how Intents are used is in *launching activities*. When you touch an app's icon in the device's launcher app, your intent is to execute the app. In this case, the launcher issues an Intent to execute that app's main Activity (discussed momentarily). Android responds to this Intent by launching the app and executing the specific Activity designated in the app's manifest as the main Activity.

### *Determining Which Activity to Execute*

Android uses information in the manifest to determine the activities that can respond to Intents and which Intents each Activity can handle. In the manifest, the activity element's nested **intent-filter** element (Fig. 3.19, lines 16–20) determines which Intent types can launch an Activity. If an Intent matches only one Activity's intent-filter, Android executes that Activity. If there are multiple matches, Android presents a list from which the user can choose an app, then executes the appropriate Activity in that app.

Android also passes the Intent to the Activity, because an Intent often contains data the Activity can use to perform its task. For example, a photo-editing app can include in a share-photo Intent the specific photo to share.

The intent-filter element must contain one or more **action elements**. The action "android.intent.action.MAIN" in line 17 of Fig. 3.19 indicates that MainActivity is the Activity to execute when the app launches. The optional **category element** in line 19 specifies what initiates the Intent—for "android.intent.category.LAUNCHER", it's the device's launcher. This category also indicates that the Activity should appear as an icon in the device's launcher with the icons for the user's other installed apps.

We'll discuss and program with Intents in the next chapter. For more information on Intents and Intent filters, visit

<http://developer.android.com/guide/components/intents-filters.html>

## **3.8 Wrap-Up**

In this chapter, you created the interactive **Tip Calculator** app. We discussed the app's capabilities, then you test-drove it to calculate the tip and total, based on the bill amount.

You built the app's GUI using Android Studio's layout editor, **Component Tree** window and **Properties** window. You also edited the layout's XML and used the **Theme Editor** to customize the `Theme.AppCompat.Light.DarkActionBar` theme's primary, dark primary and accent colors that were set by the IDE when you created the project. We presented the code for class `MainActivity`, a subclass of `AppCompatActivity` (and an indirect subclass of `Activity`) that defined the app's logic.

In the app's GUI, you used a `GridLayout` to arrange the views into rows and columns. You displayed text in `TextViews` and received input from an `EditText` and a `SeekBar`.

The `MainActivity` class required many Java object-oriented programming capabilities, including classes, objects, methods, interfaces, anonymous inner classes and inheritance. We explained the notion of inflating the GUI from its XML file into its screen representation. You learned about Android's `Activity` class and part of the `Activity` lifecycle. In particular, you overrode the `onCreate` method to initialize the app when it's launched. In the `onCreate` method, you used `Activity` method `findViewById` to get references to each of the views the app interacts with programmatically. You defined an anonymous inner class that implements the `TextWatcher` interface so the app can calculate new tips and totals as the user enters the bill amount in the `EditText`. You also defined an anonymous inner class that implements the `OnSeekBarChangeListener` interface so the app can calculate a new tip and total as the user changes the tip percentage by moving the `SeekBar`'s thumb.

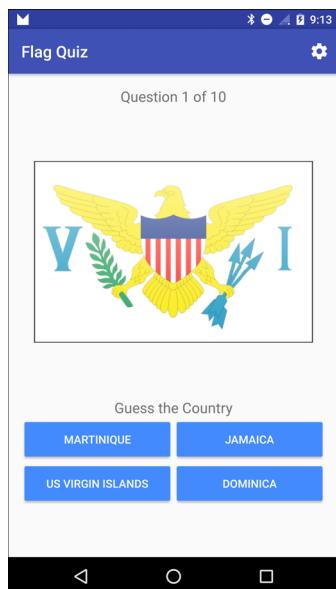
Finally, you edited the `AndroidManifest.xml` file to specify that the `MainActivity` supports only portrait orientation and that the `MainActivity` should always display the keypad. We also discussed the other elements that Android Studio placed in the manifest when you created the project.

In Chapter 4, you'll build the **Flag Quiz** app in which the user is shown a graphic of a country's flag and must guess the country from 2, 4, 6 or 8 choices. You'll use a menu and checkboxes to customize the quiz, specifying the number of guess options and limiting the flags to specific regions of the world.

# 4

# Flag Quiz App

Fragments, Menus, Preferences, Explicit Intents, Handler, AssetManager, Tweened Animations, Animators, Toasts, Color State Lists, Layouts for Multiple Device Orientations, Logging Error Messages for Debugging



## Objectives

In this chapter you'll:

- Use **Fragments** to make better use of available screen real estate in an **Activity**'s GUI on phones and tablets.
- Display a settings icon on the app bar to enable users to access the app's user preferences.
- Use a **PreferenceFragment** to automatically manage and persist an app's user preferences.
- Use a **SharedPreferences.Editor** to modify key-value pairs of data associated with an app.
- Use an app's **assets** subfolders to organize image resources and manipulate them with an **AssetManager**.
- Define an animation and apply it to a **View**.
- Use a **Handler** to schedule a future task to perform on the GUI thread.
- Use **Toasts** to display messages briefly to the user.
- Launch a specific **Activity** with an explicit **Intent**.
- Use collections from the **java.util** package.
- Define layouts for multiple device orientations.
- Use Android's logging mechanism to log error messages.

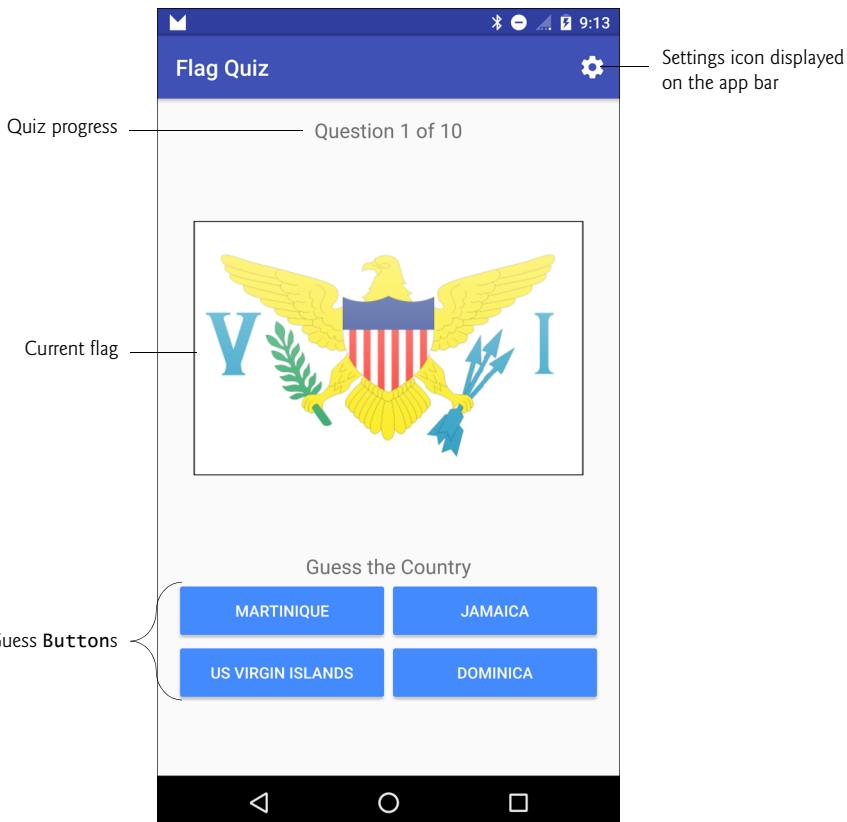
**Outline**

|   |   |
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| <b>4.1</b> Introduction   | <b>4.4.12</b> Adding Classes <code>SettingsActivity</code> and <code>SettingsActivityFragment</code> to the Project |
| <b>4.2</b> Test-Driving the <b>Flag Quiz App</b>                                  | <b>4.5</b> Building the App's GUI   |
| 4.2.1 Configuring the Quiz's Settings   | 4.5.1 <code>activity_main.xml</code> Layout for Devices in Portrait Orientation                                     |
| 4.2.2 Taking the Quiz   | 4.5.2 Designing <code>fragment_main.xml</code> Layout   |
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## 4.1 Introduction

The **Flag Quiz** app tests your ability to correctly identify 10 flags from various countries and territories (Fig. 4.1). By default, the app presents a flag image and four country-name Buttons that you click to guess the answer—one is correct and the others are randomly selected,

*nonduplicated* incorrect answers. The app displays the user's progress throughout the quiz, showing the question number (out of 10) in a `TextView` above the current flag image.



**Fig. 4.1** | Flag Quiz app running on a smartphone in portrait orientation.

As you'll see, the app also allows you to control the quiz difficulty by specifying whether to display two, four, six or eight guess Buttons, and by choosing the world regions that should be included in the quiz. These options are displayed differently, based on the device that's running the app and the orientation of the device—the app supports portrait orientation on *any* device, but landscape orientation only on tablets.

In portrait orientation, the app displays on the app bar a settings icon (⚙️). When the user touches this icon, the app displays a separate screen (another Activity) for setting the number of guess Buttons, and the world regions to use in the quiz. On a tablet in landscape orientation (Fig. 4.2), the app uses a different layout that always displays the app's settings and the quiz at the same time.

First you'll test-drive the app. Then we'll overview the technologies we used to build it. Next, you'll design the app's GUI. Finally, we'll present and walk through the app's complete source code, discussing the app's new features in more detail.



**Fig. 4.2 |** Flag Quiz app running on a tablet in landscape orientation.

## 4.2 Test-Driving the Flag Quiz App

You'll now test-drive the **Flag Quiz** app. To do so, open Android Studio, open the **Flag Quiz** app from the **FlagQuiz** folder in the book's examples folder, then execute the app in the AVD or on a device. This builds the project and runs the app (Fig. 4.1 or Fig. 4.2).

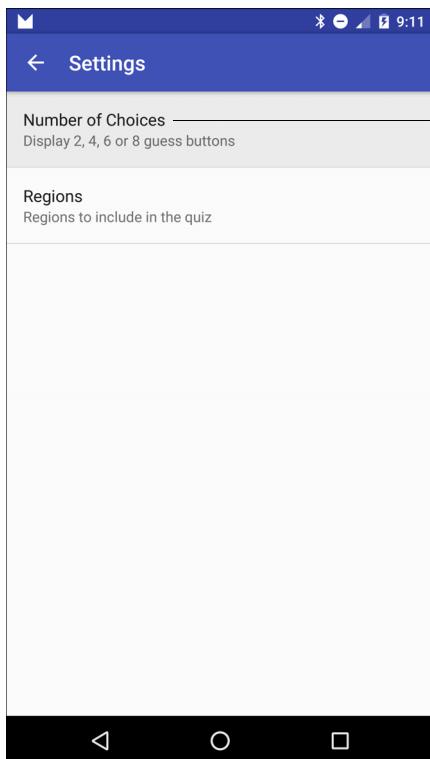
### 4.2.1 Configuring the Quiz's Settings

When you first install and run the app, the quiz is configured to display four guess Buttons and to select flags from *all* of the world's regions. For this test-drive, you'll change the app's options to select flags only from North America and you'll keep the app's default setting of four guess Buttons per flag.

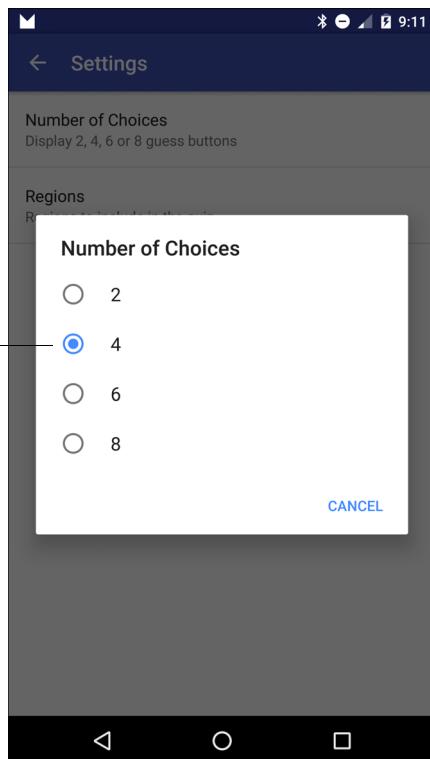
On a phone, a tablet or an AVD in portrait orientation, touch the settings icon ( ) on the app bar (Fig. 4.1) to view the **Settings** screen (Fig. 4.3(a)). On a tablet device or tablet AVD in *landscape* orientation, the app's settings appear at the left side of the screen (Fig. 4.2). Touch **Number of Choices** to display the dialog for selecting the number of Buttons that should be displayed with each flag (Fig. 4.3(b)). (On a tablet device or tablet AVD in landscape orientation, the entire app is grayed out and the dialog is centered on

the screen.) By default, 4 is selected—we used this default setting. To make the quiz easier, you could select 2, or to make the quiz more challenging, you could select 6 or 8. Touch **CANCEL** (or touch the screen outside the dialog) to return to the **Settings** screen.

a) Menu with the user touching **Number of Choices**



b) Dialog showing options for number of choices

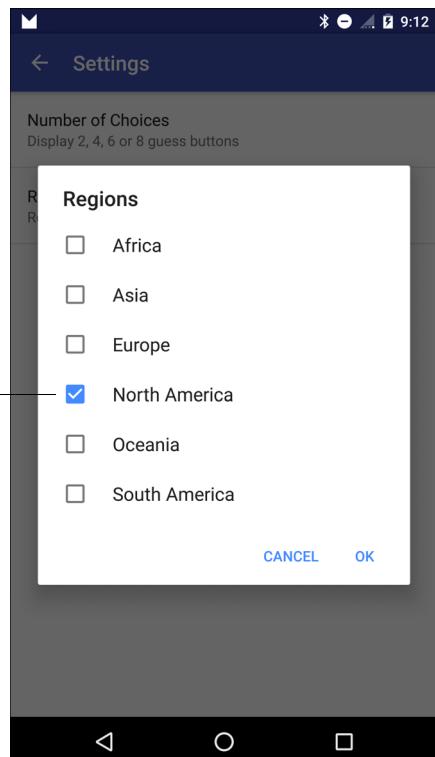


**Fig. 4.3** | Flag Quiz settings screen and the **Number of Choices** dialog.

Next, touch **Regions** (Fig. 4.4(a)) to display the checkboxes representing the world regions (Fig. 4.4(b)). By default, all regions are enabled when the app first executes, so every flag we provide with the app can be selected randomly for a quiz. Touch the checkboxes next to **Africa**, **Asia**, **Europe**, **Oceania** (Australia, New Zealand and the islands in that vicinity) and **South America** to uncheck them—this excludes those regions' countries from the quiz. Touch **OK** to save your settings. On a phone, a tablet or an AVD in portrait orientation, touch the back button ( ) to return to the quiz screen and start a new quiz with your updated settings. On a tablet device or tablet AVD in landscape orientation, a new quiz with the updated settings is immediately displayed at the right side of the screen.

a) Menu with the user touching **Regions**

b) Dialog showing regions



**Fig. 4.4** | Flag Quiz settings screen and the **Regions** dialog (after unchecking **Africa**, **Asia**, **Europe**, **Oceania** and **South America**).

## 4.2.2 Taking the Quiz

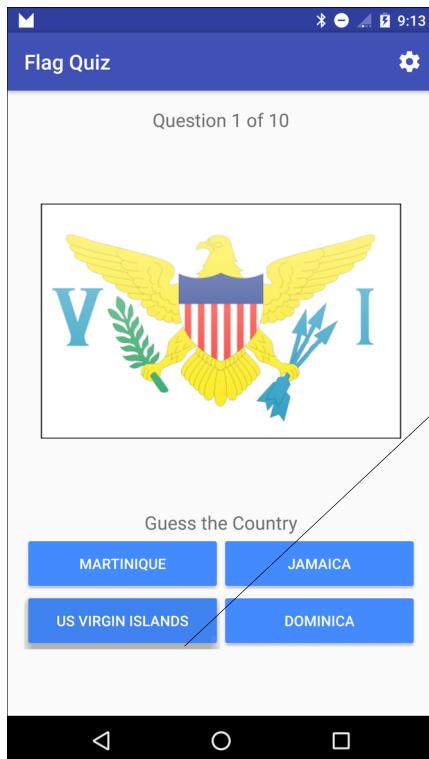
A new quiz starts with the number of answer choices you selected and flags only from the region(s) you selected. Work through the quiz by touching the guess Button for the country that you think matches each flag.

### Making a Correct Selection

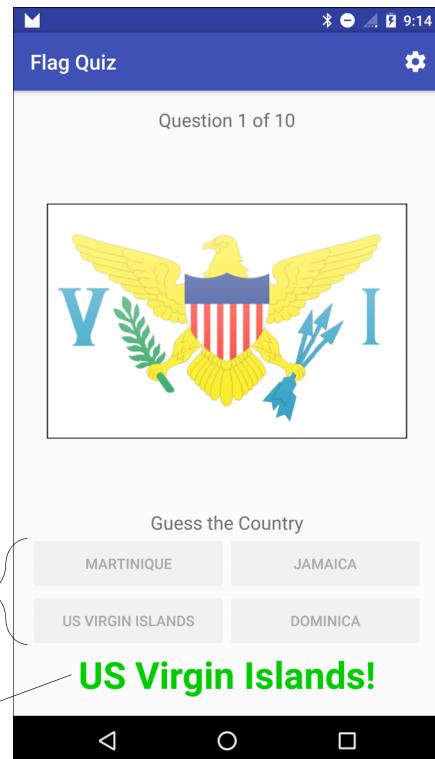
If the choice is correct (Fig. 4.5(a)), the app disables all the answer Buttons and displays the country name in green, followed by an exclamation point at the bottom of the screen (Fig. 4.5(b)). After a short delay, the app loads the next flag and animates the flag and a new set of answer Buttons onto the screen. The app transitions from the current quiz question to the next with a *circular reveal* animation:

- First, a large-diameter circle shrinks onto the screen until its diameter is zero, thus hiding the current quiz question's flag and guess Buttons.
- Then, the circle's diameter grows from zero until the new question's flag and guess Buttons are fully visible on the screen.

a) Choosing the correct answer



b) Correct answer displayed

**Fig. 4.5** | User choosing the correct answer and the correct answer displayed.

### Making an Incorrect Selection

For each incorrect country-name Button you touch (Fig. 4.6(a)), the app

- disables the corresponding country name Button
- uses an animation to *shake* the flag horizontally and
- displays **Incorrect!** in red at the bottom of the screen (Fig. 4.6(b)).

Continue guessing until you get the correct answer for that flag.

### Completing the Quiz

After you select the 10 correct country names, a popup AlertDialog displays over the app, showing your total number of guesses and the percentage of correct answers (Fig. 4.7). This is a modal dialog, so you must interact with it to dismiss it—for a non-modal dialog, touching the AVD's or device's back button ( will dismiss the dialog. When you touch the dialog's **RESET QUIZ** Button, Android dismisses the dialog and a new quiz begins, using the same number of guess options and region(s) as the quiz you just completed.

a) Choosing an incorrect answer



Button being touched  
(COSTA RICA) has a higher elevation

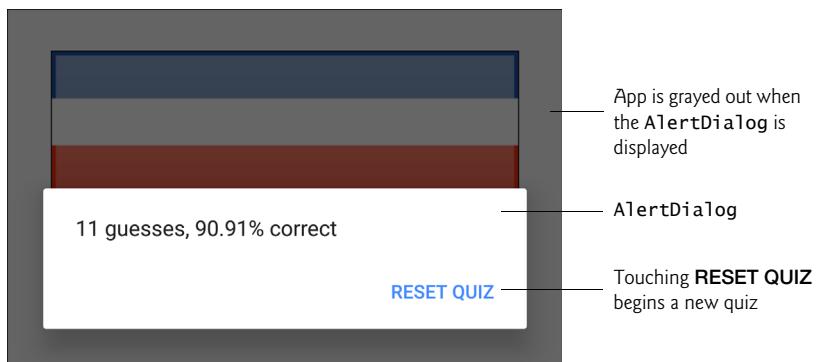
Incorrect answer's  
Button is disabled

"Incorrect!"  
displayed  
in red

b) **Incorrect!** displayed



**Fig. 4.6** | Disabled incorrect answer in the Flag Quiz app.



**Fig. 4.7** | Results displayed after quiz completion.

## 4.3 Technologies Overview

This section introduces the features you'll use to build the **Flag Quiz** app.

### 4.3.1 Menus

When you create an app's project in the IDE, the `MainActivity` is configured to display an options menu (⋮) at the right side of the action bar. In this app, you'll display the options menu only when the app is in portrait orientation. Touching the ⋮ icon expands a menu that, by default, contains only a `Settings` menu item—this typically is used to display an app's settings to the user. For this app, we'll modify the menu's XML file by providing an icon (⚙) for the `Settings` menu item and specifying that the icon should be displayed directly on the app bar. This will enable the user to touch once to view the app's settings, rather than having to first open the options menu, then touch `Settings`. You'll use Android Studio's `Vector Asset Studio` to add the material design settings icon to the project. In later apps, you'll see how to create additional menu items.

The options menu is an object of class `Menu` (package `android.view`). You override `Activity` method `onCreateOptionsMenu` (Section 4.6.5) and use the method's `Menu` argument to add the menu items—either programmatically or by inflating an XML document that describes the menu items. When the user selects a menu item, `Activity` method `onOptionsItemSelected` (Section 4.6.6) responds to the selection.

### 4.3.2 Fragments

A **fragment** typically represents a reusable portion of an `Activity`'s user interface, but may also represent reusable program logic. This app uses fragments to create and manage portions of the app's GUI. You can combine several fragments to create user interfaces that make better use of tablet screen sizes. You also can easily interchange fragments to make your GUIs more dynamic—you'll do this in Chapter 9.

Class `Fragment` (package `android.app`) is the base class of all fragments. When using subclasses of `AppCompatActivity` with `Fragments` you must use the Android Support Library's version of this class from package `android.support.v4.app`. The **Flag Quiz** app defines the following direct and indirect `Fragment` subclasses:

- Class `MainActivityFragment` (Section 4.7)—a direct subclass of `Fragment`—displays the quiz's GUI and defines the quiz's logic. Like an `Activity`, each `Fragment` has its own layout that's typically defined as an XML layout resource file (GUIs also can be created dynamically). In Section 4.5.2, you'll build `MainActivityFragment`'s GUI. You'll create *two* layouts for `MainActivity`—one for devices in portrait orientation and one only for tablets in landscape orientation. You'll then reuse the `MainActivityFragment` in both layouts.
- Class `SettingsActivityFragment` (Section 4.9) is a subclass of `PreferenceFragment` (package `android.preference`), which automatically maintains an app's user preferences in a file associated with the app. As you'll see, you create an XML file describing the user preferences, then class `PreferenceFragment` uses that file to build an appropriate preferences GUI (Figs. 4.3–4.4). We discuss preferences more in Section 4.3.5.

- When you finish a quiz, the app creates an anonymous subclass of **DialogFragment** (package `android.support.v4.app`) and displays an **AlertDialog** (introduced in Section 4.3.15) containing the quiz results (Section 4.7.10).

Fragments *must* be hosted by an Activity—they cannot execute independently. When this app runs in landscape orientation on a tablet, the **MainActivity** hosts all of the Fragments. In portrait orientation (on any device), the **SettingsActivity** (Section 4.8) hosts the **SettingsActivityFragment** and the **MainActivity** hosts the others.

### 4.3.3 Fragment Lifecycle Methods

Like an Activity, each Fragment has a *lifecycle* and provides methods that you can override to respond to *lifecycle events*. In this app, you’ll override

- onCreate**—This method (which you’ll override in class **SettingsActivityFragment**) is called when a Fragment is created. The **MainActivityFragment** and **SettingsActivityFragment** are created when the app inflates their parent activities’ layouts. The **DialogFragment** that displays the quiz results is created and displayed dynamically when the user completes a quiz.
- onCreateView**—This method (which you’ll override in class **MainActivityFragment**) is called after **onCreate** to build and return a View containing the Fragment’s GUI. As you’ll see, this method receives a **LayoutInflater**, which you’ll use to programmatically inflate a Fragment’s GUI from the components specified in a predefined XML layout.

Fragments can add their own menu items to a host Activity’s menu. Like class **Activity**, Fragments also have lifecycle method **onCreateOptionsMenu** and event-handling method **onOptionsItemSelected**.

We’ll discuss other Fragment lifecycle methods as we encounter them throughout the book. For the complete lifecycle details, visit

<http://developer.android.com/guide/components/fragments.html>

### 4.3.4 Managing Fragments

An Activity manages its Fragments via a **FragmentManager** (package `android.app`)—accessible via Activity’s **getFragmentManager** method. If the Activity needs to interact with a Fragment that’s declared in the Activity’s layout and has an id, the Activity can call **FragmentManager** method **findFragmentById** to obtain a reference to the specified Fragment. As you’ll see in Chapter 9, a **FragmentManager** can use **FragmentTransactions** to dynamically *add*, *remove* and *transition* between Fragments.

For backward compatibility, subclasses of **AppCompatActivity** must use the Android Support Library’s version of **FragmentManager** from package `android.support.v4.app`, rather than the one in package `android.app`. Class **AppCompatActivity** inherits method **getSupportFragmentManager** from the Android Support Library’s **FragmentActivity** class to obtain the correct **FragmentManager**.

### 4.3.5 Preferences

In Section 4.2.1, you customized the quiz by changing the app’s settings. These settings are stored persistently in a file as *key-value* pairs—each *key* enables you to quickly look up

a corresponding *value*. The keys in the file must be `Strings`, and the values can be `Strings` or primitive-type values. Such a file is manipulated via an object of class `SharedPreferences` (package `android.content`) and the file is accessible only to the app that creates the file.

A `PreferenceFragment` uses `Preference` objects (package `android.preference`) to manage app settings and stores those settings in a file via a `SharedPreferences` object. This app uses `Preference` subclass `ListPreference` to manage the number of guess Buttons displayed for each flag and `Preference` subclass `MultiSelectListPreference` to manage the world regions to include in the quiz. A `ListPreference` creates *mutually exclusive* radio buttons in which only one can be selected (Fig. 4.3(b)). A `MultiSelectListPreference` creates a GUI containing checkboxes, any number of which can be selected (Fig. 4.4(b)). You'll use a `PreferenceManager` object (package `android.preference`) to access and interact with the app's default `SharedPreferences` file.

You'll also interact directly with the app's default `SharedPreferences` file:

- When starting a quiz, you'll query the app's preferences to determine the number of guess Buttons to display and the region(s) from which to select flags.
- When the user changes the regions preference, the app will ensure that at least one region is selected; otherwise, there would be no flags to include in the quiz. If none is selected, the app edits the regions preference to select North America.

To modify a `SharedPreferences` file's contents, you'll use a `SharedPreferences.Editor` object (Section 4.6.7).

### 4.3.6 assets Folder

This app's flag images are loaded into the app only when needed and are located in the app's `assets folder`.<sup>1</sup> To add the images to the project, we copied each region's folder from our file system into the `assets` folder in the Project window (Section 4.4.4). The images are located in the `images/FlagQuizImages` folder with the book's examples.

Unlike an app's `drawable` folders, which require their image contents to be at the root level in each folder, the `assets` folder may contain files of any type and they can be organized in subfolders—we maintain the flag images for each region in a separate subfolder. Files in the `assets` subfolders are accessed via an `AssetManager` (package `android.content.res`), which can provide a list of all of the file names in a specified subfolder and can be used to access each asset.

### 4.3.7 Resource Folders

In Section 2.4.4, you learned about the `drawable`, `layout` and `values` subfolders of an app's `res` folder. In this app, you'll also use the `menu`, `anim`, `color` and `xml` resource folders. Figure 4.8 overviews these folders as well as the `animator` and `raw` folders.

---

1. We obtained the images from <http://www.free-country-flags.com>.

| Resource subfolder | Description   |
|--------------------|---|
| anim               | Folder names that begin with <code>anim</code> contain XML files that define <i>tweened animations</i> , which can change an object's <i>transparency, size, position</i> and <i>rotation</i> over time. You'll define such an animation in Section 4.4.10, then in Section 4.7.10 you'll play it to create a <i>shake effect</i> to provide the user with visual feedback for an incorrect guess.  |
| animator           | Folder names that begin with <code>animator</code> contain XML files that define <i>property animations</i> , which change the value of an object's property over time. In Java, a property is typically implemented in a class as an instance variable with both <i>set</i> and <i>get</i> accessors.  |
| color              | Folder names that begin with <code>color</code> contain XML files that define color state lists—lists of colors for various states, such as the states of a <code>Button</code> ( <i>unpressed, pressed, enabled, disabled</i> , and so on). We'll use a color state list to define separate colors for when the guess <code>Buttons</code> are <i>enabled</i> or <i>disabled</i> in Section 4.4.8. |
| raw                | Folder names that begin with <code>raw</code> contain resource files (such as audio clips) that are read into an app as streams of bytes. We'll use such resources in Chapter 6 to play sounds.   |
| menu               | Folder names that begin with <code>menu</code> contain XML files that describe the contents of menus. When you create a project, the IDE automatically defines a menu with a <code>Settings</code> option.  |
| xml                | Folder names that begin with <code>xml</code> contain XML files that do not fit into the other resource categories—often XML data files used by the app. In Section 4.4.11, you'll create an XML file that represents the preferences displayed by this app's <code>SettingsActivityFragment</code> .   |

**Fig. 4.8** | Other subfolders within a project's `res` folder.

### 4.3.8 Supporting Different Screen Sizes and Resolutions

In Section 2.5.1 you learned that Android devices have various *screen sizes, resolutions* and *pixel densities* (dots per inch or DPI). You also learned that you typically provide images and other visual resources in multiple resolutions so Android can choose the best resource for a device's pixel density. Similarly, in Section 2.8, you learned how to provide `String` resources for different languages and regions. Android uses resource folders with *qualified names* to choose the appropriate images, based on a device's pixel density, and the correct language strings, based on a device's locale and region settings. This mechanism also can be used to select resources from any of the resource folders discussed in Section 4.3.7.

For this app's `MainActivity`, you'll use minimum screen width and orientation qualifiers to determine which layout to use—one for portrait orientation on phones and tablets and another only for tablets in landscape orientation. To do this, you'll define two layouts that present `MainActivity`'s contents:

- `content_main.xml` is the default layout that displays only the `MainActivity`-`Fragment`.
- `content_main.xml (sw700dp-1and)` is used *only* on devices (i.e., tablets) when the app is in landscape (`1and`) orientation.

Qualified resource folder names (on disk) have the format:

*name-qualifiers*

where *qualifiers* consists of one or more qualifiers separated by dashes (-). There are currently 19 qualifier types that you can use to designate when Android should choose specific resource files. We'll explain other qualifiers as we use them throughout the book. For a complete description of all the res subfolder qualifiers and the rules for the order in which they must be defined in a fully qualified folder's name, visit

<http://developer.android.com/guide/topics/resources/providing-resources.html#AlternativeResources>

### 4.3.9 Determining the Device Orientation

In this app, we display the Menu only when the app is running on a phone-sized device or when it's running on a tablet in portrait orientation (Section 4.6.5). To determine this, we'll obtain an object of class **Configuration** (package android.content.res), which contains public instance variable **orientation** containing either ORIENTATION\_PORTRAIT or ORIENTATION\_LANDSCAPE for the device's current orientation.

### 4.3.10 Toasts for Displaying Messages

A **Toast** (package android.widget) briefly displays a message, then disappears from the screen. Toasts are often used to display minor error messages or informational messages. We use Toasts as follows:

- To indicate that the quiz will be reset after the user changes the app's settings.
- To indicate that at least one region must be selected if the user deselects all regions—in this case, the app sets North America as the quiz's default region.

### 4.3.11 Using a Handler to Execute a Runnable in the Future

When the user makes a correct guess, the app displays the correct answer for two seconds before displaying the next flag. To do this, we use a **Handler** (package android.os). Handler method **postDelayed** receives as arguments a Runnable to execute and a delay in milliseconds. After the delay has passed, the Handler's Runnable executes in the *same thread* that created the Handler.



#### Error-Prevention Tip 4.1

*Operations that interact with or modify the GUI must be performed in the GUI thread (also called the UI thread or main thread), because GUI components are not thread safe.*

### 4.3.12 Applying an Animation to a View

When the user makes an incorrect choice, the app shakes the flag by applying an **Animation** (package android.view.animation) to the **ImageView**. We use **AnimationUtils** static method **loadAnimation** to load the animation from an XML file that describes the animation's options. We also specify the number of times the animation should repeat with Animation method **setRepeatCount** and perform the animation by calling View method **startAnimation** (with the Animation as an argument) on the **ImageView**.

### 4.3.13 Using ViewAnimationUtils to Create a Circular Reveal Animator

Animations can make an app more visually appealing. In this app, shortly after the user makes a correct choice, the app animates the flag and answer Buttons off the screen and the next flag and answer Buttons onto the screen. To do this, in Section 4.7.9, you'll use the `ViewAnimationUtils` class to create a *circular reveal* Animator object by calling the `createCircularReveal` method. You'll then set the animation's duration and start the animation by calling Animator methods `setDuration` and `start`, respectively. The animation appears as a shrinking or expanding circular window that displays part of a UI element.

### 4.3.14 Specifying Colors Based on a View's State Via a Color State List

A **color state list resource file** defines a color resource that changes colors based on a View's state. For example, you could define a color state list for a Button's background color that specifies different colors for the Button's *pressed*, *unpressed*, *enabled* and *disabled* states. Similarly, for a CheckBox, you could specify different colors for its *checked* or *unchecked* states.

In this app, when the user makes an incorrect guess, the app disables that guess Button, and when the user makes a correct guess, the app disables all the guess Buttons. In a disabled Button, the white text is difficult to read. To solve this issue you'll define a **color state list** that specifies a Button's text color, based on the Button's enabled or disabled state (Section 4.4.8). For more information on color state lists, visit

<http://developer.android.com/guide/topics/resources/color-list-resource.html>

### 4.3.15 AlertDialog

You can display messages, options and confirmations to app users via `AlertDialogs` (package `android.app`). An `AlertDialog` is a **modal dialog**—when it's displayed, the user cannot interact with the app until the dialog is dismissed (closed). As you'll see, you create and configure the `AlertDialog` with an `AlertDialog.Builder` object, then use it to create the `AlertDialog`.

`AlertDialogs` can display buttons, checkboxes, radio buttons and lists of items that the user can touch to respond to the dialog's message. They can also display custom GUIs. A standard `AlertDialog` may have up to three buttons that represent:

- A *negative action*—Cancels the dialog's specified action, often labeled with `CANCEL` or `NO`. This is the leftmost button when there are multiple buttons in the dialog.
- A *positive action*—Accepts the dialog's specified action, often labeled with `OK` or `YES`. This is the rightmost button when there are multiple buttons in the dialog.
- A *neutral action*—This button indicates that the user does not want to cancel or accept the action specified by the dialog. For example, an app that asks the user to register to gain access to additional features might provide a `REMIND ME LATER` neutral button.

We use an `AlertDialog` at the end of a quiz to display the quiz results to the user (Section 4.7.10) and enable the user to touch a button to reset the quiz. You'll implement the interface `DialogInterface.OnClickListener` (package `android.content`) to handle the button's event. You can learn more about Android dialogs at

<http://developer.android.com/guide/topics/ui/dialogs.html>

### 4.3.16 Logging Exception Messages

When exceptions occur or when you want to track important aspects of your code's execution, you can *log* messages for debugging purposes with Android's built-in logging mechanism. Android provides class `Log` (package `android.util`) with several static methods that represent messages of varying detail. Logged messages can be viewed in the bottom of the Android Device Monitor's `LogCat` tab or with the **Android Logcat tool**. You can open the Android Device Monitor window from Android Studio by selecting `View > Tool Windows > Android Monitor`. For more details on logging messages, visit

<http://developer.android.com/tools/debugging/debugging-log.html>

### 4.3.17 Launching Another Activity Via an Explicit Intent

As you learned in Section 3.7.4, Android uses a technique known as *intent messaging* to communicate information between activities within one app or activities in separate apps. Each `Activity` declared in the `AndroidManifest.xml` file can specify *intent filters* indicating *actions* the `Activity` is capable of handling. In each app so far, the IDE created an intent filter for the app's only `Activity` indicating that it could respond to the predefined action named `android.intent.action.MAIN`, which specifies that the `Activity` can be used to *launch* the app to begin its execution. An `Activity` is launched by using an `Intent` that indicates an *action* to be performed and the *data* on which to perform that action.

#### *Implicit and Explicit Intents*

This app uses an **explicit Intent**. When this app runs in portrait orientation, its preferences are displayed *explicitly* in the `SettingsActivity` (Section 4.8)—the specific `Activity` that understands how to manage this app's preferences. Section 4.6.6 shows how to use an explicit Intent to launch a specific `Activity` in the same app.

Android also supports **implicit Intents** for which you do *not* specify explicitly which component should handle the Intent. For example, you can create an Intent to display the contents of a URL and allow Android to launch the most appropriate activity (a web browser), based on the type of data. If *multiple* activities can handle the action and data passed to `startActivity`, the system will display a *dialog* in which the user can select the activity to use (possibly one of several browsers the user has installed). If the system cannot find an activity to handle the action, then method `startActivity` throws an `ActivityNotFoundException`. In general, it's a good practice to handle this exception to prevent your app from crashing. You can also prevent this exception from happening by first using Intent method `resolveActivity` to determine whether there is an `Activity` to handle the Intent. For a more information on Intents, visit

<http://developer.android.com/guide/components/intents-filters.html>

### 4.3.18 Java Data Structures

This app uses various data structures from the `java.util` package. The app dynamically loads the image file names for the enabled regions and stores them in an `ArrayList<String>`. We use `Collections` method `shuffle` to randomize the order of the image file names for each new game (Section 4.7.7). We use a second `ArrayList<String>` to hold the image file names for the countries eligible to be used in the current quiz. We also use a `Set<String>` to store the world regions included in a quiz. We refer to the `ArrayList<String>` object with a variable of interface type `List<String>`.



#### Software Engineering Observation 4.1

*Refer to collection objects using variables of the corresponding generic interface type, so you can change data structures easily without affecting the rest of your app's code.*

### 4.3.19 Java SE 7 Features

Android fully supports Java SE 7. For a complete list of the features introduced in Java SE 7, visit

<http://www.oracle.com/technetwork/java/javase/jdk7-relnotes-418459.html>

This app uses the following Java SE 7 features:

- Type inference for generic instance creation—If the compiler can infer a generic object’s type from the context, you can replace `<type>` with `<>` when creating the object. For example, in the `Flag Quiz`’s `MainActivityFragment` code, the instance variable `quizCountriesList` is declared to be of type `List<String>`, so the compiler knows the collection must contain `Strings`. Thus, when we create the corresponding `ArrayList` object, we can use Java SE 7’s *diamond operator* `<>` as in the following statement, and the compiler infers that `<>` should be `<String>`, based on `quizCountriesList`’s declaration:

```
quizCountriesList = new ArrayList<>();
```

- The *try-with-resources* statement—Rather than declaring a resource, using it in a `try` block and closing it in a `finally` block, you can use the *try-with-resources* statement to declare the resource in the `try` block’s parentheses and use the resource in the `try` block. The resource is *implicitly* closed when program control leaves the `try` block. For example, in the `Flag Quiz`’s `MainActivityFragment` code, we use an `InputStream` to read the bytes of the app’s flag images and use them to create `Drawables` (Section 4.7.7):

```
try (InputStream stream =
    assets.open(region + "/" + nextImage + ".png")) {
    // code that might throw an exception
}
```

### 4.3.20 AndroidManifest.xml

As you learned in Chapter 3, the `AndroidManifest.xml` file is created for you when you create an app. All activities in an Android app must be listed in the app’s manifest file. We’ll show you how to add additional activities to the project. When you add the `Set-`

tingsActivity to the project (Section 4.4.12), the IDE will also add it to the manifest file. For the complete details of `AndroidManifest.xml`, visit

<http://developer.android.com/guide/topics/manifest/manifest-intro.html>

We'll cover various other aspects of the `AndroidManifest.xml` file in subsequent apps.

## 4.4 Creating the Project, Resource Files and Additional Classes

In this section, you'll create the project and configure the String, array, color and animation resources used by the `Flag Quiz` app. You'll also create additional classes for a second Activity that enables the user to change the app's settings.

### 4.4.1 Creating the Project

Follow the steps in Section 2.3 to create a new project. Specify the following values in the `Create New Project` dialog's `New Project` step:

- **Application name:** `Flag Quiz`
- **Company Domain:** `deitel.com` (or specify your own domain name)

For the remaining steps in the `Create New Project` dialog, use the same settings as in Section 2.3, but this time in the `Add an activity to Mobile` step, select `Blank Activity` rather than `Empty Activity` and check the `Use a Fragment` checkbox. Keep the default names provided for the `Activity Name`, `Layout Name`, `Title` and `Menu Resource Name`, then click `Finish` to create the project. The IDE will create various Java and resource files, including

- a `MainActivity` class
- a `Fragment` subclass called `MainActivityFragment` that's displayed by the `MainActivity`
- layout files for the `MainActivity` and `MainActivityFragment`, and
- a `menu_main.xml` file that defines `MainActivity`'s options menu.

Also, follow the steps in Section 2.5.2 to add an app icon to your project.

When the project opens in Android Studio, the IDE displays `content_main.xml` in the layout editor. Select `Nexus 6` from the virtual-device drop-down list (Fig. 2.11)—once again, we'll use this device as the basis for our design.

### 4.4.2 Blank Activity Template Layouts

The `Blank Activity` template is a backward-compatible app template (for Android 2.1 and higher) that uses features of the Android Design Support Library. This template can be used with or without a `Fragment`. When you choose to use the `Fragment` option, the IDE creates layouts named `activity_main.xml`, `content_main.xml` and `fragment_main.xml`.

#### `activity_main.xml`

The layout in `activity_main.xml` contains a `CoordinatorLayout` (from the package `android.support.design.widget` in the Android Design Support Library). The `CoordinatorLayout` layouts defined Android Studio's app templates typically contain an app bar,

defined as a `Toolbar` (package `android.support.v7.widget`). The templates define the app bar explicitly for backward compatibility with early Android versions that did not support app bars. `CoordinatorLayouts` also help manage material-design-based interactions with nested views—such as moving a portion of a GUI out of the way when a view animates onto the screen and restoring the GUI to its original location when a view animates off the screen.

The default `activity_main.xml` layout embeds (via an `<include>` element in the XML) the GUI defined in `content_main.xml`. The default layout also contains a `FloatingActionButton`—a round image button from the Android Design Support Library that has a higher elevation than the GUI's other components, so it “floats” over the GUI. A `FloatingActionButton` typically emphasizes an important action that the user can perform by touching the button. Each app based on the `Blank Activity` template includes a `FloatingActionButton` and other material design features. You'll use `FloatingActionButton`s starting in Chapter 7.

#### ***content\_main.xml***

The `content_main.xml` layout defines the portion of `MainActivity`'s GUI that appears below the app bar and above the system bar. When you choose the `Blank Activity` template's `Fragment` option, this file contains only a `<fragment>` element that displays the `MainActivityFragment`'s GUI defined in `fragment_main.xml`. If you do not choose the template's `Fragment` option, this file defines a `RelativeLayout` containing a `TextView`, and you'd define `MainActivity`'s GUI here.

#### ***fragment\_main.xml***

The `fragment_main.xml` layout is defined only when you choose the `Blank Activity` template's `Fragment` option. When using a `Fragment`, this is where you define the main GUI.

#### ***Preparing to Design the GUI***

We don't need the `FloatingActionButton` for this app, so open the `activity_main.xml` layout and delete the bright pink button in the layout's bottom-right corner. Also, select the `CoordinatorLayout` in the `Component Tree` and set the layout's `id` to `coordinatorLayout`. Open the `fragment_main.xml` layout and remove the `Hello World!` `TextView` defined by the app template.

### **4.4.3 Configuring Java SE 7 Support**

We use Java SE 7 programming features in this app. By default, a new Android Studio project uses Java SE 6. To use Java SE 7:

1. Right click the project's app folder and select `Open Module Settings` to open the `Project Structure` window.
2. Ensure that the `Properties` tab is selected at the top of the window.
3. In both the `Source Compatibility` and `Target Compatibility` drop-down lists, select 1.7, then click `OK`.

### **4.4.4 Adding the Flag Images to the Project**

Follow these steps to create an `assets` folder and add the flags to the project:

- Right click the app folder in the Project window and select **New > Folder > Assets Folder**. In the **Customize the Activity** dialog that appears, click **Finish**.
- Navigate to the folder on disk containing the book's examples and copy all of the folders located in the `images/FlagQuizImages` folder.
- Click the assets folder in the Project window, then paste the folders you copied in the preceding step. In the **Copy** dialog that appears, click **OK** to copy the folders and their images into your project.

#### 4.4.5 strings.xml and Formatted String Resources

In Section 3.4.5, you learned how to create a **String** resource using the **Resources** dialog. For this app, we'll create the **String** (and many other) resources in advance, then use them as we design the GUI and from the program's code. You'll now create new **String** resources using the **Translations Editor** that you first saw in Section 2.8:

- In the Project window, expand the `res/values` node, then open `strings.xml`.
- In the editor's upper-right corner, click the **Open Editor** link to open the **Translations Editor**.
- In the upper-left corner of the **Translations Editor**, click the **Add Key** button (+).
- In the dialog that appears, enter `number_of_choices` for the **Key** and `Number of Choices` for the **Default Value**, then click **OK** to create the new resource.
- Repeat Step 4 for each of the remaining string resources listed in the table (Fig. 4.9).



#### Look-and-Feel Observation 4.1

*The Android design guidelines indicate that text displayed in your GUI should be brief, simple and friendly with the important words first. For details on the recommended writing style, see <http://developer.android.com/design/style/writing.html>.*

| Key  | Default value   |
|--|---|
| <code>number_of_choices_description</code> | Display 2, 4, 6 or 8 guess buttons  |
| <code>world_regions</code>                 | Regions   |
| <code>world_regions_description</code>     | Regions to include in the quiz  |
| <code>guess_country</code>                 | Guess the Country   |
| <code>results</code>                       | %1\$d guesses, %2\$.02f% correct  |
| <code>incorrect_answer</code>              | Incorrect!  |
| <code>default_region_message</code>        | One region must be selected. Setting North America as the default region. |
| <code>restarting_quiz</code>               | Quiz will restart with your new settings                                  |
| <code>question</code>                      | Question %1\$d of %2\$d   |
| <code>reset_quiz</code>                    | Reset Quiz  |
| <code>image_description</code>             | Image of the current flag in the quiz                                     |
| <code>default_region</code>                | North_America   |

**Fig. 4.9** | String resources used in the Flag Quiz app.

### **Format Strings as String Resources**

The results and question resources are *format Strings*. When a String resource contains multiple format specifiers, you must number them for localization purposes. In the results resource

```
%1$d guesses, %2$.02f% correct
```

the notation 1\$ in %1\$d indicates that the *first* value to insert in the String should replace the format specifier %1\$d. Similarly, 2\$ in %2\$.02f indicates that the *second* value to insert in the String should replace the format specifier %2\$.02f. The d in the first format specifier formats an integer and the f in the second one formats a floating-point number. In localized versions of strings.xml, the format specifiers %1\$d and %2\$.02f can be reordered as necessary to properly translate the String resource. The *first* value to insert will replace %1\$d—*regardless* of where it appears in the format String—and the *second* value will replace %2\$.02f *regardless* of where it appears in the format String.

### **4.4.6 arrays.xml**

Technically, all of your app’s resources in the res/values folder can be defined in the *same* file. However, to make it easier to manage different types of resources, separate files are typically used for each. For example, by convention array resources are normally defined in arrays.xml, colors in colors.xml, Strings in strings.xml and numeric values in values.xml. This app uses three String array resources that are defined in arrays.xml:

- regions\_list specifies the names of the world regions with their words separated by *underscores*—these values are used to load image file names from the appropriate folders and as the selected values for the world regions the user selects in the SettingsActivityFragment.
- regions\_list\_for\_settings specifies the names of the world regions with their words separated by *spaces*—these values are used in the SettingsActivityFragment to display the region-name checkboxes to the user.
- guesses\_list specifies the Strings 2, 4, 6 and 8—these values are used in the SettingsActivityFragment to display the radio buttons that enable the user to select the number of guess Buttons to display.

Figure 4.10 shows the names and element values for these three array resources.

| Array resource name       | Values  |
|---------------------------|---|
| regions_list              | Africa, Asia, Europe, North_America, Oceania, South_America |
| regions_list_for_settings | Africa, Asia, Europe, North America, Oceania, South America |
| guesses_list              | 2, 4, 6, 8  |

**Fig. 4.10** | String array resources defined in arrays.xml.

To create `arrays.xml` and configure the array resources, perform the following steps:

1. In the project's `res` folder, right click the `values` folder, then select **New > Values resource file** to display the **New Resource File** dialog. Because you right-clicked the `values` folder, the dialog is preconfigured to add a **Values** resource file in the `values` folder.
2. Specify `arrays.xml` in the **File name** field and click **OK** to create the file.
3. Android Studio does not provide a `String` resource editor for `String` arrays, so you'll need to edit the XML to create the `String` array resources.

Each `String`-array resource has the following format:

```
<string-array name="resource_name">
    <item>first element value</item>
    <item>second element value</item>
    ...
</string-array>
```

Figure 4.11 shows the completed XML file.

---

```
1  <?xml version="1.0" encoding="utf-8"?>
2  <resources>
3
4      <string-array name="regions_list">
5          <item>Africa</item>
6          <item>Asia</item>
7          <item>Europe</item>
8          <item>North_America</item>
9          <item>Oceania</item>
10         <item>South_America</item>
11     </string-array>
12
13     <string-array name="regions_list_for_settings">
14         <item>Africa</item>
15         <item>Asia</item>
16         <item>Europe</item>
17         <item>North America</item>
18         <item>Oceania</item>
19         <item>South America</item>
20     </string-array>
21
22     <string-array name="guesses_list">
23         <item>2</item>
24         <item>4</item>
25         <item>6</item>
26         <item>8</item>
27     </string-array>
28
29 </resources>
```

---

**Fig. 4.11** | `arrays.xml` defines `String` array resources used in the **Flag Quiz** app.

#### 4.4.7 colors.xml

This app displays correct answers in green and incorrect answers in red. As with any other resource, color resources should be defined in XML so you can easily change colors without modifying your app's Java source code and so you can use Android's resource-choosing capabilities to provide colors resources for various scenarios (different locales, night and day colors, and so on). Typically, colors are defined in the file `colors.xml`, which is created for you by most of Android Studio's app templates or created when you define colors using the technique shown in Section 2.5.7; otherwise, you must create the file.

The **Blank Activity** app template already contains a `colors.xml` file that defines the theme's primary, primary dark and accent color resources. Here you'll add color resources for the correct and incorrect answers and modify the app's accent color. To do so, you'll edit the XML directly, rather than using the **Theme Editor** to modify theme colors, as you did in Section 3.5.

Open `colors.xml` (Fig. 4.12) from the project's `res/values` folder and add lines 6 and 7. Also, change the hexadecimal value for the color named `colorAccent` (line 5) from `#FF4081` (the default bright pink defined by the app template) to `#448AFF` (a lighter shade of blue than those used for `colorPrimary` and `colorPrimaryDark`). Notice in the IDE that the XML editor shows a color swatch to the left of each color.

---

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <resources>
3   <color name="colorPrimary">#3F51B5</color>
4   <color name="colorPrimaryDark">#303F9F</color>
5   <color name="colorAccent">#448AFF</color>
6   <color name="correct_answer">#00CC00</color>
7   <color name="incorrect_answer">#FF0000</color>
8 </resources>
```

---

**Fig. 4.12** | `colors.xml` defines the app's color resources.

#### 4.4.8 button\_text\_color.xml

As we discussed in Section 4.3.14, when a color state list resource is provided for a Button color (either foreground or background), the appropriate color from the list of colors is selected, based on the Button's state. For this app you'll define colors for the answer Buttons' text color in the `enabled` and `disabled` states. To create the color state list resource file:

1. Right click the project's `res` folder, then select **New > Andorid resource file** to display the **New Resource File** dialog.
2. Specify `button_text_color.xml` as the **File name**.
3. In the **Resource type** drop-down, select **Color**. The **Root element** will automatically change to **selector** and the **Directory name** will automatically change to **color**.
4. Click **OK** to create the file. The `button_text_color.xml` file will be placed in a `res/color` folder, which the IDE automatically creates with the file.
5. Add the text shown in Fig. 4.13 to the file.

The `<selector>` element (lines 2–10) contains `<item>` elements that each specify a color for a particular Button state. In this color state list, we specify the `android:state_enabled` property in each `<item>`—once for the *enabled* state (`true`; lines 3–5) and once for the *disabled* state (`false`; lines 7–9). The `android:color` property (lines 4 and 8) specifies the color for that state.

---

```

1  <?xml version="1.0" encoding="utf-8"?>
2  <selector xmlns:android="http://schemas.android.com/apk/res/android">
3      <item
4          android:color="@android:color/primary_text_dark"
5          android:state_enabled="true"/>
6
7      <item
8          android:color="@android:color/darker_gray"
9          android:state_enabled="false"/>
10     </selector>

```

---

**Fig. 4.13** | `button_text_color.xml` defines a button's text color for the *enabled* and *disabled* states.

#### 4.4.9 Editing `menu_main.xml`

In the test-drive, you touched the (⚙) icon to access the app's settings. Here, you'll add this icon to the project, then edit `menu_main.xml` to display this icon on the app bar. To add the icon to the project:

1. Select **File > New > Vector Asset** to display the **Vector Asset Studio**—this tool enables you to add to your project any of Google's recommended *material design icons* (<https://www.google.com/design/icons/>). Each icon is defined as a scalable vector graphic that smoothly scales to any size.
2. Click the **Choose** button, then in the dialog that appears, scroll to locate the (⚙) icon, select it and click **OK**. The IDE updates the **Resource name** automatically to match the selected icon—you can edit this name if you wish. Keep the other settings in the dialog as is.
3. Click **Next**, then **Finish** to add to the `res/drawable` folder the icon's scalable representation—`ic_settings_24dp.xml`.
4. By default, each icon you add to the project in this manner is black, which would be difficult to see against the dark blue app bar background. To change this, open `ic_settings_24dp.xml` and change the `<path>` element's `android:fillColor` attribute to white, as in

```
    android:fillColor="@android:color/white"
```

Next, you'll add the icon to `menu_main.xml`:

1. Open `menu_main.xml` in the editor—this file is located in the `res/menu` folder.
2. In the `<item>` element, add the following `android:icon` attribute (a preview of the icon appears in the gray margin to the left of the line):

```
    android:icon="@drawable/ic_settings_24dp"
```

3. You can force a menu item to display on the app bar, in which case it's known as an *action*. By default, the action is displayed as the menu item's icon (if there is one); otherwise, the menu item's text is displayed. To force the menu item to appear as an action on the app bar, change the `<item>` element's `app:showAsAction` attribute to

```
app:showAsAction="always"
```

In the next chapter, you'll see how to specify that menu items should be shown on the app bar only if there is room.

#### 4.4.10 Creating the Flag Shake Animation

In this section, you'll create the animation that shakes the flag when the user guesses incorrectly. We'll show how the app uses this animation in Section 4.7.10. To create the animation:

1. Right click the project's `res` folder, then select `New > Android resource file` to open the `New Resource file` dialog.
2. In the `File name` field, enter `incorrect_shake.xml`.
3. In the `Resource type` drop-down, select `Animation`. The IDE changes the `Root element` to `set` and the `Directory name` to `anim`.
4. Click `OK` to create the file. The XML file opens immediately.

The IDE does not provide an editor for animations, so you must modify the XML contents of the file as shown in Fig. 4.14.

---

```

1  <?xml version="1.0" encoding="utf-8"?>
2
3  <set xmlns:android="http://schemas.android.com/apk/res/android"
4      android:interpolator="@android:anim/decelerate_interpolator" >
5
6      <translate android:duration="100" android:fromXDelta="0"
7          android:toXDelta="-5%p" />
8
9      <translate android:duration="100" android:fromXDelta="-5%p"
10         android:toXDelta="5%p" android:startOffset="100" />
11
12     <translate android:duration="100" android:fromXDelta="5%p"
13         android:toXDelta="-5%p" android:startOffset="200" />
14 </set>

```

---

**Fig. 4.14** | `incorrect_shake.xml` defines a flag animation that's played when the user makes an incorrect guess.

In this example, we use **View animations** to create a *shake effect* that consists of three animations in an **animation set** (lines 3–14)—a collection of animations that make up a larger animation. Animation sets may contain any combination of **tweened animations**—**alpha** (transparency), **scale** (resize), **translate** (move) and **rotate**. Our shake

animation consists of a series of three `translate` animations. A `translate` animation moves a `View` within its parent. Android also supports *property animations* in which you can animate any property of any object.

The first `translate` animation (lines 6–7) moves a `View` from a starting location to an ending position over a specified period of time. The **android:fromXDelta** attribute is the `View`'s offset when the animation starts and the **android:toXDelta** attribute is the `View`'s offset when the animation ends. These attributes can have

- absolute values (in pixels)
- a percentage of the animated `View`'s size
- a percentage of the animated `View`'s *parent's* size.

For the `android:fromXDelta` attribute, we specified an absolute value of 0. For the `android:toXDelta` attribute, we specified the value `-5%p`, which indicates that the `View` should move to the *left* (due to the minus sign) by 5% of the parent's width (indicated by the `p`). To move by 5% of the `View`'s width, simply remove the `p`. The **android:duration** attribute specifies how long the animation lasts in milliseconds. So the animation in lines 6–7 will move the `View` to the left by 5% of its parent's width in 100 milliseconds.

The second animation (lines 9–10) continues from where the first finished, moving the `View` from the `-5%p` offset to a `%5p` offset in 100 milliseconds. By default, animations in an animation set are applied simultaneously (i.e., in parallel), but you can use the **android:startOffset** attribute to specify the number of milliseconds into the future at which an animation should begin. This can be used to sequence the animations in a set. In this case, the second animation starts 100 milliseconds after the first. The third animation (lines 12–13) is the same as the second, but in the reverse direction, and it starts 200 milliseconds after the first animation.

#### 4.4.11 `preferences.xml` for Specifying the App's Settings

In this section, you'll create the `preferences.xml` file that the `SettingsActivityFragment` uses to display the app's preferences. To create the file:

1. Right click the project's `res` folder, then select `New > Android resource file` to open the `New Resource File` dialog.
2. In the `File name` field enter the name `preferences.xml`.
3. In the `Resource type` drop-down list, select `XML`. The `Root element` will automatically change to `PreferenceScreen`, which represents a screen in which preferences are displayed. The `Directory name` will automatically change to `xml`.
4. Click `OK` to create the file. The `preferences.xml` file will be placed in the `xml` folder, which is created automatically.
5. If the IDE did not open `res/xml/preferences.xml` automatically, double click the file to open it.

You'll now add two types of preferences to the file, a `ListPreference` and a `MultiSelectListPreference`. Each preference has properties that we explain in Fig. 4.15 for `ListPreference` and Fig. 4.16 for `MultiSelectListPreference`. To add the preferences and their properties to the file, you'll need to edit the XML. Figure 4.17 shows the completed XML file.

| Property     | Value  | Description   |
|--------------|--|---|
| entries      | @array/guesses_list                                | An array of <code>Strings</code> that will be displayed in the list of options.   |
| entryValues  | @array/guesses_list                                | An array of values associated with the options in the <code>Entries</code> property. The selected entry's value will be stored in the app's <code>SharedPreferences</code> .                |
| key          | <code>pref_numberOfChoices</code>                  | The name of the preference stored in the app's <code>SharedPreferences</code> .   |
| title        | <code>@string/number_of_choices</code>             | The title of the preference displayed in the GUI.   |
| summary      | <code>@string/number_of_choices_description</code> | A summary description of the preference that's displayed below its title.   |
| persistent   | <code>true</code>                                  | Whether the preference should persist after the app terminates—if <code>true</code> , class <code>PreferenceFragment</code> immediately persists the preference value each time it changes. |
| defaultValue | 4  | The item in the <code>Entries</code> property that's selected by default.   |

**Fig. 4.15** | `ListPreference` property values.

| Property     | Value  | Description   |
|--------------|--|---|
| entries      | @array/regions_list_for_settings               | An array of <code>Strings</code> that will be displayed in the list of options.   |
| entryValues  | @array/regions_list                            | An array of the values associated with the options in the <code>Entries</code> property. The selected entries' values will <i>all</i> be stored in the app's <code>SharedPreferences</code> . |
| key          | <code>pref_regionsToInclude</code>             | The name of the preference stored in the app's <code>SharedPreferences</code> .   |
| title        | <code>@string/world_regions</code>             | The title of the preference displayed in the GUI.   |
| summary      | <code>@string/world_regions_description</code> | A summary description of the preference that's displayed below its title.   |
| persistent   | <code>true</code>                              | Whether the preference should persist after the app terminates.   |
| defaultValue | @array/regions_list                            | An array of the default values for this preference—in this case, all of the regions will be selected by default.  |

**Fig. 4.16** | `MultiSelectListPreference` property values.

```
1 <?xml version="1.0" encoding="utf-8"?>
2 <PreferenceScreen
3     xmlns:android="http://schemas.android.com/apk/res/android">
4
5     <ListPreference
6         android:entries="@array/guesses_list"
7         android:entryValues="@array/guesses_list"
8         android:key="pref_numberOfChoices"
9         android:title="@string/number_of_choices"
10        android:summary="@string/number_of_choices_description"
11        android:persistent="true"
12        android.defaultValue="4" />
13
14    <MultiSelectListPreference
15        android:entries="@array/regions_list_for_settings"
16        android:entryValues="@array/regions_list"
17        android:key="pref_regionsToInclude"
18        android:title="@string/world_regions"
19        android:summary="@string/world_regions_description"
20        android:persistent="true"
21        android.defaultValue="@array/regions_list" />
22
23 </PreferenceScreen>
```

**Fig. 4.17** | preferences.xml defines the preferences displayed by the SettingsActivityFragment.

#### 4.4.12 Adding Classes `SettingsActivity` and `SettingsActivityFragment` to the Project

In this section, you'll create the `SettingsActivity` class (discussed in Section 4.8) and the `SettingsActivityFragment` class (Section 4.9) by adding to the project a new `Blank Activity` that uses a `Fragment`. To add the `SettingsActivity` and `SettingsActivityFragment` (and their layouts) to the project, perform the following steps:

1. Right click the app folder and select `New > Activity > Blank Activity` to open the `New Android Activity` dialog.
2. In the `Activity Name` field, enter `SettingsActivity`. The `Layout Name` and `Title` will automatically update based on what you enter in the `Activity Name` field.
3. Specify `Settings` in the `Title` field to add a new `String` resource to `strings.xml` that will be displayed in the `SettingsActivity`'s app bar.
4. Check `Use a Fragment` which will create the `SettingsActivityFragment` class and its corresponding layout.
5. Select `MainActivity` as the `Hierarchical Parent` of the new `SettingsActivity` (use the ... button to the right of the drop-down list). This tells Android Studio to generate code that places in the activity's app bar a button that the user can touch to return to the parent activity (i.e., `MainActivity`). This button is known as the *up button*.
6. Click `Finish` to create the new classes and layouts.

The IDE creates the layout files `activity_settings.xml`, `content_settings.xml` and `fragment_settings.xml` in the app's `res/layout` folder, and the code files `SettingsActivity.java` and `SettingsActivityFragment.java` in the app's Java package folder. Open the `activity_settings.xml` layout and delete the `FloatingActionButton` as you did in Section 4.4.2 for `activity_main.xml`.

## 4.5 Building the App's GUI

In this section, you'll build the `Flag Quiz` app's user interface. In the two previous chapters, you saw how to create a GUI and configure component properties, so Sections 4.5.1–4.5.4 focus primarily on new features. Many of the component properties you need to set are specified in tables.

### 4.5.1 `activity_main.xml` Layout for Devices in Portrait Orientation

In the two prior apps, you defined the app's GUI in `activity_main.xml`. When working with Fragments, an Activity's GUI typically displays one or more Fragments' GUIs. In this app, the layout for `MainActivity`—`activity_main.xml`—uses an `<include>` element in the XML to include in `MainActivity`'s layout the GUI defined in `content_main.xml`. The `content_main.xml` layout, in turn, displays `MainActivityFragment` for which the GUI is defined in `fragment_main.xml`. All three layout files were created by the IDE when you created the project in Section 4.4.1.

The `content_main.xml` file defined by the IDE contains a `<fragment>` element as its root layout. At runtime, the `MainActivityFragment`'s GUI will fill the part of the screen occupied by this `<fragment>` element.



#### Look-and-Feel Observation 4.2

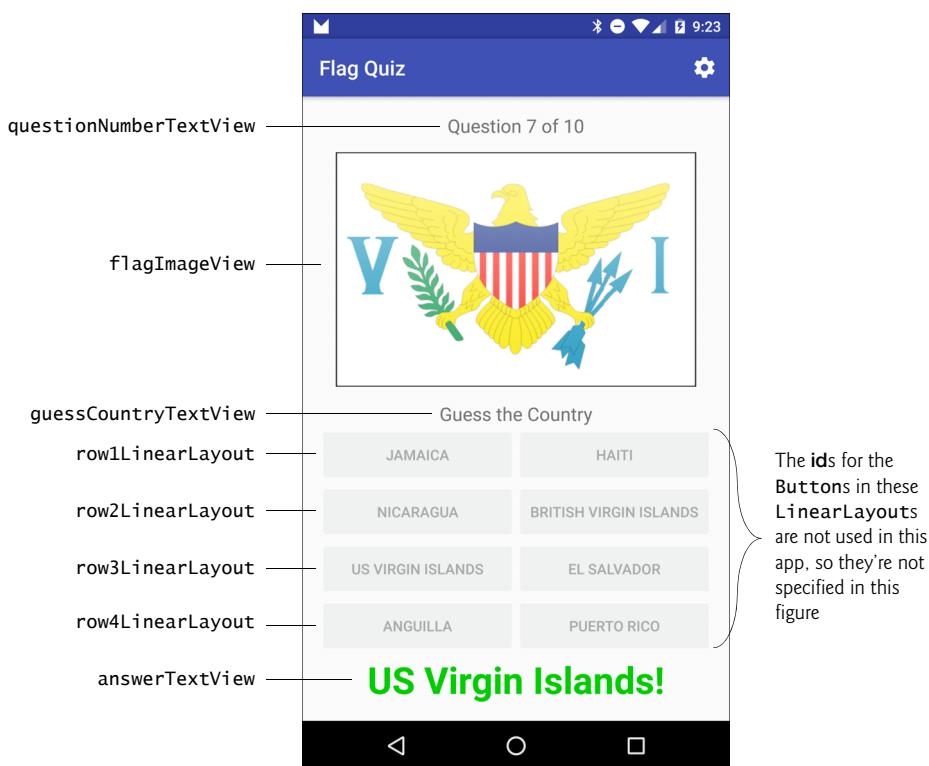
*According to the Android design guidelines, 16dp is the recommended space between the edges of a device's touchable screen area and the app's content; however, many apps (such as games) use the full screen.*

We work with multiple Fragments in this app's code. To make the code more readable when obtaining references to these Fragments, we changed this `<fragment>` element's `id` property. To do so:

1. Open `content_main.xml` in the `Design` tab.
2. In the `Component Tree` window select `fragment`—the default `id` created by the IDE.
3. In the `Properties` window, set the `id` to `quizFragment`.
4. Save `content_main.xml`.

### 4.5.2 Designing `fragment_main.xml` Layout

You'll typically define a layout for each of your Fragments, though you will not need to define one for this app's `SettingsActivityFragment`—its GUI will be auto-generated by the capabilities inherited from its superclass `PreferenceFragment`. This section presents the `MainActivityFragment`'s layout (`fragment_main.xml`). Figure 4.18 shows the `MainActivityFragment` GUI's `id` property values—you should set these `id` values as you add the components to the layout.



**Fig. 4.18 |** Flag Quiz GUI's components labeled with their `id` property values—the components are arranged in a vertical `LinearLayout`.

Using the techniques you learned in Chapter 3, you'll build the GUI in Fig. 4.18. Recall that it's often easiest to select a particular GUI component in the Component Tree window. You'll start with the basic layout and controls, then customize the controls' properties to complete the design.

#### *Step 1: Changing from a RelativeLayout to a LinearLayout*

As in the `activity_main.xml` layouts for the two prior apps, the default layout in `fragment_main.xml` is a `RelativeLayout`. Here, you'll change this to a vertical `LinearLayout` for this app's design:

1. Open the `fragment_main.xml` file, and switch to the `Text` tab.
2. In the XML, change `RelativeLayout` to `LinearLayout`.
3. Switch back to the `Design` tab.
4. In the `Component Tree` select `LinearLayout`.
5. In the `Properties` window, set the `LinearLayout`'s `orientation` to `vertical`.
6. Ensure that `layout:width` and `layout:height` are set to `match_parent`.
7. Set the `LinearLayout`'s `id` to `quizLinearLayout` for programmatic access.

By default, the IDE set the layout's **Padding Left** and **Padding Right** properties to a pre-defined dimension resource named `@dimen/activity_horizontal_margin`—located in the `dimens.xml` file of the project's `res/values` folder. This resource's value is `16dp`, so there will be `16dp` of padding on the layout's left and right sides. The IDE created this resource when you created the app's project. Similarly, the IDE sets the **Padding Top** and **Padding Bottom** properties to `@dimen/activity_vertical_margin`—another predefined dimension resource with the value `16dp`. So there will be `16dp` of padding above and below the layout. Thus, all of `MainActivityFragment`'s GUI will be inset `16dp` from the rest of `MainActivity`'s GUI.

### ***Step 2: Adding the questionNumberTextView to the LinearLayout***

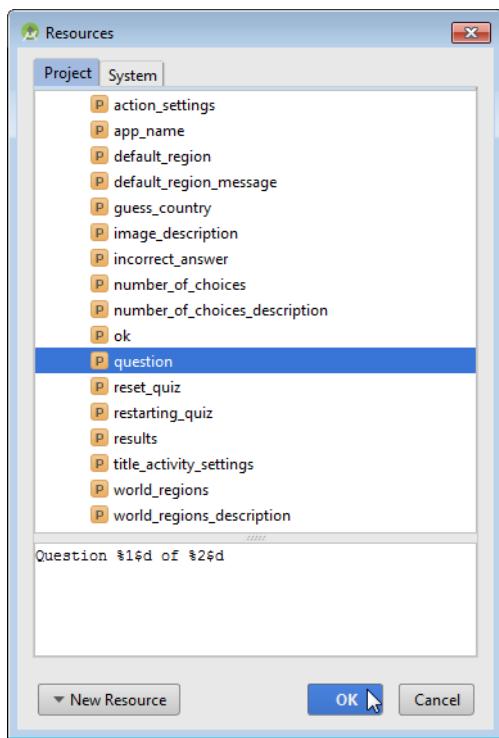
Drag a **Medium Text** component from the **Palette**'s **Widgets** section onto the `quizLinearLayout` in the **Component Tree** window, then set its `id` property to `questionNumberTextView`. Use the **Properties** window to set the following properties:

- `layout:gravity center: horizontal`—Centers the component horizontally within the layout.
- `layout:margin: @dimen/spacing`—Set this only for the **bottom margin** to add `8dp` of space below this component. *Create this dimension resource* using the techniques you learned in Section 2.5.6.
- `text: @string/question`—To set this property, click the `text` property's field, then click the ellipsis (...) button. In the **Resources** dialog's **Project** tab (Fig. 4.19), select the `question` resource, then click **OK**.

### ***Step 3: Adding the flagImageView to the LinearLayout***

Drag an **Image View** component from the **Palette**'s **Widgets** section onto the `quizLinearLayout` in the **Component Tree** window, then set its `id` property to `flagImageView`. Use the **Properties** window to set the following properties:

- `layout:width: match_parent`
- `layout:height: 0dp`—This will let the view's height be determined by the `layout:weight` property.
- `layout:gravity center: both`
- `layout:margin bottom: @dimen/spacing`—Adds `8dp` of space below this component.
- `layout:margin left and right: @dimen/activity_horizontal_margin`—Adds `16dp` of space to the left and right of this component, so the complete flag displays during the flag-shake animation that moves the flag left and right.
- `layout:weight: 1`—Setting the `layout:weight` of this component to `1` (the default is `0` for all components) makes the `flagImageView` more important than the other components in the `quizLinearLayout`. When Android lays out the components, they'll use *only the vertical space they need* and the `flagImageView` will occupy *all remaining vertical space*. Setting `flagImageView`'s `layout:height` to `0dp` is recommended by the IDE to help Android lay out the GUI faster at runtime.



**Fig. 4.19** | Resource Chooser dialog—selecting the existing String resource `question`.

- `adjustViewBounds: true`—Setting the `ImageView`'s `Adjust View Bounds` property to `true` (by checking its checkbox) indicates that the `ImageView` maintains its image's aspect ratio.
- `contentDescription: @string/image_description`
- `scaleType: fitCenter`—This indicates that the `ImageView` should scale the image to fill either the `ImageView`'s width or height while maintaining the original image's aspect ratio. If the image's width is less than the `ImageView`'s, the image is centered horizontally. Similarly, if the image's height is less than the `ImageView`'s, the image is centered vertically.



#### Look-and-Feel Observation 4.3

Recall that it's considered a best practice in Android to ensure that every GUI component can be used with TalkBack. For components that don't have descriptive text, such as `ImageViews`, set the component's `contentDescription` property.

#### Step 4: Adding the `guessCountryTextView` to the `LinearLayout`

Drag a Medium Text component from the Palette's Widgets section onto the `quizLinearLayout` in the Component Tree window, then set its `id` property to `guessCountryTextView`. Use the Properties window to set the following properties:

- `layout:gravity center: horizontal`
- `text: @string/guess_country`

### *Step 5: Adding the Buttons to the LinearLayout*

For this app, we add the Buttons to the layout in rows—each row is a horizontal `LinearLayout` containing two Buttons. You’ll set the properties of the eight Buttons in *Step 7*. Follow these steps to add the eight Buttons to the layout:

1. Drag a `LinearLayout (Horizontal)` from the Palette’s `Layouts` section to the `quizLinearLayout` in the Component Tree and set its `id` to `row1LinearLayout` and its `layout:height` to `wrap_content`.
2. Drag a Button from the Palette’s `Widgets` section onto the `row1LinearLayout` in the Component Tree. You do not need to set its `id` because the Buttons are not referenced by their `ids` in this app’s Java code.
3. Repeat *Step 2* for the other Button in the first row.
4. Repeat *Steps 1–3* for the three remaining `LinearLayouts` and set their `ids` to the values shown in Fig. 4.18 to create the last three rows of buttons.

### *Step 6: Adding the answerTextView to the LinearLayout*

Drag a Medium Text component from the Palette’s `Widgets` section onto the `quizLinearLayout` in the Component Tree window, then set its `id` property to `answerTextView`. Use the Properties window to set the following properties:

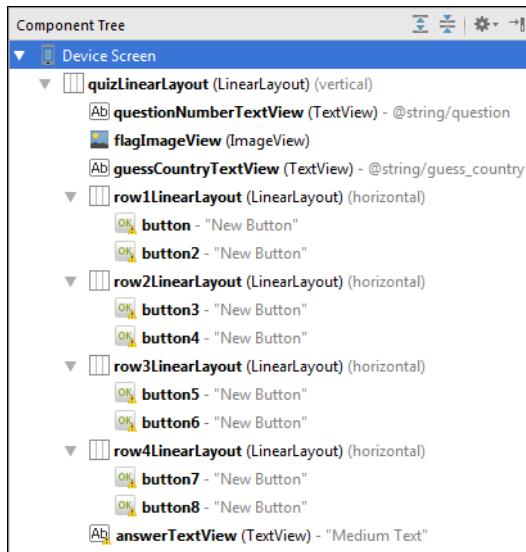
- `layout:gravity: Check bottom and set center to horizontal.`
- `gravity: center_horizontal`—This centers the `TextView`’s text when it displays as two or more lines.
- `textSize: @dimen/answer_size`—This changes the text’s size to `36sp`. Create this dimension resource using the techniques you learned in Section 2.5.6.
- `textStyle: bold`

This `TextView`’s `text` property will be set programmatically. At this point, the Component Tree window should appear as shown in Fig. 4.20.

### *Step 7: Setting the Properties of the Buttons*

Once you’ve completed *Step 6*, configure the properties of the Buttons with the values shown in Fig. 4.21—you can select all eight Buttons in the Component Tree, then set these properties to configure all the Buttons at the same time:

- Setting each Button’s `layout:width` to `0dp` and `layout:weight` to `1` enables the Buttons in a given `LinearLayout` to divide the horizontal space equally.
- Setting each Button’s `layout:height` to `match_parent` sets the Button’s height to the `LinearLayout`’s height.
- Setting each Button’s `lines` property to `2` ensures that all of the Buttons are the same height for country names that take up different numbers of lines—if a Button’s text is too long, any text that does not fit in two lines is simply truncated.



**Fig. 4.20** | Component Tree window for `fragment_main.xml`.

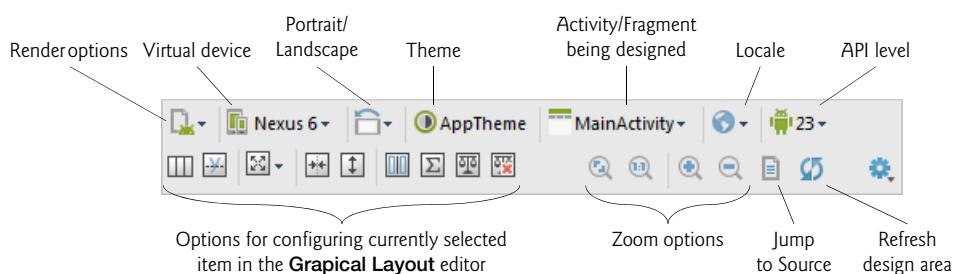
- Setting the `style` property to `@android:style/Widget.Material.Button.Colored` causes the Button to take on a colored appearance, based on the colors of the app's theme. The Buttons' color will be the app's accent color, which you specified in Section 4.4.7. To set this property, click the ellipsis (...) to open the Resources dialog, then select `Widget.Material.Button.Colored` from the System tab and click OK.
- Setting the `textColor` property to the `@color/button_text_color` color state list you defined in Section 4.4.8 ensures that the text changes color based on each Button's enabled/disabled states.

| GUI component | Property   | Value |
|---------------|--|-------|
| Buttons       | <code>Layout Parameters</code><br><code>layout:width</code> 0dp<br><code>layout:height</code> match_parent<br><code>layout:weight</code> 1<br><br><code>Other Properties</code><br><code>lines</code> 2<br><code>textColor</code> <code>@color/button_text_color</code><br><code>style</code> <code>@android:style/Widget.Material.Button.Colored</code> |       |

**Fig. 4.21** | Property values for the Buttons components in `fragment_main.xml`.

### 4.5.3 Graphical Layout Editor Toolbar

You've now completed the `MainActivityFragment`'s GUI. The layout editor's toolbar (Fig. 4.22) contains various buttons that enable you to preview the design for other screen sizes and orientations. In particular, you can view thumbnail images of many screen sizes and orientations. To do so, first open `content_main.xml`, then click the virtual device drop-down at the top of the layout editor and select **Preview All Screen Sizes**. Figure 4.23 overviews some of the buttons in the layout editor's toolbar.



**Fig. 4.22** | Canvas configuration options.

| Option                           | Description  |
|----------------------------------|--|
| Render options                   | View one design screen at a time or see your design on a variety of screen sizes all at once.  |
| Virtual device                   | Android runs on a wide variety of devices, so the layout editor comes with many device configurations that represent various screen sizes and resolutions that you can use to design your GUI. In this book, we use the predefined <b>Nexus 6</b> and <b>Nexus 9</b> screens, depending on the app. In Fig. 4.22, we selected <b>Nexus 6</b> . |
| Portrait/landscape               | Toggles the design area between <i>portrait</i> and <i>landscape</i> orientations.   |
| Theme                            | Can be used to set the theme for the GUI.  |
| Activity/fragment being designed | Shows the <b>Activity</b> or <b>Fragment</b> class that corresponds to the GUI being designed.   |
| Locale                           | For <i>internationalized</i> apps (Section 2.8), allows you to select a specific localization, so that you can see, for example, what your design looks like with different language strings.  |
| API level                        | Specifies the target API level for the design. With each new API level, there have typically been new GUI features. The layout editor window shows only features that are available in the selected API level.   |

**Fig. 4.23** | Explanation of the canvas configuration options.

### 4.5.4 `content_main.xml` Layout for Tablet Landscape Orientation

As we mentioned previously, `MainActivity`'s default `content_main.xml` layout displays the `MainActivityFragment`'s GUI. You'll now define `MainActivity`'s layout for tablets in

landscape orientation, which will show both the `SettingsActivityFragment` and the `MainActivityFragment` side-by-side. To do so, you'll create a second `content_main.xml` layout that Android will use only on appropriate devices.

### *Creating `content_main.xml` for Tablets in Landscape Orientation*

To create the layout, perform the following steps:

1. Right click the project's `res/layout` folder, and select **New > Layout resource file**.
2. Enter `content_main.xml` in the **File name** field of the **New Resource File** dialog.
3. Ensure that `LinearLayout` is specified in the **Root element** field.
4. In the **Available qualifiers** list, select the **Smallest Screen Width** qualifier, then click the **>>** button to add the qualifier to the **Chosen Qualifiers** list and set its value to `700`—the layout is meant for screens that are at least 700 pixels wide.
5. In the **Available qualifiers** list, select the **Orientation** qualifier, then click the **>>** button to add the qualifier to the **Chosen Qualifiers** list and set its value to `Landscape`.
6. Click **OK**.

This creates the new `content_main.xml` file, which is stored in a `res` subfolder named

`layout-sw700dp-land`

indicating that the layout should be used only on a device with a minimum screen width (`sw`) of `700dp` and only when the device is in landscape (`land`) orientation. Android uses the qualifiers `sw` and `land` to select appropriate resources at runtime.

In Android Studio, the `Project` window does not show the separate `layout` and `layout-sw700dp-land` folders that you'll see if you explore the project's folders on disk. Instead, it combines both layouts into a single node `content_main.xml (2)` node in the `Project` window's `res/layout` folder—`(2)` indicates that there are two layouts in the node. Expanding this node shows

- `content_main.xml` and
- `content_main.xml (sw700dp-land)`.

The layout without qualifiers in parentheses is the default layout. The one with qualifiers is used only if appropriate. After creating the file, Android Studio opens the layout in the layout editor. The `Design` view presents the layout in layout orientation.

### *Creating the Tablet Layout's GUI*

Next, you'll build the tablet layout's GUI:

1. Select `LinearLayout (vertical)` in the `Component Tree` window and set the `orientation` property to `horizontal`.
2. Click `<fragment>` in the `Palette`'s `Custom` section. In the `Fragments` dialog, select `SettingsActivityFragment`, and click **OK**. Then click the `LinearLayout` node in the `Component Tree` window. This adds the `<fragment>` to the layout. Set the `id` of the `<fragment>` to `settingsActivityFragment`.
3. Repeat the preceding step, but this time select `MainActivityFragment`. Also, set the `id` of this `<fragment>` to `quizFragment`.

4. Select the `settingsActivityFragment` node in the Component Tree window. Set `layout:width` to `0dp`, `layout:height` to `match_parent` and `layout:weight` to `1`.
5. Select the `quizFragment` node in the Component Tree window. Set `layout:width` to `0dp`, `layout:height` to `match_parent` and `layout:weight` to `2`. `MainActivityFragment`'s `layout:weight` is `2` and `SettingsActivityFragment`'s is `1`, so the total of the weights is `3` and `MainActivityFragment` will occupy two-thirds of the layout's horizontal space.
6. Switch to the Text tab and add the following two lines to the opening `LinearLayout` tag to ensure that the top of the layout appears below the app bar, rather than behind it:

```
xmlns:app="http://schemas.android.com/apk/res-auto"
    app:layout_behavior="@string/appbar_scrolling_view_behavior"
```

### Selecting a Fragment to Preview in the Layout Editor's Design View

The layout editor's Design view can show a preview of any fragment(s) displayed in a layout. If you do not specify which fragment to preview, the layout editor displays a "Rendering Problems" message. To specify the fragment to preview, right click the fragment—either in Design view or in the Component Tree—and click Choose Preview Layout.... Then in the Resources dialog, select the name of the fragment layout.

## 4.6 MainActivity Class

Class `MainActivity` (Sections 4.6.1–4.6.7) hosts the app's `MainActivityFragment` when the app is running in portrait orientation, and hosts both the `SettingsActivityFragment` and `MainActivityFragment` when the app is running on a tablet in landscape orientation.

### 4.6.1 package Statement and import Statements

Figure 4.24 shows the `MainActivity` package statement and `import` statements. Lines 6–19 import the various Android and Java classes and interfaces that the app uses. We've highlighted the new `import` statements, and we discuss the corresponding classes and interfaces in Section 4.3 and as they're encountered in Sections 4.6.2–4.6.7.

---

```
1 // MainActivity.java
2 // Hosts the MainActivityFragment on a phone and both the
3 // MainActivityFragment and SettingsActivityFragment on a tablet
4 package com.deitel.flagquiz;
5
6 import android.content.Intent;
7 import android.content.SharedPreferences;
8 import android.content.SharedPreferences.OnSharedPreferenceChangeListener;
9 import android.content.pm.ActivityInfo;
10 import android.content.res.Configuration;
11 import android.os.Bundle;
12 import android.preference.PreferenceManager;
13 import android.support.v7.app.AppCompatActivity;
14 import android.support.v7.widget.Toolbar;
```

---

**Fig. 4.24** | `MainActivity` package statement and `import` statements. (Part 1 of 2.)

---

```

15 import android.view.Menu;
16 import android.view.MenuItem;
17 import android.widget.Toast;
18
19 import java.util.Set;
20

```

---

**Fig. 4.24** | MainActivity package statement and import statements. (Part 2 of 2.)

## 4.6.2 Fields

Figure 4.25 shows class MainActivity’s fields. Lines 23–24 define constants for the preference keys you created in Section 4.4.11. You’ll use these to access the preference values. The boolean variable phoneDevice (line 26) specifies whether the app is running on a phone—if so, the app will allow only portrait orientation. The boolean variable preferencesChanged (line 27) specifies whether the app’s preferences have changed—if so, the MainActivity’s onStart lifecycle method (Section 4.6.4) will call the MainActivityFragment’s methods updateGuessRows (Section 4.7.4) and updateRegions (Section 4.7.5) to reconfigure the quiz, based on the new settings. We set this boolean to true initially so that when the app first executes, the quiz is configured using the default preferences.

---

```

21 public class MainActivity extends Activity {
22     // keys for reading data from SharedPreferences
23     public static final String CHOICES = "pref_numberOfChoices";
24     public static final String REGIONS = "pref_regionsToInclude";
25
26     private boolean phoneDevice = true; // used to force portrait mode
27     private boolean preferencesChanged = true; // did preferences change?
28

```

---

**Fig. 4.25** | MainActivity declaration and fields.

## 4.6.3 Overridden Activity Method onCreate

Fig. 4.26 shows the overridden Activity method `onCreate`—we removed the predefined event handler for the FloatingActionButton, which is not used in this app. Line 33 calls `setContentView` to set MainActivity’s GUI. Recall that `activity_main.xml` embeds in its layout the contents of the file `content_main.xml`, and that this app has two versions of that file. When inflating `activity_main.xml`, Android embeds the default `content_main.xml` file from the app’s `res/layout` folder unless the app is running on a device that’s at least 700 pixels wide in landscape orientation—in that case, Android uses the version in the `res/layout-sw700dp-land` folder. Lines 34–35 were generated by the IDE to set the Toolbar defined in MainActivity’s layout as the app bar (formerly called the action bar)—again, this is the backward-compatible manner in which an app displays an app bar.

### Setting the Default Preference Values and Registering a Change Listener

When you install and launch the app for the first time, line 38 sets the app’s *default preferences* by calling `PreferenceManager` method `setDefaultValues`—this creates and initializes the app’s `SharedPreferences` file using the default values that you specified in `preferences.xml`. The method requires three arguments:

```

29     // configure the MainActivity
30     @Override
31     protected void onCreate(Bundle savedInstanceState) {
32         super.onCreate(savedInstanceState);
33         setContentView(R.layout.activity_main);
34         Toolbar toolbar = (Toolbar) findViewById(R.id.toolbar);
35         setSupportActionBar(toolbar);
36
37         // set default values in the app's SharedPreferences
38         PreferenceManager.setDefaultValues(this, R.xml.preferences, false);
39
40         // register listener for SharedPreferences changes
41         PreferenceManager.getDefaultSharedPreferences(this).
42             registerOnSharedPreferenceChangeListener(
43                 preferencesChangeListener);
44
45         // determine screen size
46         int screenSize = getResources().getConfiguration().screenLayout &
47             Configuration.SCREENLAYOUT_SIZE_MASK;
48
49         // if device is a tablet, set phoneDevice to false
50         if (screenSize == Configuration.SCREENLAYOUT_SIZE_LARGE ||
51             screenSize == Configuration.SCREENLAYOUT_SIZE_XLARGE)
52             phoneDevice = false; // not a phone-sized device
53
54         // if running on phone-sized device, allow only portrait orientation
55         if (phoneDevice)
56             setRequestedOrientation(
57                 ActivityInfo.SCREEN_ORIENTATION_PORTRAIT);
58     }
59

```

**Fig. 4.26** | MainActivity overridden Activity method onCreate.

- The preferences' **Context** (package **android.content**), which provides access to information about the environment in which the app is running and allows you to use various Android services—in this case, the **Context** is the **Activity** (**this**) for which you are setting the default preferences.
- The resource ID for the preferences XML file (**R.xml.preferences**) that you created in Section 4.4.11.
- A boolean indicating whether the default values should be reset each time method **setDefaultValues** is called—**false** indicates that the default preference values should be set only the first time this method is called.

Each time the user changes the app's preferences, **MainActivity** should call **MainActivityFragment**'s methods **updateGuessRows** or **updateRegions** to reconfigure the quiz. **MainActivity** registers an **OnSharedPreferenceChangedListener** (lines 41–43) so that it will be notified each time a preference changes. **PreferenceManager** method **getDefaultSharedPreferences** returns a reference to the **SharedPreferences** object representing the app's preferences, and **SharedPreferences** method **registerOnSharedPreferenceChangeListener** registers the listener (defined in Section 4.6.7).

### Configuring a Phone Device for Portrait Orientation

Lines 46–52 determine whether the app is running on a tablet or a phone. Inherited method `getResources` returns the app's `Resources` object (package `android.content.res`) for accessing an app's resources and determining information about its environment. Method `getConfiguration` returns a `Configuration` object (package `android.content.res`) containing `public` instance variable `screenLayout`, which specifies the device's screen-size category. To do so, first you combine the value of `screenLayout` with `Configuration.SCREENLAYOUT_SIZE_MASK` using the bitwise AND (&) operator. Then, you compare the result to the constants `SCREENLAYOUT_SIZE_LARGE` and `SCREENLAYOUT_SIZE_XLARGE` (lines 50–51). If either is a match, the app is running on a tablet-sized device. Finally, if the device is a phone, lines 56–57 call inherited `Activity` method `setRequestedOrientation` to force the app to display `MainActivity` in only portrait orientation.

#### 4.6.4 Overridden Activity Method `onStart`

Overridden `Activity` lifecycle method `onStart` (Fig. 4.27) is called in two scenarios:

- When the app first executes, `onStart` is called after `onCreate`. We use `onStart` in this case to ensure that the quiz is configured correctly based on the app's default preferences when the app is installed and executes for the first time or based on the user's updated preferences when the app is launched subsequently.
- When the app is running in portrait orientation and the user opens the `SettingsActivity`, the `MainActivity` is *stopped* while the `SettingsActivity` is displayed. When the user returns to the `MainActivity`, `onStart` is called again. We use `onStart` in this case to ensure that the quiz is reconfigured properly if the user made any preference changes.

In both cases, if `preferencesChanged` is true, `onStart` calls `MainActivityFragment`'s `updateGuessRows` (Section 4.7.4) and `updateRegions` (Section 4.7.5) methods to reconfigure the quiz. To get a reference to the `MainActivityFragment` so we can call its methods, lines 68–70 use inherited `AppCompatActivity` method `getSupportFragmentManager` to get the `FragmentManager`, then call its `findFragmentById` method. Next, lines 71–74 call `MainActivityFragment`'s `updateGuessRows` and `updateRegions` methods, passing the app's `SharedPreferences` object as an argument so those methods can load the current preferences. Line 75 resets the quiz and line 76 sets `preferencesChanged` back to false.

---

```

60    // called after onCreate completes execution
61    @Override
62    protected void onStart() {
63        super.onStart();
64
65        if (preferencesChanged) {
66            // now that the default preferences have been set,
67            // initialize MainActivityFragment and start the quiz
68            MainActivityFragment quizFragment = (MainActivityFragment)
69                getSupportFragmentManager().findFragmentById(
70                    R.id.quizFragment);

```

---

**Fig. 4.27** | `MainActivity` overridden `Activity` method `onStart`. (Part 1 of 2.)

---

```

71     quizFragment.updateGuessRows(
72         PreferenceManager.getDefaultSharedPreferences(this));
73     quizFragment.updateRegions(
74         PreferenceManager.getDefaultSharedPreferences(this));
75     quizFragment.resetQuiz();
76     preferencesChanged = false;
77 }
78 }
79

```

---

**Fig. 4.27** | MainActivity overridden Activity method onStart. (Part 2 of 2.)

#### 4.6.5 Overridden Activity Method onCreateOptionsMenu

Overridden Activity method onCreateOptionsMenu (Fig. 4.28) initializes the Activity's options menu—this method and method onOptionsItemSelected (Section 4.6.6) were autogenerated by Android Studio's **Blank Activity** template. The system passes in the Menu object where the options will appear. In this app, we want to show the menu only when the app is running in portrait orientation, so we modified this method to check the device's orientation. Line 84 uses the Activity's Resources object (returned by inherited method **getResources**) to obtain a Configuration object (returned by method **getConfiguration**) that represents the device's current configuration. This object's public instance variable **orientation** contains either Configuration.ORIENTATION\_PORTRAIT or Configuration.ORIENTATION\_LANDSCAPE. If the device is in portrait orientation (line 87), line 89 creates the menu from **menu\_main.xml**—the default menu resource that the IDE defined when you created the project. Inherited Activity method **getMenuInflater** returns a **MenuItemInflater** on which we call **inflate** with two arguments—the resource ID of the menu resource that populates the menu and the Menu object in which the menu items will be placed. Returning **true** from **onCreateOptionsMenu** indicates that the menu should be displayed.

---

```

80     // show menu if app is running on a phone or a portrait-oriented tablet
81     @Override
82     public boolean onCreateOptionsMenu(Menu menu) {
83         // get the device's current orientation
84         int orientation = getResources().getConfiguration().orientation;
85
86         // display the app's menu only in portrait orientation
87         if (orientation == Configuration.ORIENTATION_PORTRAIT) {
88             // inflate the menu
89             getMenuInflater().inflate(R.menu.menu_main, menu);
90             return true;
91         }
92         else
93             return false;
94     }
95

```

---

**Fig. 4.28** | MainActivity overridden Activity method onCreateOptionsMenu.

#### 4.6.6 Overridden Activity Method onOptionsItemSelected

Method `onOptionsItemSelected` (Fig. 4.29) is called when a menu item is selected. In this app, the default menu provided by the IDE when you created the project contains only the `Settings` menu item, so if this method is called, the user selected `Settings`. Line 99 creates an explicit Intent for launching the `SettingsActivity`. The Intent constructor used here receives the Context from which the Activity will be launched and the class representing the Activity to launch (`SettingsActivity.class`). We then pass this Intent to the inherited Activity method `startActivity` to launch the Activity (line 100).

---

```

96     // displays the SettingsActivity when running on a phone
97     @Override
98     public boolean onOptionsItemSelected(MenuItem item) {
99         Intent preferencesIntent = new Intent(this, SettingsActivity.class);
100        startActivity(preferencesIntent);
101        return super.onOptionsItemSelected(item);
102    }
103

```

---

**Fig. 4.29** | MainActivity overridden Activity method `onOptionsItemSelected`.

#### 4.6.7 Anonymous Inner Class That Implements OnSharedPreferenceChangeListener

The `preferencesChangeListener` object (Fig. 4.30) is an anonymous-inner-class object that implements the `OnSharedPreferenceChangeListener` interface. This object was registered in method `onCreate` to listen for changes to the app's `SharedPreferences`. When a change occurs, method `onSharedPreferenceChanged` sets `preferencesChanged` to `true` (line 111), then gets a reference to the `MainActivityFragment` (lines 113–115) so that the quiz can be reset with the new preferences. If the `CHOICES` preference changed, lines 118–119 call the `MainActivityFragment`'s `updateGuessRows` and `resetQuiz` methods.

---

```

104    // listener for changes to the app's SharedPreferences
105    private OnSharedPreferenceChangeListener preferencesChangeListener =
106        new OnSharedPreferenceChangeListener() {
107            // called when the user changes the app's preferences
108            @Override
109            public void onSharedPreferenceChanged(
110                SharedPreferences sharedPreferences, String key) {
111                preferencesChanged = true; // user changed app settings
112
113                MainActivityFragment quizFragment = (MainActivityFragment)
114                    getSupportFragmentManager().findFragmentById(
115                        R.id.quizFragment);
116
117                if (key.equals(CHOICES)) { // # of choices to display changed
118                    quizFragment.updateGuessRows(sharedPreferences);

```

---

**Fig. 4.30** | Anonymous Inner class that implements `OnSharedPreferenceChangeListener`.  
(Part 1 of 2.)

```

119         quizFragment.resetQuiz();
120     }
121     else if (key.equals(REGIONS)) { // regions to include changed
122         Set<String> regions =
123             sharedPreferences.getStringSet(REGIONS, null);
124
125         if (regions != null && regions.size() > 0) {
126             quizFragment.updateRegions(sharedPreferences);
127             quizFragment.resetQuiz();
128         }
129     else {
130         // must select one region--set North America as default
131         SharedPreferences.Editor editor =
132             sharedPreferences.edit();
133         regions.add(getString(R.string.default_region));
134         editor.putStringSet(REGIONS, regions);
135         editor.apply();
136
137         Toast.makeText(MainActivity.this,
138             R.string.default_region_message,
139             Toast.LENGTH_SHORT).show();
140     }
141 }
142
143 Toast.makeText(MainActivity.this,
144     R.string.restarting_quiz,
145     Toast.LENGTH_SHORT).show();
146 }
147 }
148 }

```

**Fig. 4.30** | Anonymous Inner class that implements OnSharedPreferenceChangeListener. (Part 2 of 2.)

If the REGIONS preference changed, lines 122–123 get the `Set<String>` containing the enabled regions. `SharedPreferences` method `getStringSet` returns a `Set<String>` for the specified key. The quiz must have at least one region enabled, so if the `Set<String>` is not empty, lines 126–127 call the `MainActivityFragment`'s `updateRegions` and `resetQuiz` methods.

If the `Set<String>` is empty, lines 131–135 update the REGIONS preference with North America set as the default region. To obtain the default region's name, line 133 calls `Activity`'s inherited method `getString`, which returns the `String` resource for the specified resource ID (`R.string.default_region`).

To change a `SharedPreferences` object's contents, first call its `edit` method to obtain a `SharedPreferences.Editor` object (lines 131–132), which can add key–value pairs to, remove key–value pairs from, and modify the value associated with a particular key in a `SharedPreferences` file. Line 134 calls `SharedPreferences.Editor` method `putStringSet` to store the contents of `regions` (the `Set<String>`). Line 135 *commits* (saves) the changes by calling `SharedPreferences.Editor` method `apply`, which immediately makes the changes to the in-memory representation of the `SharedPreferences`, and asyn-

chronously writes the changes to the file in the background. There is also a `commit` method that writes the changes to the file synchronously (immediately).

Lines 137–139 use a `Toast` to indicate that the default region was set. `Toast` method `makeText` receives as arguments the `Context` on which the `Toast` is displayed, the message to display and the duration for which the `Toast` will be displayed. `Toast` method `show` displays the `Toast`. Regardless of which preference changed, lines 143–145 display a `Toast` indicating that the quiz will be reset with the new preferences. Figure 4.31 shows the `Toast` that appears after the user changes the app’s preferences.

Quiz will restart with your new settings

**Fig. 4.31** | `Toast` displayed after a preference is changed.

## 4.7 MainActivityFragment Class

Class `MainActivityFragment` (Figs. 4.32–4.42)—a subclass of the Android Support Library’s `Fragment` class (package `android.support.v4.app`)—builds the Flag Quiz’s GUI and implements the quiz’s logic.

### 4.7.1 package and import Statements

Figure 4.32 shows the `MainActivityFragment` package statement and `import` statements. Lines 5–36 `import` the various Java and Android classes and interfaces that the app uses. We’ve highlighted the key `import` statements, and we discuss the corresponding classes and interfaces in Section 4.3 and as they’re encountered in Sections 4.7.2–4.7.11.

```

1 // MainActivityFragment.java
2 // Contains the Flag Quiz logic
3 package com.deitel.flagquiz;
4
5 import java.io.IOException;
6 import java.io.InputStream;
7 import java.security.SecureRandom;
8 import java.util.ArrayList;
9 import java.util.Collections;
10 import java.util.List;
11 import java.util.Set;
12
13 import android.animation.Animator;
14 import android.animation.AnimatorListenerAdapter;
15 import android.app.AlertDialog;
16 import android.app.Dialog;
17 import android.content.DialogInterface;
18 import android.content.SharedPreferences;
19 import android.content.res.AssetManager;
20 import android.graphics.drawable.Drawable;
```

**Fig. 4.32** | `MainActivityFragment` package statement, `import` statements. (Part 1 of 2.)

```
21 import android.os.Bundle;
22 import android.support.v4.app.DialogFragment;
23 import android.support.v4.app.Fragment;
24 import android.os.Handler;
25 import android.util.Log;
26 import android.view.LayoutInflater;
27 import android.view.View;
28 import android.view.View.OnClickListener;
29 import android.view.ViewAnimationUtils;
30 import android.view.ViewGroup;
31 import android.view.animation.Animation;
32 import android.view.animation.AnimationUtils;
33 import android.widget.Button;
34 import android.widget.ImageView;
35 import android.widget.LinearLayout;
36 import android.widget.TextView;
37
```

**Fig. 4.32** | MainActivityFragment package statement, import statements. (Part 2 of 2.)

## 4.7.2 Fields

Figure 4.33 lists class MainActivityFragment's static and instance variables. The constant TAG (line 40) is used when we log error messages using class Log (Fig. 4.38) to distinguish this Activity's error messages from others that are being written to the device's log. The constant FLAGS\_IN QUIZ (line 42) represents the number of flags in the quiz.

```
38 public class MainActivityFragment extends Fragment {
39     // String used when Logging error messages
40     private static final String TAG = "FlagQuiz Activity";
41
42     private static final int FLAGS_IN QUIZ = 10;
43
44     private List<String> fileNameList; // flag file names
45     private List<String> quizCountriesList; // countries in current quiz
46     private Set<String> regionsSet; // world regions in current quiz
47     private String correctAnswer; // correct country for the current flag
48     private int totalGuesses; // number of guesses made
49     private int correctAnswers; // number of correct guesses
50     private int guessRows; // number of rows displaying guess Buttons
51     private SecureRandom random; // used to randomize the quiz
52     private Handler handler; // used to delay loading next flag
53     private Animation shakeAnimation; // animation for incorrect guess
54
55     private LinearLayout quizLinearLayout; // layout that contains the quiz
56     private TextView questionNumberTextView; // shows current question #
57     private ImageView flagImageView; // displays a flag
58     private LinearLayout[] guessLinearLayouts; // rows of answer Buttons
59     private TextView answerTextView; // displays correct answer
60
```

**Fig. 4.33** | MainActivityFragment fields.



### Good Programming Practice 4.1

For readability and modifiability, use *String constants* to represent filenames *String literals* (such as those used as the names of files or to log error messages) that do not need to be localized, and thus are not defined in *strings.xml*.

Variable `fileNameList` (line 44) holds the flag-image file names for the currently enabled geographic regions. Variable `quizCountriesList` (line 45) holds the flag file names for the countries used in the current quiz. Variable `regionsSet` (line 46) stores the geographic regions that are enabled.

Variable `correctAnswer` (line 47) holds the flag file name for the current flag's correct answer. Variable `totalGuesses` (line 48) stores the total number of correct and incorrect guesses the player has made so far. Variable `correctAnswers` (line 49) is the number of correct guesses so far; this will eventually be equal to `FLAGS_IN QUIZ` if the user completes the quiz. Variable `guessRows` (line 50) is the number of two-Button `LinearLayouts` displaying the flag answer choices—this is controlled by the app's settings (Section 4.7.4).

Variable `random` (line 51) is the random-number generator used to randomly pick the flags to include in the quiz and which `Button` in the two-Button `LinearLayouts` represents the correct answer. When the user selects a correct answer and the quiz is not over, we use the `Handler` object `handler` (line 52) to load the next flag after a short delay.

The Animation `shakeAnimation` (line 53) holds the dynamically inflated *shake animation* that's applied to the flag image when an incorrect guess is made. Lines 55–59 contain variables that we use to manipulate various GUI components programmatically.

#### 4.7.3 Overridden Fragment Method `onCreateView`

`MainActivityFragment`'s `onCreateView` method (Fig. 4.34) inflates the GUI and initializes most of the `MainActivityFragment`'s instance variables—`guessRows` and `regionsSet` are initialized when the `MainActivity` calls `MainActivityFragment`'s `updateGuessRows` and `updateRegions` methods. After calling the superclass's `onCreateView` method (line 65), we inflate the `MainActivityFragment`'s GUI (line 66–67) using the `LayoutInflater` that method `onCreateView` receives as an argument. The `LayoutInflater`'s `inflate` method receives three arguments:

- The layout resource ID indicating the layout to inflate.
- The `ViewGroup` (layout object) in which the `Fragment` will be displayed, which is received as `onCreateView`'s second argument.
- A `boolean` indicating whether or not the inflated GUI needs to be attached to the `ViewGroup` in the second argument. In a fragment's `onCreateView` method, this should always be `false`—the system automatically attaches a fragment to the appropriate host `Activity`'s `ViewGroup`. Passing `true` here would cause an exception, because the fragment's GUI is already attached.

Method `inflate` returns a reference to a `View` that contains the inflated GUI. We store that in local variable `view` so that it can be returned by `onCreateView` after the `MainActivityFragment`'s other instance variables are initialized. [Note: We removed the autogenerated, empty, no-argument constructor from this class (which appeared before method `onCreateView` in the class definition created by the IDE), as the compiler provides a default constructor for any class without constructors.]

```

61 // configures the MainActivityFragment when its View is created
62 @Override
63 public View onCreateView(LayoutInflater inflater, ViewGroup container,
64     Bundle savedInstanceState) {
65     super.onCreateView(inflater, container, savedInstanceState);
66     View view =
67         inflater.inflate(R.layout.fragment_main, container, false);
68
69     fileNameList = new ArrayList<>(); // diamond operator
70     quizCountriesList = new ArrayList<>();
71     random = new SecureRandom();
72     handler = new Handler();
73
74     // load the shake animation that's used for incorrect answers
75     shakeAnimation = AnimationUtils.loadAnimation(getActivity(),
76         R.anim.incorrect_shake);
77     shakeAnimation.setRepeatCount(3); // animation repeats 3 times
78
79     // get references to GUI components
80     quizLinearLayout =
81         (LinearLayout) view.findViewById(R.id.quizLinearLayout);
82     questionNumberTextView =
83         (TextView) view.findViewById(R.id.questionNumberTextView);
84     flagImageView = (ImageView) view.findViewById(R.id.flagImageView);
85     guessLinearLayouts = new LinearLayout[4];
86     guessLinearLayouts[0] =
87         (LinearLayout) view.findViewById(R.id.row1LinearLayout);
88     guessLinearLayouts[1] =
89         (LinearLayout) view.findViewById(R.id.row2LinearLayout);
90     guessLinearLayouts[2] =
91         (LinearLayout) view.findViewById(R.id.row3LinearLayout);
92     guessLinearLayouts[3] =
93         (LinearLayout) view.findViewById(R.id.row4LinearLayout);
94     answerTextView = (TextView) view.findViewById(R.id.answerTextView);
95
96     // configure listeners for the guess Buttons
97     for (LinearLayout row : guessLinearLayouts) {
98         for (int column = 0; column < row.getChildCount(); column++) {
99             Button button = (Button) row.getChildAt(column);
100             button.setOnClickListener(guessButtonListener);
101         }
102     }
103
104     // set questionNumberTextView's text
105     questionNumberTextView.setText(
106         getString(R.string.question, 1, FLAGS_IN QUIZ));
107     return view; // return the fragment's view for display
108 }
109

```

**Fig. 4.34** | MainActivityFragment overridden Fragment method onCreateView.

Lines 69–70 create `ArrayList<String>` objects that will store the flag-image file names for the currently enabled geographical regions and the names of the countries in the

current quiz, respectively. Line 71 creates the `SecureRandom` object for randomizing the quiz's flags and guess Buttons. Line 72 creates the `Handler` object `handler`, which we'll use to delay by two seconds the appearance of the next flag after the user correctly guesses the current flag.

Lines 75–76 dynamically load the *shake animation* that will be applied to the flag when an incorrect guess is made. `AnimationUtils` static method `loadAnimation` loads the animation from the XML file represented by the constant `R.anim.incorrect_shake`. The first argument indicates the Context containing the resources that will be animated—`inherited Fragment` method `getActivity` returns the Activity that hosts this Fragment. Activity is an indirect subclass of Context. Line 77 specifies the number of times the animation should repeat with Animation method `setRepeatCount`.

Lines 80–94 get references to various GUI components that we'll programmatically manipulate. Lines 97–102 get each guess Button from the four `guessLinearLayouts` and register `guessButtonListener` (Section 4.7.10) as the `OnClickListener`—we implement this interface to handle the event raised when the user touches any of the guess Buttons.

Lines 105–106 set the text in `questionNumberTextView` to the `String` returned by calling an overloaded version of Fragment's inherited method `getString`. The first argument to `format` is the `String` resource `R.string.question`, which represents the format `String`

```
Question %1$d of %2$d
```

This `String` contains placeholders for two integer values (as described in Section 4.4.5). The remaining arguments are the values to insert in the format `String`. Line 107 returns the `MainActivityFragment`'s GUI.

#### 4.7.4 Method updateGuessRows

Method `updateGuessRows` (Fig. 4.35) is called from the app's `MainActivity` when the app is launched and each time the user changes the number of guess Buttons to display with each flag. Lines 113–114 use the method's `SharedPreferences` argument to get the `String` for the key `MainActivity.CHICES`—a constant containing the name of the preference in which the `SettingsActivityFragment` stores the number of guess Buttons to display. Line 115 converts the preference's value to an `int` and divides it by 2 to determine the value for `guessRows`, which indicates how many of the `guessLinearLayouts` should be displayed—each with two guess Buttons. Next, lines 118–119 hide all of the `guessLinearLayouts`, so that lines 122–123 can show the appropriate `guessLinearLayouts` based on the value of `guessRows`. The constant `View.GONE` (line 119) indicates that Android should not consider the sizes of the specified components when laying out the rest of the components in the layout. There is also the constant `View.INVISIBLE`, which simply hides the component, and any space allocated to the component remains empty on the screen.

---

```
110    // update guessRows based on value in SharedPreferences
111    public void updateGuessRows(SharedPreferences sharedPreferences) {
112        // get the number of guess buttons that should be displayed
113        String choices =
114            sharedPreferences.getString(MainActivity.CHICES, null);
```

---

**Fig. 4.35** | `MainActivityFragment` method `updateGuessRows`. (Part I of 2.)

---

```

115     guessRows = Integer.parseInt(choices) / 2;
116
117     // hide all guess button LinearLayouts
118     for (LinearLayout layout : guessLinearLayouts)
119         layout.setVisibility(View.GONE);
120
121     // display appropriate guess button LinearLayouts
122     for (int row = 0; row < guessRows; row++)
123         guessLinearLayouts[row].setVisibility(View.VISIBLE);
124     }
125

```

---

**Fig. 4.35** | MainActivityFragment method updateGuessRows. (Part 2 of 2.)

#### 4.7.5 Method updateRegions

Method updateRegions (Fig. 4.36) is called from the app’s MainActivity when the app is launched and each time the user changes the world regions that should be included in the quiz. Lines 128–129 use the method’s SharedPreferences argument to get the names of all of the enabled regions as a Set<String>. MainActivity.REGIONS is a constant containing the name of the preference in which the SettingsActivityFragment stores the enabled world regions.

---

```

126     // update world regions for quiz based on values in SharedPreferences
127     public void updateRegions(SharedPreferences sharedPreferences) {
128         regionsSet =
129             sharedPreferences.getStringSet(MainActivity.REGIONS, null);
130     }
131

```

---

**Fig. 4.36** | MainActivityFragment method updateRegions.

#### 4.7.6 Method resetQuiz

Method resetQuiz (Fig. 4.37) sets up and starts a quiz. Recall that the images for the game are stored in the app’s assets folder. To access this folder’s contents, the method gets the app’s AssetManager (line 135) by calling the parent Activity’s **getAssets** method. Next, line 136 clears the fileNameList to prepare to load image file names for only the enabled geographical regions. Lines 140–146 iterate through all the enabled world regions. For each, we use the AssetManager’s **list** method (line 142) to get an array of the flag-image file names, which we store in the String array paths. Lines 144–145 remove the .png extension from each file name and place the names in the fileNameList. AssetManager’s **list** method throws **IOExceptions**, which are *checked* exceptions (so you must catch or declare the exception). If an exception occurs because the app is unable to access the assets folder, lines 148–150 catch the exception and *log* it for debugging purposes with Android’s built-in logging mechanism. Log static method **e** is used to log error messages. You can see the complete list of Log methods at

<http://developer.android.com/reference/android/util/Log.html>

```

132 // set up and start the next quiz
133 public void resetQuiz() {
134     // use AssetManager to get image file names for enabled regions
135     AssetManager assets = getActivity().getAssets();
136     fileNameList.clear(); // empty list of image file names
137
138     try {
139         // loop through each region
140         for (String region : regionsSet) {
141             // get a list of all flag image files in this region
142             String[] paths = assets.list(region);
143
144             for (String path : paths)
145                 fileNameList.add(path.replace(".png", ""));
146         }
147     }
148     catch (IOException exception) {
149         Log.e(TAG, "Error loading image file names", exception);
150     }
151
152     correctAnswers = 0; // reset the number of correct answers made
153     totalGuesses = 0; // reset the total number of guesses the user made
154     quizCountriesList.clear(); // clear prior list of quiz countries
155
156     int flagCounter = 1;
157     int numberOffFlags = fileNameList.size();
158
159     // add FLAGS_IN QUIZ random file names to the quizCountriesList
160     while (flagCounter <= FLAGS_IN QUIZ) {
161         int randomIndex = random.nextInt(numberOffFlags);
162
163         // get the random file name
164         String filename = fileNameList.get(randomIndex);
165
166         // if the region is enabled and it hasn't already been chosen
167         if (!quizCountriesList.contains(filename)) {
168             quizCountriesList.add(filename); // add the file to the list
169             ++flagCounter;
170         }
171     }
172
173     loadNextFlag(); // start the quiz by loading the first flag
174 }
175

```

**Fig. 4.37** | MainActivityFragment method resetQuiz.

Next, lines 152–154 reset the counters for the number of correct guesses the user has made (correctAnswers) and the total number of guesses the user has made (totalGuesses) to 0 and clear the quizCountriesList.

Lines 160–171 add 10 (FLAGS\_IN QUIZ) randomly selected file names to the quizCountriesList. We get the total number of flags, then randomly generate the index in the range 0 to one less than the number of flags. We use this index to select one image file

name from `fileNameList`. If the `quizCountriesList` does not already contain that file name, we add it to `quizCountriesList` and increment the `flagCounter`. We repeat this process until 10 (`FLAGS_IN QUIZ`) unique file names have been selected. Then line 173 calls `loadNextFlag` (Fig. 4.38) to load the quiz's first flag.

#### 4.7.7 Method `loadNextFlag`

Method `loadNextFlag` (Fig. 4.38) loads and displays the next flag and the corresponding set of answer Buttons. The image file names in `quizCountriesList` have the format

*regionName-countryName*

without the `.png` extension. If a `regionName` or `countryName` contains multiple words, they're separated by underscores (`_`).

```

176    // after the user guesses a correct flag, load the next flag
177    private void loadNextFlag() {
178        // get file name of the next flag and remove it from the List
179        String nextImage = quizCountriesList.remove(0);
180        correctAnswer = nextImage; // update the correct answer
181        answerTextView.setText(""); // clear answerTextView
182
183        // display current question number
184        questionNumberTextView.setText(getString(
185            R.string.question, (correctAnswers + 1), FLAGS_IN QUIZ));
186
187        // extract the region from the next image's name
188        String region = nextImage.substring(0, nextImage.indexOf('-'));
189
190        // use AssetManager to load next image from assets folder
191        AssetManager assets = getActivity().getAssets();
192
193        // get an InputStream to the asset representing the next flag
194        // and try to use the InputStream
195        try (InputStream stream =
196            assets.open(region + "/" + nextImage + ".png")) {
197            // load the asset as a Drawable and display on the flagImageView
198            Drawable flag = Drawable.createFromStream(stream, nextImage);
199            flagImageView.setImageDrawable(flag);
200
201            animate(false); // animate the flag onto the screen
202        }
203        catch (IOException exception) {
204            Log.e(TAG, "Error loading " + nextImage, exception);
205        }
206
207        Collections.shuffle(fileNameList); // shuffle file names
208
209        // put the correct answer at the end of fileNameList
210        int correct = fileNameList.indexOf(correctAnswer);
211        fileNameList.add(fileNameList.remove(correct));
212

```

Fig. 4.38 | `MainActivityFragment` method `loadNextFlag`. (Part 1 of 2.)

---

```

213     // add 2, 4, 6 or 8 guess Buttons based on the value of guessRows
214     for (int row = 0; row < guessRows; row++) {
215         // place Buttons in currentTableRow
216         for (int column = 0;
217             column < guessLinearLayouts[row].getChildCount();
218             column++) {
219             // get reference to Button to configure
220             Button newGuessButton =
221                 (Button) guessLinearLayouts[row].getChildAt(column);
222             newGuessButton.setEnabled(true);
223
224             // get country name and set it as newGuessButton's text
225             String filename = fileNameList.get((row * 2) + column);
226             newGuessButton.setText(getCountryName(filename));
227         }
228     }
229
230     // randomly replace one Button with the correct answer
231     int row = random.nextInt(guessRows); // pick random row
232     int column = random.nextInt(2); // pick random column
233     LinearLayout randomRow = guessLinearLayouts[row]; // get the row
234     String countryName = getCountryName(correctAnswer);
235     ((Button) randomRow.getChildAt(column)).setText(countryName);
236 }
237

```

---

**Fig. 4.38** | MainActivityFragment method `loadNextFlag`. (Part 2 of 2.)

Line 179 removes the first name from `quizCountriesList` and stores it in `nextImage`. We also save this in `correctAnswer` so it can be used later to determine whether the user made a correct guess. Next, we clear the `answerTextView` and display the current question number in the `questionNumberTextView` (lines 184–185) using the formatted `String` resource `R.string.question`.

Line 188 extracts from `nextImage` the region to be used as the `assets` subfolder name from which we'll load the image. Next we get the `AssetManager`, then use it in the `try-with-resources` statement to open an `InputStream` (package `java.io`) to read bytes from the flag image's file. We use that stream as an argument to class `Drawable`'s static method `createFromStream`, which creates a `Drawable` object (package `android.graphics.drawable`). The `Drawable` is set as `flagImageView`'s item to display by calling its `setImageDrawable` method. If an exception occurs, we log it for debugging purposes (line 204). Next, we call the `animate` method with `false` to animate the next flag and answer Buttons onto the screen (line 201).

Next, line 207 shuffles the `fileNameList`, and lines 210–211 locate the `correctAnswer` and move it to the end of the `fileNameList`—later we'll insert this answer randomly into the one of the guess Buttons.

Lines 214–228 iterate through the Buttons in the `guessLinearLayouts` for the current number of `guessRows`. For each Button:

- lines 220–221 get a reference to the next Button
- line 222 enables the Button

- line 225 gets the flag file name from the `fileNameList`
- line 226 sets `Button`'s text with the country name that method `getCountryName` (Section 4.7.8) returns.

Lines 231–235 pick a random row (based on the current number of `guessRows`) and column, then set the text of the corresponding `Button`.

#### 4.7.8 Method `getCountryName`

Method `getCountryName` (Fig. 4.39) parses the country name from the image file name. First, we get a substring starting from the dash (-) that separates the region from the country name. Then we call `String` method `replace` to replace the underscores (\_) with spaces.

---

```
238     // parses the country flag file name and returns the country name
239     private String getCountryName(String name) {
240         return name.substring(name.indexOf('-') + 1).replace('_', ' ');
241     }
242
```

---

**Fig. 4.39** | `MainActivityFragment` method `getCountryName`.

#### 4.7.9 Method `animate`

Method `animate` (Fig. 4.40) executes the *circular reveal* animation on the entire layout (`quizLinearLayout`) of the quiz to transition between questions. Lines 246–247 return immediately for the first question to allow the first question to just appear rather than animate onto the screen. Lines 250–253 calculate the screen coordinates of the center of the quiz UI. Line 256–257 calculate the maximum radius of the circle in the animation (the minimum radius is always 0). The `animate` method accepts one parameter, `animateOut`, and can be used in two ways. Line 262 uses `animateOut` to determine whether the animation will show or hide the quiz.

---

```
243     // animates the entire quizLinearLayout on or off screen
244     private void animate(boolean animateOut) {
245         // prevent animation into the the UI for the first flag
246         if (correctAnswers == 0)
247             return;
248
249         // calculate center x and center y
250         int centerX = (quizLinearLayout.getLeft() +
251             quizLinearLayout.getRight()) / 2;
252         int centerY = (quizLinearLayout.getTop() +
253             quizLinearLayout.getBottom()) / 2;
254
255         // calculate animation radius
256         int radius = Math.max(quizLinearLayout.getWidth(),
257             quizLinearLayout.getHeight());
258
```

---

**Fig. 4.40** | `MainActivityFragment` method `animate`. (Part I of 2.)

```

259     Animator animator;
260
261     // if the quizLinearLayout should animate out rather than in
262     if (animateOut) {
263         // create circular reveal animation
264         animator = ViewAnimationUtils.createCircularReveal(
265             quizLinearLayout, centerX, centerY, radius, 0);
266         animator.addListener(
267             new AnimatorListenerAdapter() {
268                 // called when the animation finishes
269                 @Override
270                 public void onAnimationEnd(Animator animation) {
271                     loadNextFlag();
272                 }
273             });
274     }
275
276     else { // if the quizLinearLayout should animate in
277         animator = ViewAnimationUtils.createCircularReveal(
278             quizLinearLayout, centerX, centerY, 0, radius);
279     }
280
281     animator.setDuration(500); // set animation duration to 500 ms
282     animator.start(); // start the animation
283 }
284

```

**Fig. 4.40** | MainActivityFragment method `animate`. (Part 2 of 2.)

If `animate` is called with the value `true`, the method will animate the `quizLinearLayout` off the screen (lines 264–274). Lines 264–265 create a circular-reveal `Animator` object by calling `ViewAnimationUtils` method `createCircularReveal`. This method takes five parameters:

- The first specifies the `View` on which to apply the animation (`quizLinearLayout`).
- The second and third provide the *x*- and *y*-coordinates of the animation circle's center.
- The last two determine the starting and ending radius of the animation's circle.

Because this animates the `quizLinearLayout` off screen, its starting radius is the calculated `radius` and its ending radius is 0. Lines 266–274 create and associate an `AnimatorListenerAdapter` with the `Animator`. The `AnimatorListenerAdapter`'s `onAnimationEnd` (lines 269–272) method is called when the animation finishes and loads the next flag (line 271).

If `animate` is called with the value `false`, the method will animate the `quizLinearLayout` onto the screen at the start of the next question. Lines 277–278 create the `Animator` by calling the `createCircularReveal` method, but this time, we specify 0 for the starting radius and the calculated `radius` for the ending radius. This causes the `quizLinearLayout` to animate onto the screen rather than off the screen.

Line 281 calls `Animator`'s `setDuration` method to specify a duration of 500 milliseconds for the animation. Finally, line 282 starts the animation.

#### 4.7.10 Anonymous Inner Class That Implements OnClickListener

In Fig. 4.34, lines 97–102 registered `guessButtonListener` (Fig. 4.41) as the event-handling object for each guess Button. Instance variable `guessButtonListener` refers to an anonymous-inner-class object that implements interface `OnClickListener` to respond to Button events. The method receives the clicked Button as parameter `v`. We get the Button's text (line 290) and the parsed country name (line 291), then increment `totalGuesses`. If the guess is correct (line 294), we increment `correctAnswers`. Next, we set the `answerTextView`'s text to the country name and change its color to the color represented by the constant `R.color.correct_answer` (green), and we call our utility method `disableButtons` (Section 4.7.11) to disable all the answer Buttons.

```

285 // called when a guess Button is touched
286 private OnClickListener guessButtonListener = new OnClickListener() {
287     @Override
288     public void onClick(View v) {
289         Button guessButton = ((Button) v);
290         String guess = guessButton.getText().toString();
291         String answer = getCountryName(correctAnswer);
292         ++totalGuesses; // increment number of guesses the user has made
293
294         if (guess.equals(answer)) { // if the guess is correct
295             ++correctAnswers; // increment the number of correct answers
296
297             // display correct answer in green text
298             answerTextView.setText(answer + "!");
299             answerTextView.setTextColor(
300                 getResources().getColor(R.color.correct_answer,
301                     getContext().getTheme()));
302
303             disableButtons(); // disable all guess Buttons
304
305             // if the user has correctly identified FLAGS_IN QUIZ flags
306             if (correctAnswers == FLAGS_IN QUIZ) {
307                 // DialogFragment to display quiz stats and start new quiz
308                 DialogFragment quizResults =
309                     new DialogFragment() {
310                         // create an AlertDialog and return it
311                         @Override
312                         public Dialog onCreateDialog(Bundle bundle) {
313                             AlertDialog.Builder builder =
314                                 new AlertDialog.Builder(getActivity());
315                             builder.setMessage(
316                                 getString(R.string.results,
317                                     totalGuesses,
318                                     (1000 / (double) totalGuesses)));
319
320                         // "Reset Quiz" Button
321                         builder.setPositiveButton(R.string.reset_quiz,
322                             new DialogInterface.OnClickListener() {

```

**Fig. 4.41** | Anonymous inner class that implements `OnClickListener`. (Part 1 of 2.)

```

323             public void onClick(DialogInterface dialog,
324                             int id) {
325                             resetQuiz();
326                         }
327                     );
328                 );
329             }
330         });
331     };
332   };
333
334   // use FragmentManager to display the DialogFragment
335   quizResults.setCancelable(false);
336   quizResults.show(getFragmentManager(), "quiz results");
337 }
338 else { // answer is correct but quiz is not over
339   // Load the next flag after a 2-second delay
340   handler.postDelayed(
341     new Runnable() {
342       @Override
343       public void run() {
344         animate(true); // animate the flag off the screen
345       }
346     }, 2000); // 2000 milliseconds for 2-second delay
347   }
348 }
349 else { // answer was incorrect
350   flagImageView.startAnimation(shakeAnimation); // play shake
351
352   // display "Incorrect!" in red
353   answerTextView.setText(R.string.incorrect_answer);
354   answerTextView.setTextColor(getResources().getColor(
355     R.color.incorrect_answer, getContext().getTheme()));
356   guessButton.setEnabled(false); // disable incorrect answer
357 }
358 }
359 };
360

```

**Fig. 4.41** | Anonymous inner class that implements OnClickListener. (Part 2 of 2.)

If `correctAnswers` is `FLAGS_IN QUIZ` (line 306), the quiz is over. Lines 308–332 create a new anonymous inner class that extends `DialogFragment` (package `android.support.v4.app`) and will be used to display the quiz results. The `DialogFragment`'s `onCreateDialog` method uses an `AlertDialog.Builder` (discussed momentarily) to configure and create an `AlertDialog` for showing the quiz results, then returns it. When the user touches this dialog's `Reset Quiz` Button, method `resetQuiz` is called to start a new game (line 325). Line 335 indicates that the dialog is not cancelable—the user must interact with the dialog, because touching outside the dialog or touching the back button will not return the user to the quiz. To display the `DialogFragment`, line 336 calls its `show` method, passing as arguments the `FragmentManager` returned by `getFragmentManager` and a `String`. The second argument can be used with `FragmentManager` method `getFragment-`

**ByTag** to get a reference to the `DialogFragment` at a later time—we don't use this capability in this app.

If `correctAnswers` is less than `FLAGS_IN QUIZ`, then lines 340–346 call the `postDelayed` method of `Handler` object `handler`. The first argument defines an anonymous inner class that implements the `Runnable` interface—this represents the task to perform, `animate(true)`, which animates the flags and answer Buttons off the screen and starts the transition to the next question, some number of milliseconds into the future. The second argument is the delay in milliseconds (2000). If the guess is incorrect, line 350 invokes `flagImageView`'s `startAnimation` method to play the `shakeAnimation` that was loaded in method `onCreateView`. We also set the text on `answerTextView` to display "Incorrect!" in red (lines 353–355), then disable the `guessButton` that corresponds to the incorrect answer.



### Look-and-Feel Observation 4.4

You can set an `AlertDialog`'s title (which appears above the dialog's message) with `AlertDialog.Builder` method `setTitle`. According to the Android design guidelines for dialogs (<http://developer.android.com/design/building-blocks/dialogs.html>), most dialogs do not need titles. A dialog should display a title for "a high-risk operation involving potential loss of data, connectivity, extra charges, and so on." Also, dialogs that display lists of options use the title to specify the dialog's purpose.

### Creating and Configuring the `AlertDialog`

Lines 313–329 use an `AlertDialog.Builder` to create and configure an `AlertDialog`. Lines 313–314 create the `AlertDialog.Builder`, passing the fragment's Activity as the Context argument—the dialog will be displayed in the context of the Activity that hosts the `MainActivityFragment`. Next, lines 315–318 set the dialog's message to a formatted String showing the quiz results—the resource `R.string.results` contains placeholders for the total number of guesses and the percentage of the total guesses that were correct.

In this `AlertDialog`, we need only one button that allows the user to acknowledge the message and reset the quiz. We specify this as the dialog's *positive Button* (lines 321–328)—touching this `Button` indicates that the user acknowledges the message displayed in the dialog and dismisses the dialog. Method `setPositiveButton` receives the `Button`'s label (specified with the String resource `R.string.reset_quiz`) and a reference to the `Button`'s event handler. If the app does not need to respond to the event, you can specify `null` for the event handler. In this case, we provide an object of an anonymous inner class that implements interface `DialogInterface.OnClickListener`. You override this interface's `onClick` method to respond to the event when the user touches the corresponding `Button` in the dialog.

#### 4.7.11 Method `disableButtons`

Method `disableButtons` (Fig. 4.42) iterates through the `guess Buttons` and disables them. This method is called when the user makes a correct guess.

---

```
361 // utility method that disables all answer Buttons
362 private void disableButtons() {
363     for (int row = 0; row < guessRows; row++) {
```

**Fig. 4.42** | `MainActivityFragment` method `disableButtons`. (Part I of 2.)

---

```

364         LinearLayout guessRow = guessLinearLayouts[row];
365         for (int i = 0; i < guessRow.getChildCount(); i++)
366             guessRow.getChildAt(i).setEnabled(false);
367     }
368 }
369 }
```

---

**Fig. 4.42** | MainActivityFragment method disableButtons. (Part 2 of 2.)

## 4.8 SettingsActivity Class

Class `SettingsActivity` (Fig. 4.43) hosts the `SettingsActivityFragment` when the app is running in portrait orientation. Overridden method `onCreate` (lines 11–18) calls method `setContentView` to inflate the GUI defined by `activity_settings.xml` (represented by the resource `R.layout.activity_settings`), then displays the `Toolbar` defined in `SettingsActivity`'s layout. Line 17 displays on the app bar an *up button* that the user can touch to return to the parent `MainActivity`. The IDE added this line when you added the `SettingsActivity` to the project and specified its hierarchical parent (Section 4.4.12). We removed from the class the remaining autogenerated code that's not used in this app. You can also remove the unused menu resource `menu_settings.xml`.

---

```

1 // SettingsActivity.java
2 // Activity to display SettingsActivityFragment on a phone
3 package com.deitel.flagquiz;
4
5 import android.os.Bundle;
6 import android.support.v7.app.AppCompatActivity;
7 import android.support.v7.widget.Toolbar;
8
9 public class SettingsActivity extends AppCompatActivity {
10     // inflates the GUI, displays Toolbar and adds "up" button
11     @Override
12     protected void onCreate(Bundle savedInstanceState) {
13         super.onCreate(savedInstanceState);
14         setContentView(R.layout.activity_settings);
15         Toolbar toolbar = (Toolbar) findViewById(R.id.toolbar);
16         setSupportActionBar(toolbar);
17         getSupportActionBar().setDisplayHomeAsUpEnabled(true);
18     }
19 }
```

---

**Fig. 4.43** | `SettingsActivity` displays the `SettingsActivityFragment` on a phone device and on a tablet device in portrait orientation.

## 4.9 SettingsActivityFragment Class

Class `SettingsActivityFragment` (Fig. 4.44) inherits from `PreferenceFragment` (package `android.preference`). When the `SettingsActivityFragment` is created, method `onCreate` (lines 10–14) builds the preferences GUI by calling inherited `PreferenceFragment` method `addPreferencesFromResource` to build the preferences GUI from the `preferences.xml` (Section 4.4.11). As the user interacts with the preferences GUI, the

preferences are automatically stored into a `SharedPreferences` file on the device. If the file does not exist, it will be created; otherwise, it will be updated. We removed the other unused autogenerated code from this class.

---

```

1 // SettingsActivityFragment.java
2 // Subclass of PreferenceFragment for managing app settings
3 package com.deitel.flagquiz;
4
5 import android.os.Bundle;
6 import android.preference.PreferenceFragment;
7
8 public class SettingsActivityFragment extends PreferenceFragment {
9     // creates preferences GUI from preferences.xml file in res/xml
10    @Override
11    public void onCreate(Bundle bundle) {
12        super.onCreate(bundle);
13        addPreferencesFromResource(R.xml.preferences); // Load from XML
14    }
15 }
```

---

**Fig. 4.44** | `SettingsActivityFragment` subclass of `PreferenceFragment` displays the app's preferences.

## 4.10 AndroidManifest.xml

Figure 4.45 shows the Flag Quiz app's autogenerated manifest. Each Activity in an app must be declared in `AndroidManifest.xml`; otherwise, Android will not know that the Activity exists and will not be able to launch it. When you created the app, the IDE declared `MainActivity` in `AndroidManifest.xml` (lines 11–21). The notation

`.MainActivity`

in line 12 indicates that the class is in the package specified in line 2 and is shorthand for

`com.deitel.flagquiz.MainActivity`

We added line 14, which we'll discuss momentarily.

---

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <manifest package="com.deitel.flagquiz"
3     xmlns:android="http://schemas.android.com/apk/res/android">
4
5     <application
6         android:allowBackup="true"
7         android:icon="@mipmap/ic_launcher"
8         android:label="@string/app_name"
9         android:supportsRtl="true"
10        android:theme="@style/AppTheme">
11            <activity
12                android:name=".MainActivity"
13                android:label="@string/app_name"
```

---

**Fig. 4.45** | `AndroidManifest.xml` with `SettingsActivity` declared. (Part 1 of 2.)

```
14      android:launchMode="singleTop"
15      android:theme="@style/AppTheme.NoActionBar">
16      <intent-filter>
17          <action android:name="android.intent.action.MAIN"/>
18
19          <category android:name="android.intent.category.LAUNCHER"/>
20      </intent-filter>
21  </activity>
22  <activity
23      android:name=".SettingsActivity"
24      android:label="@string/title_activity_settings"
25      android:parentActivityName=".MainActivity"
26      android:theme="@style/AppTheme.NoActionBar">
27      <meta-data
28          android:name="android.support.PARENT_ACTIVITY"
29          android:value="com.deitel.flagquiz.MainActivity">
30  </activity>
31 </application>
32
33 </manifest>
```

**Fig. 4.45** | AndroidManifest.xml with SettingsActivity declared. (Part 2 of 2.)

When you added the `SettingsActivity` to the project (Section 4.4.1), the IDE added `SettingsActivity` to the manifest file automatically (lines 22–30). If you were to create a new Activity without using the IDE’s tools, you’d have to declare the new Activity by inserting an `<activity>` element like the one in lines 22–30. For complete manifest file details, visit

<http://developer.android.com/guide/topics/manifest/manifest-intro.html>

### *Launch Mode*

Line 14 specifies `MainActivity`’s `launchMode`. By default each Activity you create uses the “standard” launch mode. In this mode, when Android receives an Intent to launch the Activity, Android creates a new instance of that Activity.

Recall from Section 4.4.12 that you specified `SettingsActivity`’s hierarchical parent. Again, this enables Android to define on the app bar an *up button* that a user can touch to navigate back to the specified parent Activity. When the user touches this button and the parent Activity uses “standard” launch mode, Android uses an Intent to launch the parent Activity. This results in a new instance of `MainActivity`. This also causes the Flag Quiz app to crash in `MainActivity`’s `OnSharedPreferenceChangeListener` (Section 4.6.7) when it tries to update a `quizFragment` that no longer exists—it was defined in a different `MainActivity` instance.

Line 14 fixes this problem by changing `MainActivity`’s `launchMode` to “`singleTop`”. With this launch mode, when the user touches the *up button*, Android brings the *existing MainActivity* to the foreground, rather than creating a new `MainActivity` object. For more information on the `<activity>` element’s `launchMode` values, visit

<https://developer.android.com/guide/topics/manifest/activity-element.html#lmode>

## 4.11 Wrap-Up

In this chapter, you built a **Flag Quiz** app that tests a user's ability to correctly identify country flags. A key feature of this chapter was using **Fragments** to create portions of an **Activity**'s GUI. You used two activities to display the **MainActivityFragment** and the **SettingsActivityFragment** when the app was running in portrait orientation. You used one **Activity** to display both **Fragments** when the app was running on a tablet in landscape orientation—thus, making better use of the available screen real estate. You used a subclass of **PreferenceFragment** to automatically maintain and persist the app's settings and a subclass of **DialogFragment** to display an **AlertDialog** to the user. We discussed portions of a **Fragment**'s lifecycle and showed how to use the **FragmentManager** to obtain a reference to a **Fragment** so that you could interact with it programmatically.

In portrait orientation, you provided an icon for the **MainActivity**'s **Settings** menu item. This appeared on the app bar, so the user could touch it to display the **SettingsActivity** containing the **SettingsActivityFragment**. To launch the **SettingsActivity**, you used an explicit **Intent**. You saw how to obtain preferences from the app's **SharedPreferences** file and how to edit that file using **SharedPreferences.Editor**.

We showed how to use a **Configuration** object to determine whether the app was running on a tablet in landscape orientation. We demonstrated how to manage a large number of image resources using subfolders in the app's assets folder and how to access those resources via an **AssetManager**. You created a **Drawable** from an image's bytes by reading them from an **InputStream**, then displayed the **Drawable** in an **ImageView**.

You learned about additional subfolders of the app's **res** folder—**menu** for storing menu resource files, **anim** for storing animation resource files and **xml** for storing XML data files. We discussed how to use qualifiers to create a folder for storing a layout that should be used only on large devices in landscape orientation. We also demonstrated how to use a color state list resource to ensure that the text in the **Buttons** is readable for both the *enabled* and *disabled* states.

You used **Toasts** to display minor error messages or informational messages that appear on the screen briefly. To display the next flag in the quiz after a short delay, you used a **Handler**, which executes a **Runnable** after a specified number of milliseconds. You learned that a **Handler**'s **Runnable** executes in the thread that created the **Handler** (the GUI thread in this app).

We defined an **Animation** in XML and applied it to the app's **ImageView** when the user guessed incorrectly to provide visual feedback to the user. We also used **ViewAnimationUtils** to create a circular reveal **Animator** for transitioning between questions. You learned how to log exceptions for debugging purposes with Android's built-in logging mechanism and class **Log**. You also used various classes and interfaces from the **java.util** package, including **List**, **ArrayList**, **Collections** and **Set**.

Finally, we presented the app's **AndroidManifest.xml** file. We discussed the autogenerated **<activity>** elements. We also changed the **MainActivity**'s **launchMode** to "singleTop" so that the app used one instance of **MainActivity**, rather than creating a new one each time the user touches the *up button* on the app bar.

In Chapter 5, we present the **Doodlz** app, which uses Android's graphics capabilities to turn a device's screen into a *virtual canvas*. You'll also learn about Android's immersive mode and printing capabilities.

# 5

## Doodlz App

2D Graphics, Canvas, Bitmap, Accelerometer,  
SensorManager, Multitouch Events, MediaStore,  
Printing, Android 6.0 Permissions, Gradle



### Objectives

In this chapter you'll:

- Detect when the user touches the screen, moves a finger across the screen and removes a finger from the screen.
- Process multiple touches so the user can draw with multiple fingers at once.
- Use a **SensorManager** and the accelerometer to detect motion events.
- Use a **Paint** object to specify the color and width of a line.
- Use **Path** objects to store each line's data and use a **Canvas** to draw each line into a **Bitmap**.
- Create a menu and display menu items on the app bar.
- Use the printing framework and the Android Support Library's **PrintHelper** class to enable the user to print a drawing.
- Use Android 6.0's new permissions model to request permission for saving an image to external storage.
- Add libraries to an app with the Gradle build system.

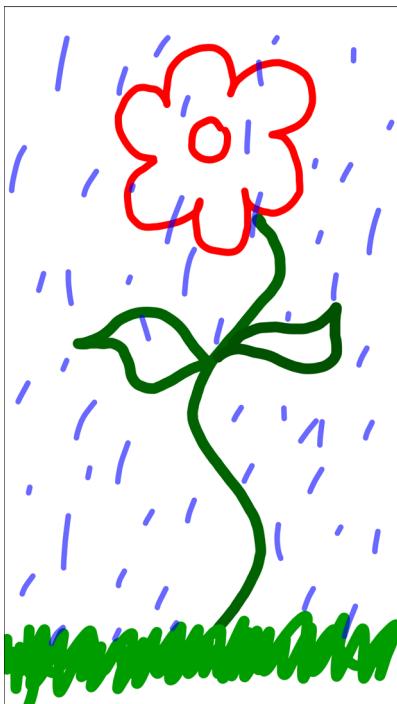
- 5.1** Introduction
- 5.2** Test-Driving the **Doodlz** App in an Android Virtual Device (AVD)
- 5.3** Technologies Overview
  - 5.3.1 Activity and Fragment Lifecycle Methods
  - 5.3.2 Custom Views
  - 5.3.3 Using SensorManager to Listen for Accelerometer Events
  - 5.3.4 Custom DialogFragments
  - 5.3.5 Drawing with Canvas, Paint and Bitmap
  - 5.3.6 Processing Multiple Touch Events and Storing Lines in Paths
  - 5.3.7 Saving to the Device
  - 5.3.8 Printing and the Android Support Library's PrintHelper Class
  - 5.3.9 New Android 6.0 (Marshmallow) Permissions Model
  - 5.3.10 Adding Dependencies Using the Gradle Build System
- 5.4** Creating the Project and Resources
  - 5.4.1 Creating the Project
  - 5.4.2 Gradle: Adding a Support Library to the Project
  - 5.4.3 strings.xml
  - 5.4.4 Importing the Material Design Icons for the App's Menu Items
  - 5.4.5 MainActivityFragment Menu
  - 5.4.6 Adding a Permission to AndroidManifest.xml
- 5.5** Building the App's GUI
  - 5.5.1 content\_main.xml Layout for MainActivity
  - 5.5.2 fragment\_main.xml Layout for MainActivityFragment
  - 5.5.3 fragment\_color.xml Layout for ColorDialogFragment
  - 5.5.4 fragment\_line\_width.xml Layout for LineWidthDialogFragment
  - 5.5.5 Adding Class EraseImageDialogFragment
- 5.6** MainActivity Class
- 5.7** MainActivityFragment Class
  - 5.7.1 package Statement, import Statements and Fields
  - 5.7.2 Overridden Fragment Method onCreateView
  - 5.7.3 Methods onResume and enableAccelerometerListening
- 5.8** DoodleView Class
  - 5.8.1 package Statement and import Statements
  - 5.8.2 static and Instance Variables
  - 5.8.3 Constructor
  - 5.8.4 Overridden View Method onSizeChanged
  - 5.8.5 Methods clear, setDrawingColor, getDrawingColor, setLineWidth and getLineWidth
  - 5.8.6 Overridden View Method onDraw
  - 5.8.7 Overridden View Method onTouchEvent
  - 5.8.8 touchStarted Method
  - 5.8.9 touchMoved Method
  - 5.8.10 touchEnded Method
  - 5.8.11 Method saveImage
  - 5.8.12 Method printImage
- 5.9** ColorDialogFragment Class
  - 5.9.1 Overridden DialogFragment Method onCreateDialog
  - 5.9.2 Method getDoodleFragment
  - 5.9.3 Overridden Fragment Lifecycle Methods onAttach and onDetach
  - 5.9.4 Anonymous Inner Class That Responds to the Events of the Alpha, Red, Green and Blue SeekBars
- 5.10** LineWidthDialogFragment Class
  - 5.10.1 Method onCreateDialog
  - 5.10.2 Anonymous Inner Class That Responds to the Events of the widthSeekBar
- 5.11** EraseImageDialogFragment Class
- 5.12** Wrap-Up

## 5.1 Introduction

The **Doodlz** app enables you to paint by dragging one or more fingers across the screen (Fig. 5.1). The app provides options for setting the drawing color and line width. Additional options allow you to

- clear the screen
- save the current drawing on your device, and
- print the current drawing.

Depending on your device's screen size, some or all of the app's options are displayed as icons directly on the app bar—any that do not fit are displayed as text in the overflow options menu (⋮) that appears on the app bar.



**Fig. 5.1** | Doodlz app with a finished drawing.

This app introduces Android 6.0's new permissions mechanism. For example, Android requires the user's permission to allow an app to save files (like this app's drawings) on a device. In Android 6.0, rather than prompting the user at installation time with a complete list of permissions the app requires, the app requests each permission individually, only when the permission is required to perform a given task for the first time. In this app, Android prompts for permission the first time the user attempts to save a drawing.

First, you'll test-drive the app. Then we'll overview the technologies used to build it. Next, you'll design the app's GUI. Finally, we'll walk through the app's complete source code, emphasizing the app's new features.

## 5.2 Test-Driving the Doodlz App in an Android Virtual Device (AVD)

### *Opening and Running the App*

Open Android Studio and open the **Doodlz** app from the **Doodlz** folder in the book's examples folder, then execute the app in the AVD or on a device. This builds the project and runs the app.

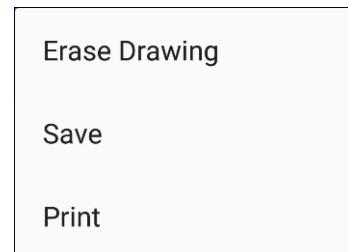
### *Understanding the App's Options*

Figure 5.2(a) and (b) show the app bar and overflow options menu on the Nexus 6 AVD, and Fig. 5.2(c) shows the app bar on the Nexus 9 AVD.

a) Nexus 6 AVD app bar



b) Nexus 6 AVD overflow options menu



c) Nexus 9 AVD app bar—there was enough room on the app bar to display all menu items as their icons



**Fig. 5.2** | Doodlz app bar and overflow menu.

This app has the following menu items:

- **Color** (🎨)—Displays a dialog for changing the line color.
- **Line Width** (🖌)—Displays a dialog for changing the thickness of the line that will be drawn as you drag your finger(s) on the screen.
- **Erase Image** (⌫)—First confirms whether you wish to erase the entire image, then clears the drawing area if you do not cancel the action.
- **Save** (💾)—Saves the image on the device. You can view the image via the Google Photos app by opening that app's menu and touching **Device Folders** to see thumbnails of your stored images.<sup>1</sup>

1. On some devices you might need to take a picture with the device's camera app before you'll be able to save properly from the **Doodlz** app.

- Print (🖨️)—Displays a GUI for selecting an available printer so you can print your image or save it as a PDF document (the default).

You'll explore each of these options momentarily.

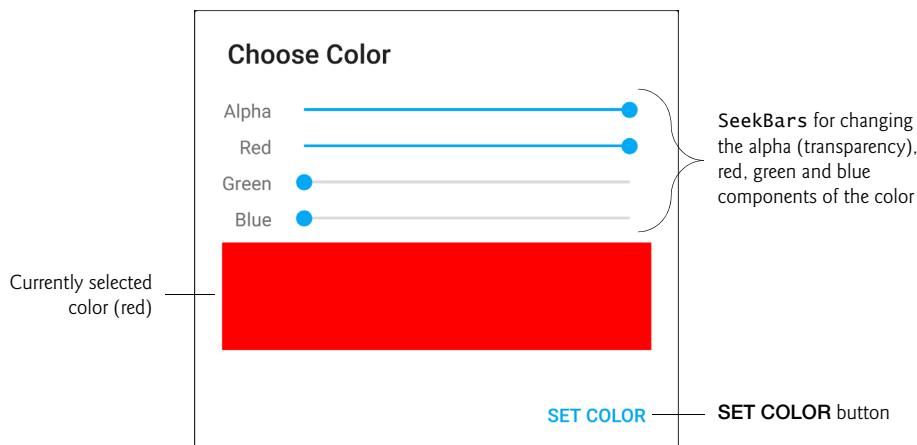


### Look-and-Feel Observation 5.1

When a menu item is displayed on the app bar, if the menu item has an icon, that icon is displayed; otherwise, the menu item's text is displayed in small capital letters. Any menu items in this app that cannot fit on the app bar are accessible in the drop-down options menu (☰), which displays the menu items using their text labels.

#### Changing the Brush Color to Red

To change the brush color, touch 🖌 on the app bar—or select **Color** from the options menu if the icon is not displayed on the app bar. This displays the **Choose Color** dialog (Fig. 5.3).

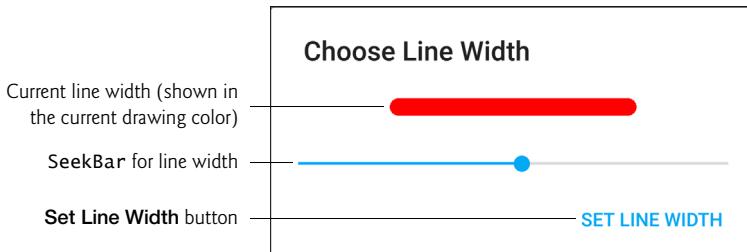


**Fig. 5.3** | Changing the drawing color to red.

Colors are defined using the *ARGB color scheme* in which the *alpha* (i.e., *transparency*), red, green and blue components, respectively, are specified by integers in the range 0–255. For alpha, 0 means *completely transparent* and 255 means *completely opaque*. For red, green and blue, 0 means *none* of that color and 255 means the *maximum amount* of that color. The GUI consists of **Alpha**, **Red**, **Green** and **Blue** SeekBars that allow you to select the amount of alpha, red, green and blue, respectively, in the drawing color. You drag the SeekBars to change the color. As you do, the app displays the new color below the SeekBars. Select a red color now by dragging the **Red** SeekBar to the right as in Fig. 5.3. Touch the **SET COLOR** button to set this color as the drawing color and dismiss the dialog. If you do not wish to change the color, you can simply touch outside the dialog to dismiss it. You can erase by changing the drawing color to white (i.e., moving all four SeekBars' thumbs to the far right).

***Changing the Line Width***

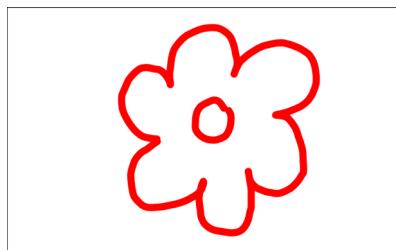
To change the line width, touch  on the app bar—or select **Line Width** from the options menu if the icon is not displayed on the app bar. This displays the **Choose Line Width** dialog. Drag the SeekBar for the line width to the right to thicken the line (Fig. 5.4). Touch the **SET LINE WIDTH** button to return to the drawing area.



**Fig. 5.4** | Changing the line width.

***Drawing the Flower Petals***

Drag your “finger”—the mouse when using the emulator—on the drawing area to draw flower petals (Fig. 5.5).



**Fig. 5.5** | Drawing the flower petals.

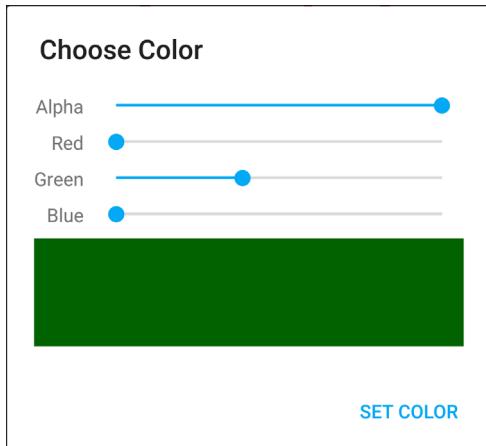
***Changing the Brush Color to Dark Green***

Touch  or select the **Color** menu item to display the **Choose Color** dialog. Select a dark green color by dragging the **Green** SeekBar to the right and ensuring that the **Red** and **Blue** SeekBars are at the far left (Fig. 5.6(a)).

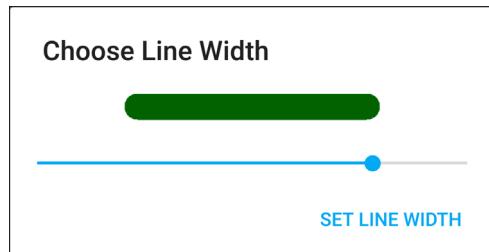
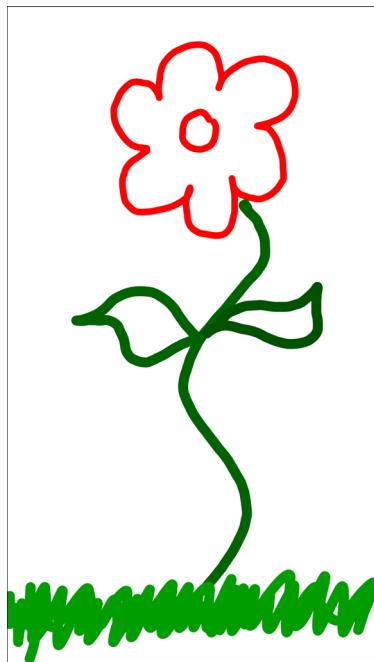
***Changing the Line Width and Drawing the Stem and Leaves***

Touch  or select the **Line Width** menu item to display the **Choose Line Width** dialog. Drag the SeekBar for the line width to the right to thicken the line (Fig. 5.6(b)). Draw the flower stem and leaves. Repeat *Steps 9 and 10* for a lighter green color and thinner line, then draw the grass (Fig. 5.7).

a) Selecting dark green as the drawing color



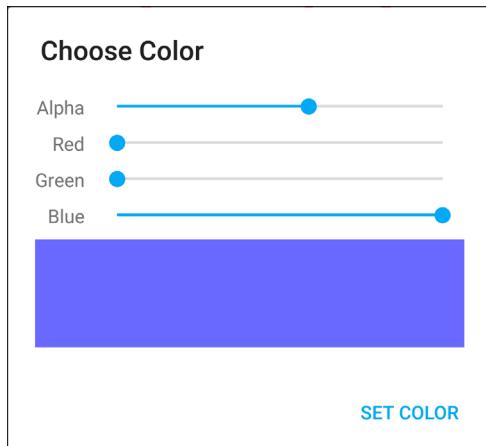
b) Selecting a thicker line

**Fig. 5.6** | Changing the color to dark green and making the line thicker.**Fig. 5.7** | Drawing the stem and grass.

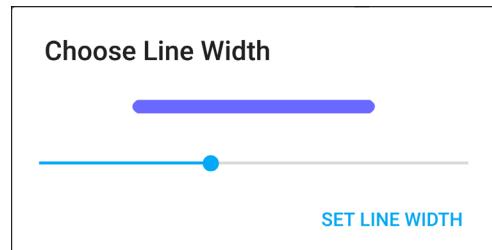
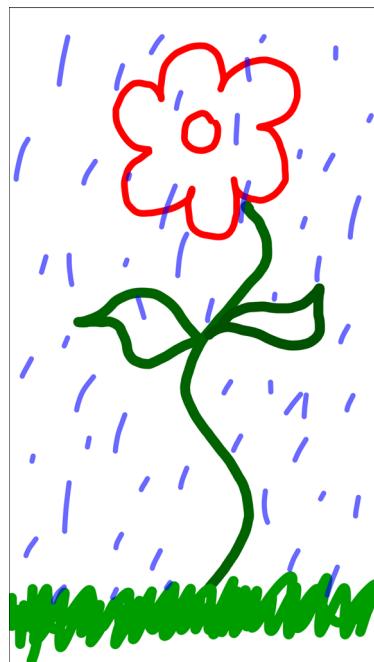
### *Finishing the Drawing*

Next, change the drawing color to a semitransparent blue (Fig. 5.8(a)) and select a narrower line (Fig. 5.8(b)). Then draw the raindrops (Fig. 5.9).

a) Selecting blue as the drawing color



b) Selecting a thinner line

**Fig. 5.8** | Changing the line color to blue and narrowing the line.**Fig. 5.9** | Drawing the rain in the new line color and line width.

### Saving the Image

You can save your image to the device and view it using the **Photos** app. To do so, touch on the app bar—or select **Save** from the options menu if the icon is not displayed on

the app bar. You can then view this image and others stored on the device by opening the **Photos** app.

### *Printing the Image*

To print the image, touch  on the app bar—or select **Print** from the options menu if the icon is not displayed on the app bar. This displays a dialog of printing options. By default, you can save the image as a PDF document. To choose a printer, tap **Save as PDF** and select from the list of available printers. If no printers appear in the list, you need to configure Google Cloud Print for your printer. For information on this, visit

<http://www.google.com/cloudprint/learn/>

## 5.3 Technologies Overview

This section presents the new technologies that we use in the **Doodlz** app.

### 5.3.1 Activity and Fragment Lifecycle Methods

A **Fragment**'s lifecycle is tied to that of its parent **Activity**. There are six **Activity** lifecycle methods that have corresponding **Fragment** lifecycle methods—**onCreate**, **onStart**, **onResume**, **onPause**, **onStop** and **onDestroy**. When the system calls these methods on an **Activity**, it will also call the corresponding methods (and potentially other **Fragment** lifecycle methods) on all of the **Activity**'s attached **Fragment**s.

This app uses **Fragment** lifecycle methods **onResume** and **onPause**. An **Activity**'s **onResume** method is called when a **Fragment** is on the screen and ready for the user to interact with it. When an **Activity** hosts **Fragment**s and the **Activity** is resumed, all of its **Fragment**s' **onResume** methods are called. In this app, **MainActivityFragment** overrides **onResume** to enable listening for the accelerometer events so the user can shake the device to erase a drawing (Section 5.7.3).

An **Activity**'s **onPause** method is called when *another* **Activity** receives the focus, which pauses the one that loses the focus and sends it to the background. When an **Activity** hosts **Fragment**s and the **Activity** is paused, all of its **Fragment**s' **onPause** methods are called. In this app, **MainActivityFragment** overrides **onPause** to suspend listening for the shake-to-erase accelerometer events (Section 5.7.4).



#### Performance Tip 5.1

*When an app is paused, it should remove listeners for sensor events so these events are not delivered to the app when it's not on the screen. This saves battery.*

We discuss other **Activity** and **Fragment** lifecycle methods as we need them. For more information on the complete **Activity** lifecycle, visit

[#ActivityLifecycle](http://developer.android.com/reference/android/app/Activity.html)

and for more information on the complete **Fragment** lifecycle, visit

[#Lifecycle](http://developer.android.com/guide/components/fragments.html)

### 5.3.2 Custom Views

You can create a *custom view* by extending class `View` or one of its subclasses, as we do with class `DoodleView` (Section 5.8), which extends `View`. To add a custom component to a layout's XML file, you must provide its *fully qualified name* (i.e., its package and class name), so the custom `View`'s class must exist before you add it to the layout. We demonstrate how to create the `DoodleView` class and add it to a layout in Section 5.5.2.

### 5.3.3 Using SensorManager to Listen for Accelerometer Events

In this app, you can shake the device to erase a drawing. Most devices have an **accelerometer** for detecting device movement. Other currently supported sensors include gravity, gyroscope, light, linear acceleration, magnetic field, orientation, pressure, proximity, rotation vector and temperature. You'll use class `Sensor`'s sensor-type constants to specify the sensors for which your app should receive data. The list of `Sensor` constants can be found at

<http://developer.android.com/reference/android/hardware/Sensor.html>

We'll discuss the accelerometer and sensor event handling in Section 5.7. For a complete discussion of Android's other sensors, see the *Sensors Overview* at

[http://developer.android.com/guide/topics/sensors/sensors\\_overview.html](http://developer.android.com/guide/topics/sensors/sensors_overview.html)

### 5.3.4 Custom DialogFragments

Several previous apps have used `AlertDialogs` in `DialogFragments` to display information to the user or to ask questions and receive responses from the user in the form of `Button` clicks. The `AlertDialogs` you've used so far were created using anonymous inner classes that extended `DialogFragment` and displayed only text and buttons. `AlertDialogs` may also contain custom `Views`. In this app, you'll define three subclasses of `DialogFragment`:

- `ColorDialogFragment` (Section 5.9) displays an `AlertDialog` with a custom `View` containing GUI components for previewing and selecting a new ARGB drawing color.
- `LineWidthDialogFragment` (Section 5.10) displays an `AlertDialog` with a custom `View` containing a GUI for previewing and selecting the line thickness.
- `EraseImageDialogFragment` (Section 5.11) displays a standard `AlertDialog` asking the user to confirm whether the entire image should be erased.

For the `ColorDialogFragment` and `EraseImageDialogFragment`, you'll inflate the custom `View` from a layout resource file. In each of the three `DialogFragment` subclasses, you'll also override the following `Fragment` lifecycle methods:

- **onAttach**—The *first* `Fragment` lifecycle method called when a `Fragment` is attached to a parent `Activity`.
- **onDetach**—The *last* `Fragment` lifecycle method called when a `Fragment` is about to be detached from a parent `Activity`.

#### Preventing Multiple Dialogs from Appearing at the Same Time

It's possible that the event handler for the shake event could try to display the confirmation dialog for erasing an image when another dialog is already on the screen. To prevent this,

you'll use `onAttach` and `onDetach` to set the value of a `boolean` that indicates whether a dialog is on the screen. When this `boolean`'s value is `true`, we will not allow the event handler for the shake event to display a dialog.

### 5.3.5 Drawing with Canvas, Paint and Bitmap

You can use methods of class **Canvas** to draw text, lines and circles. **Canvas** methods draw on a **View**'s **Bitmap** (both from package `android.graphics`). You can associate a **Canvas** with a **Bitmap**, then use the **Canvas** to draw on the **Bitmap**, which can then be displayed on the screen (Section 5.8). A **Bitmap** also can be saved into a file—we'll use this capability to store drawings in the device's gallery when you touch the **Save** option. Each drawing method in class **Canvas** uses an object of class **Paint** (package `android.graphics`) to specify drawing characteristics, including color, line thickness, font size and more. These capabilities are presented with the `onDraw` method in the **DoodleView** class (Section 5.8.6). For more details on the drawing characteristics you can specify with a **Paint** object, visit

<http://developer.android.com/reference/android/graphics/Paint.html>

### 5.3.6 Processing Multiple Touch Events and Storing Lines in Paths

You can drag one or more fingers across the screen to draw. The app stores the information for each *individual* finger as a **Path** object (package `android.graphics`) that represents line segments and curves. You process *touch events* by overriding the **View** method **onTouchEvent** (Section 5.8.7). This method receives a **MotionEvent** (package `android.view`) that contains the type of touch event that occurred and the ID of the finger (known as a *pointer*) that generated the event. We use the IDs to distinguish the different fingers and add information to the corresponding **Path** objects. We use the type of the touch event to determine whether the user has *touched* the screen, *dragged* across the screen or *lifted a finger* from the screen.

In addition to standard touch-event handling, Android 6.0 provides enhanced support for using a Bluetooth stylus with apps, including access to pressure data and which stylus button the user presses. In this app, for example, you could use a stylus button to specify an erase mode, or you could use the stylus' pressure data to change the stroke thickness dynamically as the user draws. For more information, visit

<https://developer.android.com/about/versions/marshmallow/android-6.0.html#bluetooth-stylus>

### 5.3.7 Saving to the Device

The app's **Save** option allows you to save a drawing to the device. You can view the image in the **Photos** app by selecting **Device Folders** from the app's menu to see thumbnails of the stored images—touch a thumbnail to view the full-size image. A **ContentResolver** (package `android.content`) enables the app to read data from and store data on a device. You'll use a **ContentResolver** (Section 5.8.11) and the method **insertImage** of class **MediaStore.Images.Media** to save an image into the device's **Photos** app. The **MediaStore** manages media files (images, audio and video) stored on a device.

### 5.3.8 Printing and the Android Support Library's PrintHelper Class

In this app, we use class `PrintHelper` (Section 5.8.12) from Android's printing framework to print the current drawing. Class `PrintHelper` provides a user interface for selecting a printer, has a method for determining whether a given device supports printing and provides a method for printing a `Bitmap`. `PrintHelper` is part of the *Android Support Library*, which provides new Android features for use in current and older Android versions. The support library also includes additional convenience features, like class `PrintHelper`, that support specific Android versions.

### 5.3.9 New Android 6.0 (Marshmallow) Permissions Model

Android requires the permission `android.permission.WRITE_EXTERNAL_PERMISSION` before an app can write to external storage. For `Doodlz`, we need this permission to save the image that the user draws.

Android 6.0 (Marshmallow) has a new permissions model that's designed for a better user experience. Before Android 6.0, a user was required *at installation time* to grant in advance all permissions that an app would ever need—this caused many people not to install certain apps. With the new model, the app is installed without asking for *any* permissions. Instead, the user is asked to grant a permission only the first time the corresponding feature is used.

Once the user grants a permission, the app has that permission until:

- the app is reinstalled or
- the user changes the app's permissions via the Android **Settings** app.

You'll learn how to implement the new permissions model in Sections 5.7.8–5.7.9.

### 5.3.10 Adding Dependencies Using the Gradle Build System

Android Studio uses the **Gradle build system** to compile your code into an APK file—the installable app. Gradle also handles project dependencies, such as including in the build process any libraries used by the app. For `Doodlz`, you'll add a support library dependency to your project so you can use the `PrintHelper` class for printing an image (Section 5.4.2).

## 5.4 Creating the Project and Resources

In this section, you'll create the project, import material design icons for the app's menu items and edit the various resources used by the GUI and the app's Java code.

### 5.4.1 Creating the Project

Create a new **Blank Activity** project. Specify the following values in the **Create New Project** dialog's **New Project** step:

- **Application name:** `Doodlz`
- **Company Domain:** `deitel.com` (or specify your own domain name)

For the remaining steps in the **Create New Project** dialog, use the same settings as in Section 4.4.1. This creates a `MainActivity` that hosts a `Fragment`. The `Fragment` will define

the app's drawing area and respond to the user's touches. Follow the steps in Section 2.5.2 to add an app icon to your project.

Once the project is open in Android Studio, in the layout editor, select **Nexus 6** from the virtual-device drop-down list (Fig. 2.11). Also, delete the **Hello world!** **TextView** in **fragment\_main.xml** and the **FloatingActionButton** in **activity\_main.xml**.

Use the **Theme Editor** (Section 3.5.2) to specify **Material Blue 500** as the app's primary color, **Material Blue 700** as the dark primary color and **Light blue accent 400** as the accent color. Also, follow the steps in Section 4.4.3 to configure the project for Java SE 7 support.

### 5.4.2 Gradle: Adding a Support Library to the Project

This app requires the Android Support Library to use the **PrintHelper** class. To add the support library as a project dependency, follow these steps:

1. Right click the app folder, then select **Open Module Settings**.
2. In the **Project Structure** window that appears, open the **Dependencies** tab.
3. Click the Add button (), then select **Library dependency** to open the **Choose Library Dependency** dialog.
4. Select **support-v4 (com.android.support:support-v4:23.1.0)** from the list, then click **OK**. The dependency will appear in the list in the **Dependencies** tab.
5. Click **OK**. The IDE will display **Gradle project sync in progress...** while the project is being configured to use the Android Support Library.

For more on when to use and how to set up the Android Support Library, visit

<http://developer.android.com/tools/support-library>  
<http://developer.android.com/tools/support-library/setup.html>

### 5.4.3 strings.xml

You created **String** resources in earlier chapters, so we show only a table of the **String** resource names and corresponding values here (Fig. 5.10). Double click **strings.xml** in the **res/values** folder, then click the **Open editor** link to display the **Translations Editor** for creating these **String** resources.



#### Look-and-Feel Observation 5.2

*For languages that support uppercase letters, Google's material design specification indicates that a Button's text should use all capital letters (e.g., CANCEL or SET COLOR).*

| Key                        | Default Value                    |
|----------------------------|----------------------------------|
| button_erase               | Erase Image                      |
| button_set_color           | Set Color                        |
| button_set_line_width      | Set Line Width                   |
| line_imageview_description | This displays the line thickness |

**Fig. 5.10** | String resources used in the **Doodlz** app. (Part I of 2.)

| Key                     | Default Value  |
|-------------------------|--|
| label_alpha             | Alpha  |
| label_red               | Red  |
| label_green             | Green  |
| label_blue              | Blue   |
| menuitem_color          | Color  |
| menuitem_delete         | Erase Drawing  |
| menuitem_line_width     | Line Width   |
| menuitem_save           | Save   |
| menuitem_print          | Print  |
| message_erase           | Erase the drawing?   |
| message_error_saving    | There was an error saving the image  |
| message_saved           | Your saved painting can be viewed in the Photos app by selecting Device Folders from that app's menu<br>[Note: \' is the single-quote (') escape sequence—without the \, the IDE issues the warning “Apostrophe not preceded by \”.] |
| message_error_printing  | Your device does not support printing  |
| permission_explanation  | To save an image, the app requires permission to write to external storage   |
| title_color_dialog      | Choose Color   |
| title_line_width_dialog | Choose Line Width  |

**Fig. 5.10** | String resources used in the **Doodlz** app. (Part 2 of 2.)

#### 5.4.4 Importing the Material Design Icons for the App's Menu Items

This app's menu specifies icons for each menu item. Menus items that fit on the app bar (which depends on the device) display the corresponding icon. Use the techniques you learned in Section 4.4.9 to import the following material design vector icons:

-  (ic\_palette\_24dp)
-  (ic\_brush\_24dp)
-  (ic\_delete\_24dp)
-  (ic\_save\_24dp)
-  (ic\_print\_24dp)

The names in parentheses are the names that are displayed as tooltips in the **Vector Asset Studio** dialog when you hover over an image. For each image, open its XML file and change the `fillColor` to

```
@android:color/white
```

so that the icons are displayed in white against the app's blue app bar.

### 5.4.5 MainActivityFragment Menu

In Chapter 4, you edited the default menu provided by the IDE to display the Flag Quiz app's **Settings** menu item. In this app, you'll define your own menu for the **MainActivityFragment**. You will not use **MainActivity**'s default menu in this app, so you can delete the `menu_main.xml` file in your project's `res/menu` folder. You should also remove the methods `onCreateOptionsMenu` and `onOptionsItemSelected` from class **MainActivity**, as these will not be used.

#### *Menus for Different Android Versions*

Keep in mind that the printing capability is not available in versions prior to Android 4.4. If you are developing an app with menus for multiple versions of Android, you may want to create multiple menu resources by using the resource qualifiers discussed in earlier apps. For example, you could create a menu resource for Android versions prior to 4.4 and a separate one for Android versions 4.4 and higher. In the menu resource for pre-Android-4.4, you can omit menu options that are unavailable in earlier Android versions. For more information on creating menu resources, visit

<http://developer.android.com/guide/topics/ui/menus.html>

#### *Creating the Menu*

To create the menu resource, follow these steps:

1. Right click the `res/menu` folder and select **New > Menu resource file** to open the **New Resource File** dialog.
2. Enter `doodle_fragment_menu.xml` in the **File name** field, and click **OK**. The IDE opens the file in the editor where it displays the file's XML. You must edit the XML directly to add menu items to the menu resource.
3. In this menu, we'll use each menu item's `showAsAction` property to specify that the menu item should be displayed on the app bar if there is room. When working with the Android Support Libraries to provide a backward-compatible app bar, you must use the `showAsAction` attribute from the XML namespace `app`, rather than the XML namespace `android`. Edit the `<menu>` element's opening tag to include the `app` XML namespace

`xmlns:app="http://schemas.android.com/apk/res-auto"`

4. Add the code for the first menu item in Fig. 5.11 to the XML file. The `id` of the menu item is `@+id/color`, its `title` property is `@string/menuitem_color`, its `icon` property is `@drawable/ic_palette_24dp` and its `showAsAction` property is `ifRoom`. The value `ifRoom` indicates that Android should display the menu item on the app bar if there's room available; otherwise, the menu item will appear as a text menu item in the overflow options menu at the right side of the app bar. Other `showAsAction` values can be found at

<http://developer.android.com/guide/topics/resources/menu-resource.html>

---

```

1 <item
2   android:id="@+id/color"
3   android:title="@string/menuitem_color"
4   android:icon="@drawable/ic_palette_24dp"
5   app:showAsAction="ifRoom">
6 </item>
```

---

**Fig. 5.11** | An `<item>` element representing a menu item.

5. Repeat *Step 3* for each of the IDs and titles in Fig. 5.12 to create the menu items for **Line Width**, **Delete**, **Save** and **Print**, then save and close the menu's file. The completed XML for the menu is shown in Fig. 5.13.

| Id                  | Title                       |
|---------------------|-----------------------------|
| @+id/line_width     | @string/menuitem_line_width |
| @+id/delete_drawing | @string/menuitem_delete     |
| @+id/save           | @string/menuitem_save       |
| @+id/print          | @string/menuitem_print      |

**Fig. 5.12** | Additional menu items for the `MainActivityFragment`.

---

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <menu xmlns:android="http://schemas.android.com/apk/res/android"
3   xmlns:app="http://schemas.android.com/apk/res-auto">
4   <item
5     android:id="@+id/color"
6     android:title="@string/menuitem_color"
7     android:icon="@drawable/ic_palette_24dp"
8     app:showAsAction="ifRoom">
9   </item>
10
11   <item
12     android:id="@+id/line_width"
13     android:title="@string/menuitem_line_width"
14     android:icon="@drawable/ic_brush_24dp"
15     app:showAsAction="ifRoom">
16   </item>
17
18   <item
19     android:id="@+id/delete_drawing"
20     android:title="@string/menuitem_delete"
21     android:icon="@drawable/ic_delete_24dp"
22     app:showAsAction="ifRoom">
23   </item>
24 
```

---

**Fig. 5.13** | `doodle_fragment_menu.xml`. (Part I of 2.)

```

25    <item
26        android:id="@+id/save"
27        android:title="@string/menuitem_save"
28        android:icon="@drawable/ic_save_24dp"
29        app:showAsAction="ifRoom">
30    </item>
31
32    <item
33        android:id="@+id/print"
34        android:title="@string/menuitem_print"
35        android:icon="@drawable/ic_print_24dp"
36        app:showAsAction="ifRoom">
37    </item>
38 </menu>

```

**Fig. 5.13** | `doodle_fragment_menu.xml`. (Part 2 of 2.)

#### 5.4.6 Adding a Permission to `AndroidManifest.xml`

In addition to using Android 6.0’s new permissions model in which the app asks the user to grant permissions dynamically, each app also must specify any permissions it uses in the `AndroidManifest.xml` file. To do so:

1. Expand the project’s `manifests` folder and open `AndroidManifest.xml`.
2. Inside the `<manifest>` element and before the `<application>` element, add

```

<uses-permission
    android:name="android.permission.WRITE_EXTERNAL_STORAGE" />

```

## 5.5 Building the App’s GUI

In this section, you’ll create the app’s GUI and create the classes for the app’s dialogs.

### 5.5.1 `content_main.xml` Layout for `MainActivity`

The `content_main.xml` layout for this app’s `MainActivity` contains only the `MainActivityFragment`, which was created automatically when you created the project. For more readable code, we changed the fragment’s `id` property:

1. Open `content_main.xml` in the layout editor’s **Design** view.
2. Select the fragment in the **Component Tree**, then change the Fragment’s `id` to `doodleFragment` in the **Properties** window and save the layout.

### 5.5.2 `fragment_main.xml` Layout for `MainActivityFragment`

The `fragment_main.xml` layout for the `MainActivityFragment` needs to display only a `DoodleView`. The layout file was created with a `RelativeLayout` automatically when you created the project. To change the root element of the layout from a `RelativeLayout` to a `DoodleView`, you must first create class `DoodleView` (a subclass of `View`), so you can select it when placing the custom view in the layout:

1. Expand the `java` folder in the **Project** window.

2. Right click the `com.deitel.doodlz` node, then select **New > Java Class**.
3. In the **Create New Class** dialog that appears, enter `DoodleView` in the **Name** field, then click **OK**. The file will open in the editor automatically.
4. In `DoodleView.java`, indicate that class `DoodleView` is a subclass of `View` by adding `extends View` to the class's definition. If the IDE does not add an `import` for `android.view.View`, place the cursor immediately following `extends View`. Next, click the red bulb ( ) that appears above the beginning of class `DoodleView`'s definition and select **Import Class**.
5. The IDE will display an error indicating that you have not defined a constructor for the new class. To fix this, place the cursor immediately following `extends View`. Click the red bulb ( ) that appears above the beginning of class `DoodleView`'s definition and select **Create constructor matching super**. In the **Choose Super Class Constructors** dialog, choose the two-argument constructor, then click **OK**. The IDE will add the constructor to the class. You'll add code to this constructor in Section 5.8.3. The two-argument constructor is called by Android when inflating the `DoodleView` from a layout—the second argument specifies the `View` properties set in the layout XML file. You can learn more about class `View`'s constructors at

[http://developer.android.com/reference/android/view/View.html#View\(android.content.Context\)](http://developer.android.com/reference/android/view/View.html#View(android.content.Context))

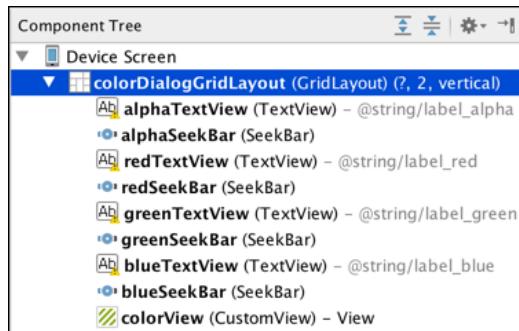
6. Switch back to `fragment_main.xml` in the layout editor and click the **Text** tab.
7. Change `RelativeLayout` to `com.deitel.doodlz.DoodleView`.
8. Remove the properties for top, right, bottom and left padding—the `DoodleView` should occupy the entire screen.
9. In Design view, select `CustomView - com.deitel.doodlz.DoodleView` in the Component Tree window, then set the `id` to `doodleView`.
10. Save and close `fragment_main.xml`.

### 5.5.3 `fragment_color.xml` Layout for `ColorDialogFragment`

The `fragment_color.xml` layout for the `ColorDialogFragment` contains a two-column `GridLayout` that displays a GUI for selecting and previewing a new drawing color. In this section, you'll create `ColorDialogFragment`'s layout and the `ColorDialogFragment` class. To add the `fragment_color.xml` layout:

1. Expand the project's `res/layout` node in the Project window.
2. Right click the `layout` folder and select **New > Layout resource file** to display the **New Resource File** dialog.
3. In the dialog's **File name** field, enter `fragment_color.xml`
4. In the **Root element** field, enter `GridLayout`, then click **OK**.
5. In the Component Tree window, select the `GridLayout`.
6. In the Properties window, change the `id` value to `colorDialogGridLayout` and the `columnCount` to 2.

- Using the layout editor's **Palette**, drag Plain **TextViews** and **SeekBar**s onto the **colorDialogGridLayout** node in the **Component Tree** window. Drag the items in the order they're listed in Fig. 5.14 and set each item's **id** as shown in the figure. We'll show you how to add the **colorView** next.



**Fig. 5.14** | Component Tree view for `fragment_color.xml`.

### *Adding the colorView to the Layout*

The `colorView` does not need its own class—we'll programmatically use methods of class `View` to change the color displayed in `colorView`. Android Studio does not provide a drag-and-drop way to add an object of class `View` to a layout, so you'll need to edit the layout's XML directly to add the `colorView`. To do so:

- Click the **Text** tab at the bottom of the layout editor to switch from the **Design** view to the layout's XML text.
- Add the code in Fig. 5.15 immediately before closing `</GridLayout>` tag.

```

1 <View
2   android:layout_width="wrap_content"
3   android:layout_height="@dimen/color_view_height"
4   android:id="@+id/colorView"
5   android:layout_column="0"
6   android:layout_columnSpan="2"
7   android:layout_gravity="fill_horizontal"/>

```

**Fig. 5.15** | `fragment_color.xml`.

- Switch back to the layout editor's **Design** tab.
- Configure the GUI component properties with the values shown in Fig. 5.16. For the dimension value `color_view_height`, recall that in the **Resources** dialog, you can click **New Resource** and select **New Dimension Value...** to open the **New Dimension Value Resource** dialog. Specify `80dp` for the `color_view_height`.
- Save and close `fragment_color.xml`.

| GUI component         | Property   | Value   |
|-----------------------|--|---|
| colorDialogGridLayout | <b>columnCount</b><br><b>orientation</b><br><b>useDefaultMargins</b><br><b>padding top</b><br><b>padding bottom</b><br><b>padding left</b><br><b>padding right</b> | 2<br>vertical<br>true<br>@dimen/activity_vertical_margin<br>@dimen/activity_vertical_margin<br>@dimen/activity_horizontal_margin<br>@dimen/activity_horizontal_margin |
| alphaTextView         | <i>Layout Parameters</i><br><b>layout:column</b><br><b>layout:gravity</b><br><b>layout:row</b><br><i>Other Properties</i><br><b>text</b>                           | 0<br>right, center_vertical<br>0<br>@string/label_alpha   |
| alphaSeekBar          | <i>Layout Parameters</i><br><b>layout:column</b><br><b>layout:gravity</b><br><b>layout:row</b><br><i>Other Properties</i><br><b>max</b>                            | 1<br>fill_horizontal<br>0<br>255  |
| redTextView           | <i>Layout Parameters</i><br><b>layout:column</b><br><b>layout:gravity</b><br><b>layout:row</b><br><i>Other Properties</i><br><b>text</b>                           | 0<br>right, center_vertical<br>1<br>@string/label_red   |
| redSeekBar            | <i>Layout Parameters</i><br><b>layout:column</b><br><b>layout:gravity</b><br><b>layout:row</b><br><i>Other Properties</i><br><b>max</b>                            | 1<br>fill_horizontal<br>1<br>255  |
| greenTextView         | <i>Layout Parameters</i><br><b>layout:column</b><br><b>layout:gravity</b><br><b>layout:row</b><br><i>Other Properties</i><br><b>text</b>                           | 0<br>right, center_vertical<br>2<br>@string/label_green   |
| greenSeekBar          | <i>Layout Parameters</i><br><b>layout:column</b><br><b>layout:gravity</b><br><b>layout:row</b><br><i>Other Properties</i><br><b>max</b>                            | 1<br>fill_horizontal<br>2<br>255  |

**Fig. 5.16** | Property values for the GUI components in `fragment_color.xml`. (Part I of 2.)

| GUI component | Property   | Value  |
|---------------|--|--|
| blueTextView  | <i>Layout Parameters</i><br>layout:column<br>layout:gravity<br>layout:row<br><i>Other Properties</i><br>text | 0<br>right, center_vertical<br>3<br>@string/label_blue |
| blueSeekBar   | <i>Layout Parameters</i><br>layout:column<br>layout:gravity<br>layout:row<br><i>Other Properties</i><br>max  | 1<br>fill_horizontal<br>3<br>255                       |
| colorView     | <i>Layout Parameters</i><br>layout:height<br>layout:column<br>layout:columnSpan<br>layout:gravity            | @dimen/color_view_height<br>0<br>2<br>fill_horizontal  |

**Fig. 5.16** | Property values for the GUI components in `fragment_color.xml`. (Part 2 of 2.)

### *Adding Class `ColorDialogFragment` to the Project*

To add class `ColorDialogFragment` to the project:

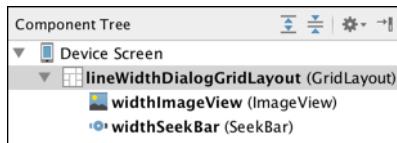
1. In the project's `java` folder, right click the upper package `com.deitel.doodlz` and select `New > Java Class` to display the `Create New Class` dialog.
2. In the `Name` field, enter `ColorDialogFragment`.
3. Click `OK` to create the class. You'll create the code for this class in Section 5.9.

### **5.5.4 `fragment_line_width.xml` Layout for `LineWidthDialogFragment`**

The `fragment_line_width.xml` layout for the `LineWidthDialogFragment` contains a `GridLayout` that displays a GUI for selecting and previewing a new line thickness. In this section, you'll create `LineWidthDialogFragment`'s layout and the `LineWidthDialogFragment` class. To add the `fragment_line_width.xml` layout:

1. Expand the project's `res/layout` node in the `Project` window.
2. Right click the `layout` folder and select `New > Layout resource file` to display the `New Resource File` dialog.
3. In the dialog's `File name` field, enter `fragment_line_width.xml`
4. In the `Root element` field, enter `GridLayout`, then click `OK`.
5. In the `Component Tree` window, select the `GridLayout`, and change its `id` value to `lineWidthDialogGridLayout`.

6. Using the layout editor's **Palette**, drag an **ImageView** and a **SeekBar** onto the **lineWidthDialogGridLayout** node in the **Component Tree** window so that the window appears as shown in Fig. 5.17. Set each item's id as shown in the figure.



**Fig. 5.17** | Component Tree view for `fragment_line_width.xml`.

7. Configure the GUI component properties with the values shown in Fig. 5.18. Give the dimension value `line_imageview_height` a value of `50dp`.  
 8. Save and close `fragment_line_width.xml`.

| GUI component                                | Property   | Value   |
|--|--|---|
| <code>lineWidthDialog-<br/>GridLayout</code> | <code>column Count</code>                                  | 1   |
|  | <code>orientation</code>                                   | vertical  |
|  | <code>useDefaultMargins</code>                             | true  |
|  | <code>padding top</code>                                   | <code>@dimen/activity_vertical_margin</code>    |
|  | <code>padding bottom</code>                                | <code>@dimen/activity_vertical_margin</code>    |
|  | <code>padding left</code>                                  | <code>@dimen/activity_horizontal_margin</code>  |
|  | <code>padding right</code>                                 | <code>@dimen/activity_horizontal_margin</code>  |
| <code>widthImageView</code>                  | <i>Layout Parameters</i><br><code>layout:height</code>     | <code>@dimen/line_imageview_height</code>       |
|  | <code>layout:gravity</code>                                | <code>fill_horizontal</code>                    |
|  | <i>Other Properties</i><br><code>contentDescription</code> | <code>@string/line_imageview_description</code> |
| <code>widthSeekBar</code>                    | <i>Layout Parameters</i><br><code>layout:gravity</code>    | <code>fill_horizontal</code>                    |
|  | <i>Other Properties</i><br><code>max</code>                | 50  |

**Fig. 5.18** | Property values for the GUI components in `fragment_line_width.xml`.

### *Adding Class `LineWidthDialogFragment` to the Project*

To add class `LineWidthDialogFragment` to the project:

- In the project's java folder, right click the upper package `com.deitel.doodlz` and select **New > Java Class** to display the **Create New Class** dialog.
- In the **Name** field, enter `LineWidthDialogFragment`.
- Click **OK** to create the class.

### 5.5.5 Adding Class EraseImageDialogFragment

The `EraseImageDialogFragment` does not require a layout resource, as it will display a simple `AlertDialog` containing text. To add class `EraseImageDialogFragment` to the project:

1. In the project's java folder, right click the upper package `com.deitel.doodlz` and select **New > Java Class** to display the **Create New Class** dialog.
2. In the **Name** field, enter `EraseImageDialogFragment`.
3. Click **OK** to create the class.

## 5.6 MainActivity Class

This app consists of six classes:

- `MainActivity` (discussed below)—This is the parent `Activity` for the app's `Fragments`.
- `MainActivityFragment` (Section 5.7)—Manages the `DoodleView` and accelerometer event handling.
- `DoodleView` (Section 5.8)—Provides the drawing, saving and printing capabilities.
- `ColorDialogFragment` (Section 5.9)—A `DialogFragment` that's displayed when the user chooses the option to set the drawing color.
- `LineWidthDialogFragment` (Section 5.10)—A `DialogFragment` that's displayed when the user chooses the option to set the line width.
- `EraseImageDialogFragment` (Section 5.11)—A `DialogFragment` that's displayed when the user chooses the option to erase, or shakes the device to erase, the current drawing.

Class `MainActivity`'s `onCreate` method (Fig. 5.19) inflates the GUI (line 16) and configures its app bar (lines 17–18), then uses the techniques you learned in Section 4.6.3 to determine the device's size and set `MainActivity`'s orientation. If this app is running on an extra-large device (line 26), we set the orientation to landscape (lines 27–28); otherwise, we set it to portrait (lines 30–31). We removed the other autogenerated methods in class `MainActivity`, as they're not used in this app.

---

```

1 // MainActivity.java
2 // Sets MainActivity's layout
3 package com.deitel.doodlz;
4
5 import android.content.pm.ActivityInfo;
6 import android.content.res.Configuration;
7 import android.os.Bundle;
8 import android.support.v7.app.AppCompatActivity;
9 import android.support.v7.widget.Toolbar;
```

---

**Fig. 5.19** | `MainActivity` class. (Part I of 2.)

```
10 public class MainActivity extends AppCompatActivity {  
11     // configures the screen orientation for this app  
12     @Override  
13     protected void onCreate(Bundle savedInstanceState) {  
14         super.onCreate(savedInstanceState);  
15         setContentView(R.layout.activity_main);  
16         Toolbar toolbar = (Toolbar) findViewById(R.id.toolbar);  
17         setSupportActionBar(toolbar);  
18  
19         // determine screen size  
20         int screenSize =  
21             getResources().getConfiguration().screenLayout &  
22             Configuration.SCREENLAYOUT_SIZE_MASK;  
23  
24         // use landscape for extra large tablets; otherwise, use portrait  
25         if (screenSize == Configuration.SCREENLAYOUT_SIZE_XLARGE)  
26             setRequestedOrientation(  
27                 ActivityInfo.SCREEN_ORIENTATION_LANDSCAPE);  
28         else  
29             setRequestedOrientation(  
30                 ActivityInfo.SCREEN_ORIENTATION_PORTRAIT);  
31     }  
32 }  
33 }
```

Fig. 5.19 | MainActivity class. (Part 2 of 2.)

## 5.7 MainActivityFragment Class

The `MainActivityFragment` (Sections 5.7.1–5.7.10) displays the `DoodleView` (Section 5.8), manages the menu options displayed on the app bar and in the options menu, and manages the sensor event handling for the app’s *shake-to-erase* feature.

### 5.7.1 package Statement, import Statements and Fields

Section 5.3 discussed the key new classes and interfaces used by `MainActivityFragment`. We’ve highlighted these classes and interfaces in Fig. 5.20. `DoodleView` variable `doodleView` (line 24) represents the drawing area. Accelerometer information is delivered to the app as `float` values. The `float` variables in lines 25–27 are used to calculate changes in the device’s acceleration to determine when a *shake* event occurs (so we can ask whether the user would like to erase the drawing). Line 28 defines a `boolean` variable with the default value `false` that will be used throughout this class to specify when there’s a dialog displayed on the screen. We use this to prevent multiple dialogs from being displayed simultaneously—for example, if the `Choose Color` dialog is displayed and the user accidentally shakes the device, the dialog for erasing the image should *not* be displayed. The constant in line 31 is used to ensure that small device movements (which happen frequently) are *not* interpreted as shakes—we picked this constant via trial and error by shaking the app on several different types of devices. The constant in line 35 is used to identify the request for the permission needed to save the user’s drawing.

```

1 // MainActivityFragment.java
2 // Fragment in which the DoodleView is displayed
3 package com.deitel.doodlz;
4
5 import android.Manifest;
6 import android.app.AlertDialog;
7 import android.content.Context;
8 import android.content.DialogInterface;
9 import android.content.pm.PackageManager;
10 import android.hardware.Sensor;
11 import android.hardware.SensorEvent;
12 import android.hardware.SensorEventListener;
13 import android.hardware.SensorManager;
14 import android.os.Bundle;
15 import android.support.v4.app.Fragment;
16 import android.view.LayoutInflater;
17 import android.view.Menu;
18 import android.view.MenuInflater;
19 import android.view.MenuItem;
20 import android.view.View;
21 import android.view.ViewGroup;
22
23 public class MainActivityFragment extends Fragment {
24     private DoodleView doodleView; // handles touch events and draws
25     private float acceleration;
26     private float currentAcceleration;
27     private float lastAcceleration;
28     private boolean dialogOnScreen = false;
29
30     // value used to determine whether user shook the device to erase
31     private static final int ACCELERATION_THRESHOLD = 100000;
32
33     // used to identify the request for using external storage, which
34     // the save image feature needs
35     private static final int SAVE_IMAGE_PERMISSION_REQUEST_CODE = 1;
36

```

**Fig. 5.20** | MainActivityFragment class package statement, import statements and fields.

### 5.7.2 Overridden Fragment Method onCreateView

Method `onCreateView` (Fig. 5.21) inflates MainActivityFragment's GUI and initializes the instance variables. A Fragment can place items in the app's app bar and options menu. To do so, the Fragment must call its `setHasOptionsMenu` method with the argument `true`. If the parent Activity also has options menu items, then the Activity's and the Fragment's items will be placed on the app bar or in the options menu (based on their settings).

```

37     // called when Fragment's view needs to be created
38     @Override
39     public View onCreateView(LayoutInflater inflater, ViewGroup container,
40                             Bundle savedInstanceState) {

```

**Fig. 5.21** | Overriding Fragment method `onCreateView`. (Part I of 2.)

```

41     super.onCreateView(inflater, container, savedInstanceState);
42     View view =
43         inflater.inflate(R.layout.fragment_main, container, false);
44
45     setHasOptionsMenu(true); // this fragment has menu items to display
46
47     // get reference to the DoodleView
48     doodleView = (DoodleView) view.findViewById(R.id.doodleView);
49
50     // initialize acceleration values
51     acceleration = 0.00f;
52     currentAcceleration = SensorManager.GRAVITY_EARTH;
53     lastAcceleration = SensorManager.GRAVITY_EARTH;
54
55     return view;
56 }
```

**Fig. 5.21** | Overriding Fragment method onCreateView. (Part 2 of 2.)

Line 48 gets a reference to the `DoodleView`, then lines 51–53 initialize the instance variables that help calculate acceleration changes to determine whether the user shook the device. We initially set variables `currentAcceleration` and `lastAcceleration` to `SensorManager`'s `GRAVITY_EARTH` constant, which represents the acceleration due to Earth's gravity. `SensorManager` also provides constants for other planets in the solar system, for the moon and for other entertaining values, which you can see at

[http://developer.android.com/reference/android/hardware/  
SensorManager.html](http://developer.android.com/reference/android/hardware/SensorManager.html)

### 5.7.3 Methods onResume and enableAccelerometerListening

*Accelerometer listening* should be enabled only when the `MainActivityFragment` is visible. For this reason, we override Fragment lifecycle method `onResume` (Fig. 5.22, lines 58–62), which is called when the Fragment is on the screen and ready for the user to interact with it. Method `onResume` calls method `enableAccelerometerListening` (lines 65–75) to begin listening for accelerometer events. A `SensorManager` is used to register listeners for accelerometer events.

Method `enableAccelerometerListening` first uses Activity's `getSystemService` method to retrieve the system's `SensorManager` service, which enables the app to interact with the device's sensors. Lines 72–74 then register to receive accelerometer events using `SensorManager`'s `registerListener` method, which receives three arguments:

- The `SensorEventListener` that responds to the events (defined in Section 5.7.5).
- A `Sensor` object representing the type of sensor data the app wishes to receive—this is retrieved by calling `SensorManager`'s `getDefaultSensor` method and passing in a `Sensor`-type constant (`Sensor.TYPE_ACCELEROMETER` in this app).
- The rate at which Android delivers sensor events—`SENSOR_DELAY_NORMAL` indicates the default rate. A faster rate can be used to get more accurate data, but this is also more CPU and battery intensive.

---

```

57    // start listening for sensor events
58    @Override
59    public void onResume() {
60        super.onResume();
61        enableAccelerometerListening(); // listen for shake event
62    }
63
64    // enable listening for accelerometer events
65    private void enableAccelerometerListening() {
66        // get the SensorManager
67        SensorManager sensorManager =
68            (SensorManager) getActivity().getSystemService(
69                Context.SENSOR_SERVICE);
70
71        // register to listen for accelerometer events
72        sensorManager.registerListener(sensorEventListener,
73            sensorManager.getDefaultSensor(Sensor.TYPE_ACCELEROMETER),
74            SensorManager.SENSOR_DELAY_NORMAL);
75    }
76

```

**Fig. 5.22** | Methods onResume and enableAccelerometerListening.

#### 5.7.4 Methods onPause and disableAccelerometerListening

To ensure that accelerometer listening is disabled when the MainActivityFragment is not on the screen, we override Fragment lifecycle method onPause (Fig. 5.23, lines 78–82), which calls method disableAccelerometerListening (lines 85–94). Method disableAccelerometerListening uses class SensorManager's **unregisterListener** method to stop listening for accelerometer events.

---

```

77    // stop listening for accelerometer events
78    @Override
79    public void onPause() {
80        super.onPause();
81        disableAccelerometerListening(); // stop listening for shake
82    }
83
84    // disable listening for accelerometer events
85    private void disableAccelerometerListening() {
86        // get the SensorManager
87        SensorManager sensorManager =
88            (SensorManager) getActivity().getSystemService(
89                Context.SENSOR_SERVICE);
90
91        // stop listening for accelerometer events
92        sensorManager.unregisterListener(sensorEventListener,
93            sensorManager.getDefaultSensor(Sensor.TYPE_ACCELEROMETER));
94    }
95

```

**Fig. 5.23** | Methods onPause and disableAccelerometerListening.

### 5.7.5 Anonymous Inner Class for Processing Accelerometer Events

Figure 5.24 overrides SensorEventListener method `onSensorChanged` (lines 100–123) to process accelerometer events. If the user moves the device, this method determines whether the movement was enough to be considered a shake. If so, line 121 calls method `confirmErase` (Section 5.7.6) to display an `EraseImageDialogFragment` (Section 5.11) and confirm whether the user really wants to erase the image. Interface `SensorEventListener` also contains method `onAccuracyChanged` (line 127)—we don't use this method in this app, so we provide an empty body because the method is required by the interface.

---

```

96    // event handler for accelerometer events
97    private final SensorEventListener sensorEventListener =
98        new SensorEventListener() {
99            // use accelerometer to determine whether user shook device
100           @Override
101           public void onSensorChanged(SensorEvent event) {
102               // ensure that other dialogs are not displayed
103               if (!dialogOnScreen) {
104                   // get x, y, and z values for the SensorEvent
105                   float x = event.values[0];
106                   float y = event.values[1];
107                   float z = event.values[2];
108
109                   // save previous acceleration value
110                   lastAcceleration = currentAcceleration;
111
112                   // calculate the current acceleration
113                   currentAcceleration = x * x + y * y + z * z;
114
115                   // calculate the change in acceleration
116                   acceleration = currentAcceleration *
117                           (currentAcceleration - lastAcceleration);
118
119                   // if the acceleration is above a certain threshold
120                   if (acceleration > ACCELERATION_THRESHOLD)
121                       confirmErase();
122               }
123           }
124
125           // required method of interface SensorEventListener
126           @Override
127           public void onAccuracyChanged(Sensor sensor, int accuracy) {}
128       };
129

```

---

**Fig. 5.24** | Anonymous inner class that implements interface `SensorEventListener` to process accelerometer events.

The user can shake the device even when dialogs are already displayed on the screen. For this reason, `onSensorChanged` first checks whether a dialog is displayed (line 103). This test ensures that no other dialogs are displayed; otherwise, `onSensorChanged` simply returns. This is important because the sensor events occur in a different thread of execu-

tion. Without this test, we'd be able to display the confirmation dialog for erasing the image when another dialog is on the screen.

The `SensorEvent` parameter contains information about the sensor change that occurred. For accelerometer events, this parameter's `values` array contains three elements representing the acceleration (in *meters/second<sup>2</sup>*) in the *x* (left/right), *y* (up/down) and *z* (forward/backward) directions. A description and diagram of the coordinate system used by the `SensorEvent` API is available at

[http://developer.android.com/reference/android/hardware/  
SensorEvent.html](http://developer.android.com/reference/android/hardware/SensorEvent.html)

This link also describes the real-world meanings for a `SensorEvent`'s *x*, *y* and *z* values for each different Sensor.

Lines 105–107 store the acceleration values. It's important to handle sensor events quickly or to copy the event data (as we did here) because the array of sensor values is *reused* for each sensor event. Line 110 stores the last value of `currentAcceleration`. Line 113 sums the squares of the *x*, *y* and *z* acceleration values and stores them in `currentAcceleration`. Then, using the `currentAcceleration` and `lastAcceleration` values, we calculate a value (`acceleration`) that can be compared to our `ACCELERATION_THRESHOLD` constant. If the value is greater than the constant, the user moved the device enough for this app to consider the movement a shake. In this case, we call method `confirmErase`.

### 5.7.6 Method `confirmErase`

Method `confirmErase` (Fig. 5.25) simply creates an `EraseImageDialogFragment` (Section 5.11) and uses the `DialogFragment` method `show` to display it.

---

```

130    // confirm whether image should be erased
131    private void confirmErase() {
132        EraseImageDialogFragment fragment = new EraseImageDialogFragment();
133        fragment.show(getFragmentManager(), "erase dialog");
134    }
135

```

---

**Fig. 5.25** | Method `confirmErase` displays an `EraseImageDialogFragment`.

### 5.7.7 Overridden Fragment Methods `onCreateOptionsMenu` and `onOptionsItemSelected`

Figure 5.26 overrides `Fragment`'s `onCreateOptionsMenu` method (lines 137–141) to add the options to the method's `Menu` argument using the method's `MenuInflater` argument. When the user selects a menu item, `Fragment` method `onOptionsItemSelected` (lines 144–169) responds to the selection.

We use the `MenuItem` argument's `getItemId` method (line 147) to get the resource ID of the selected menu item, then take different actions based on the selection. The actions are as follows:

- For `R.id.color`, lines 149–150 create and show a `ColorDialogFragment` (Section 5.9) to allow the user to select a new drawing color.

- For R.id.line\_width, lines 153–155 create and show a LineWidthDialogFragment (Section 5.10) to allow the user to select a new line width.
- For R.id.delete\_drawing, line 158 calls method confirmErase (Section 5.7.6) to display an EraseImageDialogFragment (Section 5.11) and confirm whether the user really wants to erase the image.
- For R.id.save, line 161 calls the saveImage method to save the painting as an image stored in the device’s Photos after checking for and, if necessary, requesting permission to write to external storage.
- For R.id.print, line 164 calls doodleView’s printImage method to allow the user to save the image as a PDF or to print the image.

---

```

136     // displays the fragment's menu items
137     @Override
138     public void onCreateOptionsMenu(Menu menu, MenuInflater inflater) {
139         super.onCreateOptionsMenu(menu, inflater);
140         inflater.inflate(R.menu.doodle_fragment_menu, menu);
141     }
142
143     // handle choice from options menu
144     @Override
145     public boolean onOptionsItemSelected(MenuItem item) {
146         // switch based on the MenuItem id
147         switch (item.getItemId()) {
148             case R.id.color:
149                 ColorDialogFragment colorDialog = new ColorDialogFragment();
150                 colorDialog.show(getFragmentManager(), "color dialog");
151                 return true; // consume the menu event
152             case R.id.line_width:
153                 LineWidthDialogFragment widthDialog =
154                     new LineWidthDialogFragment();
155                 widthDialog.show(getFragmentManager(), "Line width dialog");
156                 return true; // consume the menu event
157             case R.id.delete_drawing:
158                 confirmErase(); // confirm before erasing image
159                 return true; // consume the menu event
160             case R.id.save:
161                 saveImage(); // check permission and save current image
162                 return true; // consume the menu event
163             case R.id.print:
164                 doodleView.printImage(); // print the current images
165                 return true; // consume the menu event
166         }
167
168         return super.onOptionsItemSelected(item);
169     }
170

```

---

**Fig. 5.26** | Overridden Fragment methods onCreateOptionsMenu and onOptionsItemSelected.

### 5.7.8 Method saveImage

Method `saveImage` (Fig. 5.27) is called by the `onOptionsItemSelected` method when the user selects the `Save` option in the options menu. The `saveImage` method implements part of the new Android 6.0 permissions model that first checks whether the app has the required permission before performing a task. If not, the app requests permission from the user before attempting to perform the task.

Lines 176–178 check whether the app does not yet have permission to write to external storage so that it can save the image. If the app does not have the permission `android.permission.WRITE_EXTERNAL_STORAGE`, lines 181–182 use the built-in `shouldShowRequestPermissionRationale` method to determine whether an explanation of why the app needs this permission should be displayed. The method returns `true` when it would be helpful to explain to the user why the app requires permission—for example, if the user denied the permission previously. If so, lines 183–203 create and display a dialog with the explanation. When the user clicks the dialog's `OK` button, lines 195–197 request the `android.permission.WRITE_EXTERNAL_STORAGE` permission using the inherited `Fragment` method `requestPermissions`. If an explanation is not necessary—for example, if this is the first time the app needs the permission—lines 207–209 immediately request the permission.

---

```

171 // requests the permission needed for saving the image if
172 // necessary or saves the image if the app already has permission
173 private void saveImage() {
174     // checks if the app does not have permission needed
175     // to save the image
176     if (getContext().checkSelfPermission(
177         Manifest.permission.WRITE_EXTERNAL_STORAGE) !=
178         PackageManager.PERMISSION_GRANTED) {
179
180         // shows an explanation of why permission is needed
181         if (shouldShowRequestPermissionRationale(
182             Manifest.permission.WRITE_EXTERNAL_STORAGE)) {
183             AlertDialog.Builder builder =
184                 new AlertDialog.Builder(getActivity());
185
186             // set Alert Dialog's message
187             builder.setMessage(R.string.permission_explanation);
188
189             // add an OK button to the dialog
190             builder.setPositiveButton(android.R.string.ok,
191                 new DialogInterface.OnClickListener() {
192                     @Override
193                     public void onClick(DialogInterface dialog, int which) {
194                         // request permission
195                         requestPermissions(new String[]{
196                             Manifest.permission.WRITE_EXTERNAL_STORAGE},
197                             SAVE_IMAGE_PERMISSION_REQUEST_CODE);
198                     }
199                 });
200
201 };

```

**Fig. 5.27** | Method `saveImage`. (Part 1 of 2.)

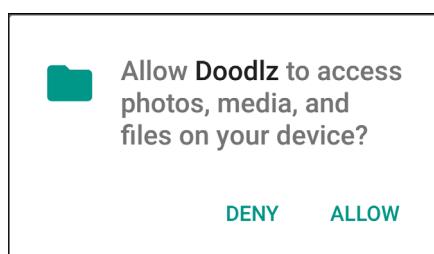
```

202         // display the dialog
203         builder.create().show();
204     }
205     else {
206         // request permission
207         requestPermissions(
208             new String[]{Manifest.permission.WRITE_EXTERNAL_STORAGE},
209             SAVE_IMAGE_PERMISSION_REQUEST_CODE);
210     }
211 }
212 else { // if app already has permission to write to external storage
213     doodleView.saveImage(); // save the image
214 }
215 }
216

```

**Fig. 5.27** | Method saveImage. (Part 2 of 2.)

The `requestPermissions` method receives a `String` array of permissions the app is requesting and an integer (`SAVE_IMAGE_PERMISSION_REQUEST_CODE`) that's used to identify this request for permission. When `requestPermissions` is called, Android displays a dialog (Fig. 5.28) that allows the user to **DENY** or **ALLOW** the requested permissions. The system invokes the callback method `onRequestPermissionsResult` (Section 5.7.9) to process the user's response. If the app already has the requested permission, line 213 calls the `DoodleView`'s `saveImage` method to save the image.

**Fig. 5.28** | Dialog enabling the user to deny or allow writing to external storage.

### 5.7.9 Overridden Method onRequestPermissionsResult

Method `onRequestPermissionsResult` (Fig. 5.29) receives a permission `requestCode` for the request that was made and passes it to the `switch` in lines 224–229, which executes appropriate code for the request. This app has only one permission request, so the `switch` statement has only one `case` identified by the `SAVE_IMAGE_PERMISSION_REQUEST_CODE` constant. For apps that require multiple permissions you should specify unique values for each permission when you call method `requestPermissions`. Line 226 checks whether the user granted the app permission to write to external storage. If so, line 227 calls the `DoodleView`'s `saveImage` method to save the image.



### Software Engineering Observation 5.1

If the user attempts to save the image and denies permission, the next time the user attempts to save, the permission dialog will contain a **Never ask again** checkbox. If the user checks this and denies permission, then attempts to save in the future, method `onRequestPermissionsResult` will be called with `PackageManager.PERMISSION_DENIED` as an argument. A production app should handle this case and tell the user how to change the app's permissions via the **Settings** app.

```

217 // called by the system when the user either grants or denies the
218 // permission for saving an image
219 @Override
220 public void onRequestPermissionsResult(int requestCode,
221     String[] permissions, int[] grantResults) {
222     // switch chooses appropriate action based on which feature
223     // requested permission
224     switch (requestCode) {
225         case SAVE_IMAGE_PERMISSION_REQUEST_CODE:
226             if (grantResults[0] == PackageManager.PERMISSION_GRANTED)
227                 doodleView.saveImage(); // save the image
228             return;
229     }
230 }
231

```

**Fig. 5.29** | Overridden Fragment method `onRequestPermissionsResult`.

### 5.7.10 Methods `getDoodleView` and `setDialogOnScreen`

Methods `getDoodleView` and `setDialogOnScreen` (Fig. 5.30) are called by methods of the app's `DialogFragment` subclasses. Method `getDoodleView` returns a reference to this Fragment's `DoodleView` so that a `DialogFragment` can set the drawing color, set the line width or clear the image. Method `setDialogOnScreen` is called by Fragment lifecycle methods of the app's `DialogFragment` subclasses to indicate when a dialog is on the screen.



### Software Engineering Observation 5.2

This app's Fragments interact with one another directly. We chose this tightly coupled approach for simplicity in this app. Generally, a parent Activity manages an app's Fragment interactions. To pass data to a Fragment, the Activity provides a Bundle of arguments. Each Fragment class typically provides an interface of callback methods that the Activity implements. When the Fragment needs to notify its parent Activity of a state change, the Fragment calls the appropriate callback method. These techniques make Fragments more reusable across activities. We'll demonstrate these techniques in Chapter 9's **Address Book** app.

```

232 // returns the DoodleView
233 public DoodleView getDoodleView() {
234     return doodleView;
235 }

```

**Fig. 5.30** | Methods `getDoodleView` and `setDialogOnScreen`. (Part 1 of 2.)

```
236
237     // indicates whether a dialog is displayed
238     public void setDialogOnScreen(boolean visible) {
239         dialogOnScreen = visible;
240     }
241 }
```

**Fig. 5.30** | Methods `getDoodleView` and `setDialogOnScreen`. (Part 2 of 2.)

## 5.8 DoodleView Class

The `DoodleView` class (Sections 5.8.1–5.8.12) processes the user’s touches and draws the corresponding lines.

### 5.8.1 package Statement and import Statements

Figure 5.31 lists class `DoodleView`’s package statement and `import` statements. The new classes and interfaces are highlighted here. Many of these were discussed in Section 5.3, and the rest are discussed as we use them throughout class `DoodleView`.

```
1 // DoodleView.java
2 // Main View for the Doodlz app.
3 package com.deitel.doodlz;
4
5 import android.content.Context;
6 import android.graphics.Bitmap;
7 import android.graphics.Canvas;
8 import android.graphics.Color;
9 import android.graphics.Paint;
10 import android.graphics.Path;
11 import android.graphics.Point;
12 import android.provider.MediaStore;
13 import android.support.v4.print.PrintHelper;
14 import android.util.AttributeSet;
15 import android.view.Gravity;
16 import android.view.MotionEvent;
17 import android.view.View;
18 import android.widget.Toast;
19
20 import java.util.HashMap;
21 import java.util.Map;
22
```

**Fig. 5.31** | `DoodleView` package statement and `import` statements.

### 5.8.2 static and Instance Variables

Class `DoodleView`’s static and instance variables (Fig. 5.32) are used to manage the data for the set of lines that the user is currently drawing and to draw those lines. Line 34 creates the `pathMap`, which maps each finger ID (known as a pointer) to a corresponding `Path` object for the lines currently being drawn. Line 35 creates the `previousPointMap`, which maintains the last point for each finger—as each finger moves, we draw a line from its cur-

rent point to its previous point. We discuss the other fields as we use them in class `DoodleView`.

---

```

23 // custom View for drawing
24 public class DoodleView extends View {
25     // used to determine whether user moved a finger enough to draw again
26     private static final float TOUCH_TOLERANCE = 10;
27
28     private Bitmap bitmap; // drawing area for displaying or saving
29     private Canvas bitmapCanvas; // used to draw on the bitmap
30     private final Paint paintScreen; // used to draw bitmap onto screen
31     private final Paint paintLine; // used to draw lines onto bitmap
32
33     // Maps of current Paths being drawn and Points in those Paths
34     private final Map<Integer, Path> pathMap = new HashMap<>();
35     private final Map<Integer, Point> previousPointMap = new HashMap<>();
36

```

---

**Fig. 5.32** | `DoodleView` static and instance variables.

### 5.8.3 Constructor

The constructor (Fig. 5.33) initializes several of the class's instance variables—the two Maps are initialized in their declarations in Fig. 5.32. Line 40 of Fig. 5.33 creates the `Paint` object `paintScreen` that will be used to display the user's drawing on the screen, and line 43 creates the `Paint` object `paintLine` that specifies the settings for the line(s) the user is currently drawing. Lines 44–48 specify the settings for the `paintLine` object. We pass `true` to `Paint`'s `setAntiAlias` method to enable *anti-aliasing* which smooths the edges of the lines. Next, we set the `Paint`'s style to `Paint.Style.STROKE` with `Paint`'s `setStyle` method. The style can be `STROKE`, `FILL` or `FILL_AND_STROKE` for a line, a filled shape without a border and a filled shape with a border, respectively. The default option is `Paint.Style.FILL`. We set the line's width using `Paint`'s `setStrokeWidth` method. This sets the app's *default line width* to five pixels. We also use `Paint`'s `setStrokeCap` method to round the ends of the lines with `Paint.Cap.ROUND`.

---

```

37     // DoodleView constructor initializes the DoodleView
38     public DoodleView(Context context, AttributeSet attrs) {
39         super(context, attrs); // pass context to View's constructor
40         paintScreen = new Paint(); // used to display bitmap onto screen
41
42         // set the initial display settings for the painted line
43         paintLine = new Paint();
44         paintLine.setAntiAlias(true); // smooth edges of drawn line
45         paintLine.setColor(Color.BLACK); // default color is black
46         paintLine.setStyle(Paint.Style.STROKE); // solid line
47         paintLine.setStrokeWidth(5); // set the default line width
48         paintLine.setStrokeCap(Paint.Cap.ROUND); // rounded line ends
49     }
50

```

---

**Fig. 5.33** | `DoodleView` constructor.

### 5.8.4 Overridden View Method onSizeChanged

The DoodleView's size is not determined until it's inflated and added to the MainActivitiy's View hierarchy; therefore, we can't determine the size of the drawing Bitmap in onCreate. So, we override View method onSizeChanged (Fig. 5.34), which is called when the DoodleView's size changes—e.g., when it's added to an Activity's View hierarchy or when the user rotates the device. In this app, onSizeChanged is called only when the DoodleView is added to the Doodlz Activity's View hierarchy, because the app always displays in portrait on phones and small tablets, and in landscape on large tablets.



#### Software Engineering Observation 5.3

*In apps that support both portrait and landscape orientations, onSizeChanged is called each time the user rotates the device. In this app, that would result in a new Bitmap each time the method is called. When replacing a Bitmap, you should call the prior Bitmap's recycle method to release its resources.*

---

```

51    // creates Bitmap and Canvas based on View's size
52    @Override
53    public void onSizeChanged(int w, int h, int oldW, int oldH) {
54        bitmap = Bitmap.createBitmap(getWidth(), getHeight(),
55            Bitmap.Config.ARGB_8888);
56        bitmapCanvas = new Canvas(bitmap);
57        bitmap.eraseColor(Color.WHITE); // erase the Bitmap with white
58    }
59

```

---

Fig. 5.34 | Overridden View method onSizeChanged.

Bitmap's static `createBitmap` method creates a Bitmap of the specified width and height—here we use the DoodleView's width and height as the Bitmap's dimensions. The last argument to `createBitmap` is the Bitmap's encoding, which specifies how each pixel in the Bitmap is stored. The constant `Bitmap.Config.ARGB_8888` indicates that each pixel's color is stored in four bytes (one byte each for the alpha, red, green and blue values) of the pixel's color. Next, we create a new Canvas that's used to draw shapes directly to the Bitmap. Finally, we use Bitmap's `eraseColor` method to fill the Bitmap with white pixels—the default Bitmap background is black.

### 5.8.5 Methods clear, setDrawingColor, getDrawingColor, setLineWidth and getLineWidth

Figure 5.35 defines methods `clear` (lines 61–66), `setDrawingColor` (lines 69–71), `getDrawingColor` (lines 74–76), `setLineWidth` (lines 79–81) and `getLineWidth` (lines 84–86), which are called from the `MainActivityFragment`. Method `clear`, which we use in the `EraseImageDialogFragment`, empties the `pathMap` and `previousPointMap`, erases the Bitmap by setting all of its pixels to white, then calls the inherited View method `invalidate` to indicate that the View needs to be redrawn. Then, the system automatically determines when the View's `onDraw` method should be called. Method `setDrawingColor` changes the current drawing color by setting the color of the `Paint` object `paintLine`.

Paint's `setColor` method receives an `int` that represents the new color in ARGB format. Method `getDrawingColor` returns the current color, which we use in the `ColorDialogFragment`. Method `setLineWidth` sets `paintLine`'s stroke width to the specified number of pixels. Method `getLineWidth` returns the current stroke width, which we use in the `LineWidthDialogFragment`.

---

```

60    // clear the painting
61    public void clear() {
62        pathMap.clear(); // remove all paths
63        previousPointMap.clear(); // remove all previous points
64        bitmap.eraseColor(Color.WHITE); // clear the bitmap
65        invalidate(); // refresh the screen
66    }
67
68    // set the painted line's color
69    public void setDrawingColor(int color) {
70        paintLine.setColor(color);
71    }
72
73    // return the painted line's color
74    public int getDrawingColor() {
75        return paintLine.getColor();
76    }
77
78    // set the painted line's width
79    public void setLineWidth(int width) {
80        paintLine.setStrokeWidth(width);
81    }
82
83    // return the painted line's width
84    public int getLineWidth() {
85        return (int) paintLine.getStrokeWidth();
86    }
87

```

---

**Fig. 5.35** | DoodleView methods `clear`, `setDrawingColor`, `getDrawingColor`, `setLineWidth` and `getLineWidth`.

### 5.8.6 Overridden View Method `onDraw`

When a View needs to be *redrawn*, its `onDraw` method is called. Figure 5.36 overrides `onDraw` to display `bitmap` (the `Bitmap` that contains the drawing) on the `DoodleView` by calling the `Canvas` argument's `drawBitmap` method. The first argument is the `Bitmap` to draw, the next two arguments are the *x-y* coordinates where the upper-left corner of the `Bitmap` should be placed on the View and the last argument is the `Paint` object that specifies the drawing characteristics. Lines 95–96 then loop through and display the `Paths` that are currently being drawn. For each `Integer` key in the `pathMap`, we pass the corresponding `Path` to `Canvas`'s `drawPath` method to draw the `Path` using the `paintLine` object, which defines the line *width* and *color*.

```
88     // perform custom drawing when the DoodleView is refreshed on screen
89     @Override
90     protected void onDraw(Canvas canvas) {
91         // draw the background screen
92         canvas.drawBitmap(bitmap, 0, 0, paintScreen);
93
94         // for each path currently being drawn
95         for (Integer key : pathMap.keySet())
96             canvas.drawPath(pathMap.get(key), paintLine); // draw line
97     }
98 }
```

---

Fig. 5.36 | Overridden View method onDraw.

### 5.8.7 Overridden View Method onTouchEvent

Method `onTouchEvent` (Fig. 5.37) is called when the View receives a touch event. Android supports *multitouch*—that is, having multiple fingers touching the screen. At any time, the user can touch the screen with more fingers or remove fingers from the screen. For this reason, each finger—known as a *pointer*—has a unique ID that identifies it across touch events. We'll use that ID to locate the corresponding Path objects that represent each line currently being drawn. These Paths are stored in `pathMap`.

```
99     // handle touch event
100    @Override
101    public boolean onTouchEvent(MotionEvent event) {
102        int action = event.getActionMasked(); // event type
103        int actionIndex = event.getActionIndex(); // pointer (i.e., finger)
104
105        // determine whether touch started, ended or is moving
106        if (action == MotionEvent.ACTION_DOWN ||
107            action == MotionEvent.ACTION_POINTER_DOWN) {
108            touchStarted(event.getX(actionIndex), event.getY(actionIndex),
109                         event.getPointerId(actionIndex));
110        }
111        else if (action == MotionEvent.ACTION_UP ||
112                  action == MotionEvent.ACTION_POINTER_UP) {
113            touchEnded(event.getPointerId(actionIndex));
114        }
115        else {
116            touchMoved(event);
117        }
118
119        invalidate(); // redraw
120        return true;
121    }
122 }
```

---

Fig. 5.37 | Overridden View method onTouchEvent.

`MotionEvent`'s `getActionMasked` method (line 102) returns an `int` representing the `MotionEvent` type, which you can use with constants from class `MotionEvent` to determine

how to handle each event. `MotionEvent`'s `getActionIndex` method (line 103) returns an integer index representing which finger caused the event. This index is *not* the finger's unique ID—it's simply the index at which that finger's information is located in this `MotionEvent` object. To get the finger's unique ID that persists across `MotionEvent`s until the user removes that finger from the screen, we'll use `MotionEvent`'s `getPointerID` method (lines 109 and 113), passing the finger index as an argument.

If the action is `MotionEvent.ACTION_DOWN` or `MotionEvent.ACTION_POINTER_DOWN` (lines 106–107), the user *touched the screen with a new finger*. The first finger to touch the screen generates a `MotionEvent.ACTION_DOWN` event, and all other fingers generate `MotionEvent.ACTION_POINTER_DOWN` events. For these cases, we call the `touchStarted` method (Fig. 5.38) to store the initial coordinates of the touch. If the action is `MotionEvent.ACTION_UP` or `MotionEvent.ACTION_POINTER_UP`, the user *removed a finger from the screen*, so we call method `touchEnded` (Fig. 5.40) to draw the completed Path to the bitmap so that we have a permanent record of that Path. For all other touch events, we call method `touchMoved` (Fig. 5.39) to draw the lines. After the event is processed, line 119 (of Fig. 5.37) calls the inherited `View` method `invalidate` to redraw the screen, and line 120 returns `true` to indicate that the event has been processed.

### 5.8.8 touchStarted Method

The `touchStarted` method (Fig. 5.38) is called when a finger first *touches* the screen. The coordinates of the touch and its ID are supplied as arguments. If a Path already exists for the given ID (line 129), we call Path's `reset` method to *clear* any existing points so we can *reuse* the Path for a new stroke. Otherwise, we create a new Path, add it to `pathMap`, then add a new Point to the `previousPointMap`. Lines 142–144 call Path's `moveTo` method to set the Path's starting coordinates and specify the new Point's x and y values.

---

```

123    // called when the user touches the screen
124    private void touchStarted(float x, float y, int lineID) {
125        Path path; // used to store the path for the given touch id
126        Point point; // used to store the last point in path
127
128        // if there is already a path for lineID
129        if (pathMap.containsKey(lineID)) {
130            path = pathMap.get(lineID); // get the Path
131            path.reset(); // resets the Path because a new touch has started
132            point = previousPointMap.get(lineID); // get Path's last point
133        }
134        else {
135            path = new Path();
136            pathMap.put(lineID, path); // add the Path to Map
137            point = new Point(); // create a new Point
138            previousPointMap.put(lineID, point); // add the Point to the Map
139        }
140
141        // move to the coordinates of the touch
142        path.moveTo(x, y);

```

---

**Fig. 5.38** | `touchStarted` method of class `DoodleView`. (Part I of 2.)

```
143     point.x = (int) x;
144     point.y = (int) y;
145 }
146
```

Fig. 5.38 | touchStarted method of class DoodleView. (Part 2 of 2.)

### 5.8.9 touchMoved Method

The touchMoved method (Fig. 5.39) is called when the user moves one or more fingers across the screen. The system `MotionEvent` passed from `onTouchEvent` contains touch information for multiple moves on the screen if they occur at the same time. `MotionEvent` method `getPointerCount` (line 150) returns the number of touches this `MotionEvent` describes. For each, we store the finger's ID (line 152) in `pointerID`, and store the finger's corresponding index in this `MotionEvent` (line 153) in `pointerIndex`. Then we check whether there's a corresponding Path in `pathMap` (line 156). If so, we use `MotionEvent`'s `getX` and `getY` methods to get the last coordinates for this *drag* event for the specified `pointerIndex`. We get the corresponding Path and last Point for the `pointerID` from each respective `HashMap`, then calculate the difference between the last point and the current point—we want to update the Path *only* if the user has moved a distance that's greater than our `TOUCH_TOLERANCE` constant. We do this because many devices are sensitive enough to generate `MotionEvents` indicating small movements when the user is attempting to hold a finger motionless on the screen. If the user moved a finger further than the `TOUCH_TOLERANCE`, we use Path's `quadTo` method (lines 173–174) to add a geometric curve (specifically a *quadratic Bezier curve*) from the previous Point to the new Point. We then update the most recent Point for that finger.

---

```
147 // called when the user drags along the screen
148 private void touchMoved(MotionEvent event) {
149     // for each of the pointers in the given MotionEvent
150     for (int i = 0; i < event.getPointerCount(); i++) {
151         // get the pointer ID and pointer index
152         int pointerID = event.getPointerId(i);
153         int pointerIndex = event.findPointerIndex(pointerID);
154
155         // if there is a path associated with the pointer
156         if (pathMap.containsKey(pointerID)) {
157             // get the new coordinates for the pointer
158             float newX = event.getX(pointerIndex);
159             float newY = event.getY(pointerIndex);
160
161             // get the path and previous point associated with
162             // this pointer
163             Path path = pathMap.get(pointerID);
164             Point point = previousPointMap.get(pointerID);
165
```

Fig. 5.39 | touchMoved method of class DoodleView. (Part 1 of 2.)

```

166         // calculate how far the user moved from the last update
167         float deltaX = Math.abs(newX - point.x);
168         float deltaY = Math.abs(newY - point.y);
169
170         // if the distance is significant enough to matter
171         if (deltaX >= TOUCH_TOLERANCE || deltaY >= TOUCH_TOLERANCE) {
172             // move the path to the new location
173             path.quadTo(point.x, point.y, (newX + point.x) / 2,
174                         (newY + point.y) / 2);
175
176             // store the new coordinates
177             point.x = (int) newX;
178             point.y = (int) newY;
179         }
180     }
181 }
182 }
183 }
```

**Fig. 5.39** | touchMoved method of class DoodleView. (Part 2 of 2.)

### 5.8.10 touchEnded Method

The touchEnded method (Fig. 5.40) is called when the user lifts a finger from the screen. The method receives the ID of the finger (`lineID`) for which the touch just ended as an argument. Line 186 gets the corresponding Path. Line 187 calls the `bitmapCanvas`'s `drawPath` method to draw the Path on the `Bitmap` object named `bitmap` before we call Path's `reset` method to clear the Path. Resetting the Path does not erase its corresponding painted line from the screen, because those lines have already been drawn to the `bitmap` that's displayed to the screen. The lines that are currently being drawn by the user are displayed on top of that `bitmap`.

```

184     // called when the user finishes a touch
185     private void touchEnded(int lineID) {
186         Path path = pathMap.get(lineID); // get the corresponding Path
187         bitmapCanvas.drawPath(path, paintLine); // draw to bitmapCanvas
188         path.reset(); // reset the Path
189     }
190 }
```

**Fig. 5.40** | touchEnded method of class DoodleView.

### 5.8.11 Method saveImage

Method `saveImage` (Fig. 5.41) saves the current drawing. Line 194 creates a filename for the image, then lines 197–199 store the image in the device's **Photos** app by calling class `MediaStore.Images.Media`'s `insertImage` method. The method receives four arguments:

- a `ContentResolver` that the method uses to locate where the image should be stored on the device
- the `Bitmap` to store

- the name of the image
- a description of the image

Method `insertImage` returns a `String` representing the image's location on the device, or null if the image could not be saved. Lines 201–217 check whether the image was saved and display an appropriate `Toast`.

```

191 // save the current image to the Gallery
192 public void saveImage() {
193     // use "Doodlz" followed by current time as the image name
194     final String name = "Doodlz" + System.currentTimeMillis() + ".jpg";
195
196     // insert the image on the device
197     String location = MediaStore.Images.Media.insertImage(
198         getContext().getContentResolver(), bitmap, name,
199         "Doodlz Drawing");
200
201     if (location != null) {
202         // display a message indicating that the image was saved
203         Toast message = Toast.makeText(getContext(),
204             R.string.message_saved,
205             Toast.LENGTH_SHORT);
206         message.setGravity(Gravity.CENTER, message.getXOffset() / 2,
207             message.getYOffset() / 2);
208         message.show();
209     }
210     else {
211         // display a message indicating that there was an error saving
212         Toast message = Toast.makeText(getContext(),
213             R.string.message_error_saving, Toast.LENGTH_SHORT);
214         message.setGravity(Gravity.CENTER, message.getXOffset() / 2,
215             message.getYOffset() / 2);
216         message.show();
217     }
218 }
219

```

**Fig. 5.41** | `DoodleView` method `saveImage`.

### 5.8.12 Method `printImage`

Method `printImage` (Fig. 5.42) uses the Android Support Library's `PrintHelper` class to print the current drawing—this is available only on devices running Android 4.4 or higher. Line 222 first confirms that printing support is available on the device. If so, line 224 creates a `PrintHelper` object. Next, line 227 specifies the image's *scale mode*—`PrintHelper.SCALE_MODE_FIT` indicates that the image should fit within the printable area of the paper. There's also the scale mode `PrintHelper.SCALE_MODE_FILL`, which causes the image to fill the paper, possibly cutting off a portion of the image. Finally, line 228 calls `PrintHelper` method `printBitmap`, passing as arguments the print job name (used by the printer to identify the print) and the `Bitmap` containing the image to print. This displays Android's print dialog, which allows the user to choose whether to save the image as a PDF document on the device or to print it to an available printer.

---

```

220    // print the current image
221    public void printImage() {
222        if (PrintHelper.systemSupportsPrint()) {
223            // use Android Support Library's PrintHelper to print image
224            PrintHelper printHelper = new PrintHelper(getApplicationContext());
225
226            // fit image in page bounds and print the image
227            printHelper.setScaleMode(PrintHelper.SCALE_MODE_FIT);
228            printHelper.printBitmap("Doodlz Image", bitmap);
229        }
230        else {
231            // display message indicating that system does not allow printing
232            Toast message = Toast.makeText(getApplicationContext(),
233                R.string.message_error_printing, Toast.LENGTH_SHORT);
234            message.setGravity(Gravity.CENTER, message.getXOffset() / 2,
235                message.getYOffset() / 2);
236            message.show();
237        }
238    }
239 }
```

**Fig. 5.42** | DoodleView method printImage.

## 5.9 ColorDialogFragment Class

Class ColorDialogFragment (Figs. 5.43–5.47) extends DialogFragment to create an AlertDialog for setting the drawing color. The class’s instance variables (lines 18–23) are used to reference the GUI controls for selecting the new color, displaying a preview of it and storing the color as a 32-bit int value that represents the color’s ARGB values.

---

```

1  // ColorDialogFragment.java
2  // Allows user to set the drawing color on the DoodleView
3  package com.deitel.doodlz;
4
5  import android.app.Activity;
6  import android.app.AlertDialog;
7  import android.app.Dialog;
8  import android.content.DialogInterface;
9  import android.graphics.Color;
10 import android.os.Bundle;
11 import android.support.v4.app.DialogFragment;
12 import android.view.View;
13 import android.widget.SeekBar;
14 import android.widget.SeekBar.OnSeekBarChangeListener;
15
16 // class for the Select Color dialog
17 public class ColorDialogFragment extends DialogFragment {
18     private SeekBar alphaSeekBar;
19     private SeekBar redSeekBar;
```

**Fig. 5.43** | ColorDialogFragment’s package statement, import statements and instance variables. (Part 1 of 2.)

---

```

20     private SeekBar greenSeekBar;
21     private SeekBar blueSeekBar;
22     private View colorView;
23     private int color;
24

```

---

**Fig. 5.43** | ColorDialogFragment's package statement, import statements and instance variables. (Part 2 of 2.)

### 5.9.1 Overridden DialogFragment Method onCreateDialog

Method `onCreateDialog` (Fig. 5.44) inflates the custom View (lines 31–32) defined by `fragment_color.xml` containing the GUI for selecting a color, then attaches that View to the `AlertDialog` by calling `AlertDialog.Builder's` `setView` method (line 33). Lines 39–47 get references to the dialog's `SeekBar`s and `colorView`. Next, lines 50–53 register `colorChangedListener` (Fig. 5.47) as the listener for the `SeekBar`s' events.

---

```

25     // create an AlertDialog and return it
26     @Override
27     public Dialog onCreateDialog(Bundle bundle) {
28         // create dialog
29         AlertDialog.Builder builder =
30             new AlertDialog.Builder(getActivity());
31         View colorDialogView = getActivity().getLayoutInflater().inflate(
32             R.layout.fragment_color, null);
33         builder.setView(colorDialogView); // add GUI to dialog
34
35         // set the AlertDialog's message
36         builder.setTitle(R.string.title_color_dialog);
37
38         // get the color SeekBars and set their onChange listeners
39         alphaSeekBar = (SeekBar) colorDialogView.findViewById(
40             R.id.alphaSeekBar);
41         redSeekBar = (SeekBar) colorDialogView.findViewById(
42             R.id.redSeekBar);
43         greenSeekBar = (SeekBar) colorDialogView.findViewById(
44             R.id.greenSeekBar);
45         blueSeekBar = (SeekBar) colorDialogView.findViewById(
46             R.id.blueSeekBar);
47         colorView = colorDialogView.findViewById(R.id.colorView);
48
49         // register SeekBar event listeners
50         alphaSeekBar.setOnSeekBarChangeListener(colorChangedListener);
51         redSeekBar.setOnSeekBarChangeListener(colorChangedListener);
52         greenSeekBar.setOnSeekBarChangeListener(colorChangedListener);
53         blueSeekBar.setOnSeekBarChangeListener(colorChangedListener);
54
55         // use current drawing color to set SeekBar values
56         final DoodleView doodleView = getDoodleFragment().getDoodleView();
57         color = doodleView.getDrawingColor();

```

---

**Fig. 5.44** | Overridden DialogFragment method `onCreateDialog`. (Part 1 of 2.)

---

```

58     alphaSeekBar.setProgress(Color.alpha(color));
59     redSeekBar.setProgress(Color.red(color));
60     greenSeekBar.setProgress(Color.green(color));
61     blueSeekBar.setProgress(Color.blue(color));
62
63     // add Set Color Button
64     builder.setPositiveButton(R.string.button_set_color,
65         new DialogInterface.OnClickListener() {
66             public void onClick(DialogInterface dialog, int id) {
67                 doodleView.setDrawingColor(color);
68             }
69         }
70     );
71
72     return builder.create(); // return dialog
73 }
74

```

---

**Fig. 5.44** | Overridden DialogFragment method onCreateDialog. (Part 2 of 2.)

Line 56 (Fig. 5.44) calls method `getDoodleFragment` (Fig. 5.45) to get a reference to the `DoodleFragment`, then calls the `MainActivityFragment`'s `getDoodleView` method to get the `DoodleView`. Lines 57–61 get the `DoodleView`'s current drawing color, then use it to set each `SeekBar`'s value. `Color`'s static methods `alpha`, `red`, `green` and `blue` extract the ARGB values from the color, and `SeekBar`'s `setProgress` method positions the thumbs. Lines 64–70 configure the `AlertDialog`'s positive button to set the `DoodleView`'s new drawing color. Line 72 returns the `AlertDialog`.

## 5.9.2 Method `getDoodleFragment`

Method `getDoodleFragment` (Fig. 5.45) simply uses the `FragmentManager` to get a reference to the `DoodleFragment`.

---

```

75     // gets a reference to the MainActivityFragment
76     private MainActivityFragment getDoodleFragment() {
77         return (MainActivityFragment) getSupportFragmentManager().findFragmentById(
78             R.id.doodleFragment);
79     }
80

```

---

**Fig. 5.45** | Method `getDoodleFragment`.

## 5.9.3 Overridden Fragment Lifecycle Methods `onAttach` and `onDetach`

When the `ColorDialogFragment` is added to a parent Activity, method `onAttach` (Fig. 5.46, lines 82–89) is called. Line 85 gets a reference to the `MainActivityFragment`. If that reference is not `null`, line 88 calls `MainActivityFragment`'s `setDialogOnScreen` method to indicate that the `Choose Color` dialog is now displayed. When the `ColorDialogFragment` is removed from a parent Activity, method `onDetach` (lines 92–99) is

called. Line 98 calls `MainActivityFragment`'s `setDialogOnScreen` method to indicate that the `Choose Color` dialog is no longer on the screen.

---

```

81    // tell MainActivityFragment that dialog is now displayed
82    @Override
83    public void onAttach(Activity activity) {
84        super.onAttach(activity);
85        MainActivityFragment fragment = getDoodleFragment();
86
87        if (fragment != null)
88            fragment.setDialogOnScreen(true);
89    }
90
91    // tell MainActivityFragment that dialog is no longer displayed
92    @Override
93    public void onDetach() {
94        super.onDetach();
95        MainActivityFragment fragment = getDoodleFragment();
96
97        if (fragment != null)
98            fragment.setDialogOnScreen(false);
99    }
100

```

---

**Fig. 5.46** | Overridden Fragment lifecycle methods `onAttach` and `onDetach`.

#### 5.9.4 Anonymous Inner Class That Responds to the Events of the Alpha, Red, Green and Blue SeekBars

Figure 5.47 defines an anonymous inner class that implements interface `OnSeekBarChangeListener` to respond to events when the user adjusts the `SeekBar`s in the `Choose Color` Dialog. This was registered as the `SeekBar`s' event handler in Fig. 5.44 (lines 50–53). Method `onProgressChanged` (Fig. 5.47, lines 105–114) is called when the position of a `SeekBar`'s thumb changes. If the user moved a `SeekBar`'s thumb (line 109), lines 110–112 store the new color. Class `Color`'s static method `argb` combines the `SeekBar`s' values into a `Color` and returns the appropriate color as an `int`. We then use class `View`'s `setBackgroundColor` method to update the `colorView` with a color that matches the current state of the `SeekBar`s.

---

```

101    // OnSeekBarChangeListener for the SeekBars in the color dialog
102    private final OnSeekBarChangeListener colorChangedListener =
103        new OnSeekBarChangeListener() {
104            // display the updated color
105            @Override
106            public void onProgressChanged(SeekBar seekBar, int progress,
107                boolean fromUser) {
108

```

---

**Fig. 5.47** | Anonymous inner class that implements interface `OnSeekBarChangeListener` to respond to the events of the alpha, red, green and blue `SeekBar`s. (Part I of 2.)

```

109         if (fromUser) // user, not program, changed SeekBar progress
110             color = Color.argb(alphaSeekBar.getProgress(),
111                                 redSeekBar.getProgress(), greenSeekBar.getProgress(),
112                                 blueSeekBar.getProgress());
113             colorView.setBackgroundColor(color);
114     }
115
116     @Override
117     public void onStartTrackingTouch(SeekBar seekBar) {} // required
118
119     @Override
120     public void onStopTrackingTouch(SeekBar seekBar) {} // required
121 }
122 }
```

**Fig. 5.47** | Anonymous inner class that implements interface OnSeekBarChangeListener to respond to the events of the alpha, red, green and blue SeekBars. (Part 2 of 2.)

## 5.10 LineWidthDialogFragment Class

Class LineWidthDialogFragment (Fig. 5.48) extends DialogFragment to create an Alert-Dialog for setting the line width. The class is similar to class ColorDialogFragment, so we discuss only the key differences here. The class's only instance variable is an ImageView (line 21) in which we draw a line showing the current line-width setting.

```

1 // LineWidthDialogFragment.java
2 // Allows user to set the drawing color on the DoodleView
3 package com.deitel.doodlz;
4
5 import android.app.Activity;
6 import android.app.AlertDialog;
7 import android.app.Dialog;
8 import android.content.DialogInterface;
9 import android.graphics.Bitmap;
10 import android.graphics.Canvas;
11 import android.graphics.Paint;
12 import android.os.Bundle;
13 import android.support.v4.app.DialogFragment;
14 import android.view.View;
15 import android.widget.ImageView;
16 import android.widget.SeekBar;
17 import android.widget.SeekBar.OnSeekBarChangeListener;
18
19 // class for the Select Line Width dialog
20 public class LineWidthDialogFragment extends DialogFragment {
21     private ImageView widthImageView;
22 }
```

**Fig. 5.48** | Class LineWidthDialogFragment. (Part 1 of 3.)

```
23     // create an AlertDialog and return it
24     @Override
25     public Dialog onCreateDialog(Bundle bundle) {
26         // create the dialog
27         AlertDialog.Builder builder =
28             new AlertDialog.Builder(getActivity());
29         View lineWidthDialogView =
30             getActivity().getLayoutInflater().inflate(
31                 R.layout.fragment_line_width, null);
32         builder.setView(lineWidthDialogView); // add GUI to dialog
33
34         // set the AlertDialog's message
35         builder.setTitle(R.string.title_line_width_dialog);
36
37         // get the ImageView
38         widthImageView = (ImageView) lineWidthDialogView.findViewById(
39             R.id.widthImageView);
40
41         // configure widthSeekBar
42         final DoodleView doodleView = getDoodleFragment().getDoodleView();
43         final SeekBar widthSeekBar = (SeekBar)
44             lineWidthDialogView.findViewById(R.id.widthSeekBar);
45         widthSeekBar.setOnSeekBarChangeListener(lineWidthChanged);
46         widthSeekBar.setProgress(doodleView.getLineWidth());
47
48         // add Set Line Width Button
49         builder.setPositiveButton(R.string.button_set_line_width,
50             new DialogInterface.OnClickListener() {
51                 public void onClick(DialogInterface dialog, int id) {
52                     doodleView.setLineWidth(widthSeekBar.getProgress());
53                 }
54             }
55         );
56
57         return builder.create(); // return dialog
58     }
59
60     // return a reference to the MainActivityFragment
61     private MainActivityFragment getDoodleFragment() {
62         return (MainActivityFragment) getSupportFragmentManager().findFragmentById(
63             R.id.doodleFragment);
64     }
65
66     // tell MainActivityFragment that dialog is now displayed
67     @Override
68     public void onAttach(Activity activity) {
69         super.onAttach(activity);
70         MainActivityFragment fragment = getDoodleFragment();
71
72         if (fragment != null)
73             fragment.setDialogOnScreen(true);
74     }
```

Fig. 5.48 | Class LineWidthDialogFragment. (Part 2 of 3.)

```

75
76     // tell MainActivityFragment that dialog is no longer displayed
77     @Override
78     public void onDetach() {
79         super.onDetach();
80         MainActivityFragment fragment = getDoodleFragment();
81
82         if (fragment != null)
83             fragment.setDialogOnScreen(false);
84     }
85
86     // OnSeekBarChangeListener for the SeekBar in the width dialog
87     private final OnSeekBarChangeListener lineWidthChanged =
88         new OnSeekBarChangeListener() {
89             final Bitmap bitmap = Bitmap.createBitmap(
90                 400, 100, Bitmap.Config.ARGB_8888);
91             final Canvas canvas = new Canvas(bitmap); // draws into bitmap
92
93             @Override
94             public void onProgressChanged(SeekBar seekBar, int progress,
95                 boolean fromUser) {
96                 // configure a Paint object for the current SeekBar value
97                 Paint p = new Paint();
98                 p.setColor(
99                     getDoodleFragment().getDoodleView().getDrawingColor());
100                p.setStrokeCap(Paint.Cap.ROUND);
101                p.setStrokeWidth(progress);
102
103                // erase the bitmap and redraw the line
104                bitmap.eraseColor(
105                    getResources().getColor(android.R.color.transparent,
106                        getContext().getTheme()));
107                canvas.drawLine(30, 50, 370, 50, p);
108                widthImageView.setImageBitmap(bitmap);
109            }
110
111            @Override
112            public void onStartTrackingTouch(SeekBar seekBar) {} // required
113
114            @Override
115            public void onStopTrackingTouch(SeekBar seekBar) {} // required
116        };
117    }

```

**Fig. 5.48** | Class LineWidthDialogFragment. (Part 3 of 3.)

### 5.10.1 Method onCreateDialog

Method `onCreateDialog` (lines 24–58) inflates the custom View (lines 29–31) defined by `fragment_line_width.xml` that displays the GUI for selecting the line width, then attaches that View to the `AlertDialog` by calling `AlertDialog.Builder's` `setView` method (line 32). Lines 38–39 get a reference to the `ImageView` in which the sample line will be drawn. Next, lines 42–46 get a reference to the `widthSeekBar`, register `lineWidthChanged` (lines 87–116) as the `SeekBar`'s listener and set the `SeekBar`'s current value to the current line

width. Lines 49–55 define the dialog's positive button to call the `DoodleView`'s `setLineWidth` method when the user touches the `Set Line Width` button. Line 57 returns the `AlertDialog` for display.

### 5.10.2 Anonymous Inner Class That Responds to the Events of the widthSeekBar

Lines 87–116 define the `lineWidthChanged OnSeekBarChangeListener` that responds to events when the user adjusts the `SeekBar` in the `Choose Line Width` dialog. Lines 89–90 create a `Bitmap` on which to display a sample line representing the selected line thickness. Line 91 creates a `Canvas` for drawing on the `Bitmap`. Method `onProgressChanged` (lines 93–109) draws the sample line based on the current drawing color and the `SeekBar`'s value. First, lines 97–101 configure a `Paint` object for drawing the sample line. Class `Paint`'s `setStrokeCap` method (line 100) specifies the appearance of the line ends—in this case, they're rounded (`Paint.Cap.ROUND`). Lines 104–106 clear `bitmap`'s background to the predefined Android color `android.R.color.transparent` with `Bitmap` method `eraseColor`. We use `canvas` to draw the sample line. Finally, line 108 displays `bitmap` in the `widthImageView` by passing it to `ImageView`'s `setImageBitmap` method.

## 5.11 EraseImageDialogFragment Class

Class `EraseImageDialogFragment` (Fig. 5.49) extends `DialogFragment` to create an `AlertDialog` that confirms whether the user really wants to erase the entire image. The class is similar to class `ColorDialogFragment` and `LineWidthDialogFragment`, so we discuss only method `onCreateDialog` (lines 15–35) here. The method creates an `AlertDialog` with `Erase Image` and `Cancel` button. Lines 24–30 configure the `Erase Image` button as the positive button—when the user touches this, line 27 in the button's listener calls the `DoodleView`'s `clear` method to erase the image. Line 33 configures `Cancel` as the negative button—when the user touches this, the dialog is dismissed. In this case, we use the predefined Android `String` resource `android.R.string.cancel`. For other predefined `String` resources, visit

<http://developer.android.com/reference/android/R.string.html>

Line 34 returns the `AlertDialog`.

---

```

1 // EraseImageDialogFragment.java
2 // Allows user to erase image
3 package com.deitel.doodlz;
4
5 import android.app.Activity;
6 import android.app.AlertDialog;
7 import android.app.Dialog;
8 import android.support.v4.app.DialogFragment;
9 import android.content.DialogInterface;
10 import android.os.Bundle;
11

```

---

Fig. 5.49 | Class `EraseImageDialogFragment`. (Part 1 of 2.)

```
12 // class for the Erase Image dialog
13 public class EraseImageDialogFragment extends DialogFragment {
14     // create an AlertDialog and return it
15     @Override
16     public Dialog onCreateDialog(Bundle bundle) {
17         AlertDialog.Builder builder =
18             new AlertDialog.Builder(getActivity());
19
20         // set the AlertDialog's message
21         builder.setMessage(R.string.message_erase);
22
23         // add Erase Button
24         builder.setPositiveButton(R.string.button_erase,
25             new DialogInterface.OnClickListener() {
26                 public void onClick(DialogInterface dialog, int id) {
27                     getDoodleFragment().getDoodleView().clear(); // clear image
28                 }
29             });
30
31         // add cancel Button
32         builder.setNegativeButton(android.R.string.cancel, null);
33         return builder.create(); // return dialog
34     }
35
36
37     // gets a reference to the MainActivityFragment
38     private MainActivityFragment getDoodleFragment() {
39         return (MainActivityFragment) getSupportFragmentManager().findFragmentById(
40             R.id.doodleFragment);
41     }
42
43     // tell MainActivityFragment that dialog is now displayed
44     @Override
45     public void onAttach(Activity activity) {
46         super.onAttach(activity);
47         MainActivityFragment fragment = getDoodleFragment();
48
49         if (fragment != null)
50             fragment.setDialogOnScreen(true);
51     }
52
53     // tell MainActivityFragment that dialog is no longer displayed
54     @Override
55     public void onDetach() {
56         super.onDetach();
57         MainActivityFragment fragment = getDoodleFragment();
58
59         if (fragment != null)
60             fragment.setDialogOnScreen(false);
61     }
62 }
```

Fig. 5.49 | Class EraseImageDialogFragment. (Part 2 of 2.)

## 5.12 Wrap-Up

In this chapter, you built the **Doodlz** app, which enables users to paint by dragging one or more fingers across the screen. You implemented a shake-to-erase feature by using Android’s `SensorManager` to register a `SensorEventListener` that responds to accelerometer events, and you learned that Android supports many other sensors.

You created subclasses of `DialogFragment` for displaying custom `Views` in `AlertDialogs`. You also overrode the `Fragment` lifecycle methods `onAttach` and `onDetach`, which are called when a `Fragment` is attached to or detached from a parent `Activity`, respectively.

We showed how to associate a `Canvas` with a `Bitmap`, then use the `Canvas` to draw into the `Bitmap`. We demonstrated how to handle multitouch events, so the app could respond to multiple fingers being dragged across the screen at the same time. You stored the information for each individual finger as a `Path`. You processed the touch events by overriding the `View` method `onTouchEvent`, which receives a `MotionEvent` containing the event type and the ID of the pointer (finger) that generated the event. We used the IDs to distinguish among the fingers and add information to the corresponding `Path` objects.

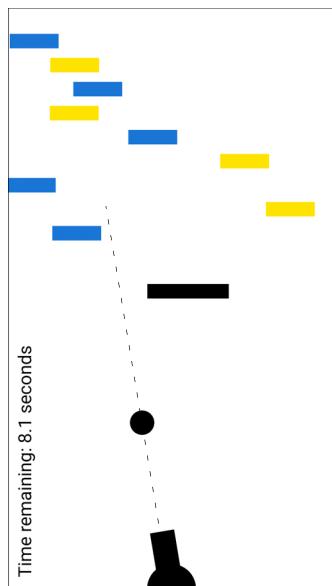
You used a `ContentResolver` and the `MediaStore.Images.Media.insertImage` method to save an image onto the device. To enable this feature, you used Android 6.0’s new permissions model to request permission from the user to save to external storage.

We showed how to use the printing framework to allow users to print their drawings. You used the Android Support Library’s `PrintHelper` class to print a `Bitmap`. The `PrintHelper` displayed a user interface for selecting a printer or saving the image into a PDF document. To incorporate Android Support Library features into the app, you used Gradle to specify the app’s dependency on features from that library.

In Chapter 6, you’ll create a **Cannon Game** using multithreading and frame-by-frame animation. You’ll handle touch gestures to fire a cannon. You’ll also learn how to create a game loop that updates the display as fast as possible to create smooth animations and to make the game feel like it executes at the same speed regardless of a given device’s processor speed.

# Cannon Game App

Manual Frame-By-Frame Animation, Graphics, Sound,  
Threading, SurfaceView and SurfaceHolder,  
Immersive Mode and Full-Screen



## Objectives

In this chapter you'll:

- Create a simple game app that's easy to code and fun to play.
- Create a custom `SurfaceView` subclass for displaying the game's graphics from a separate thread of execution.
- Draw graphics using `Paints` and a `Canvas`.
- Override `View`'s `onTouchEvent` method to fire a cannonball when the user touches the screen.
- Perform simple collision detection.
- Add sound to your app using a `SoundPool` and the `AudioManager`.
- Override `Fragment` lifecycle method `onDestroy`.
- Use immersive mode to enable the game to occupy the entire screen, but still allow the user to access the system bars.

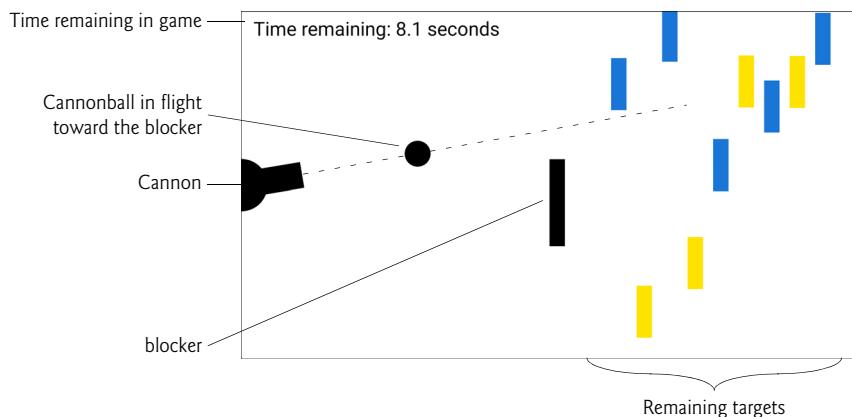
|             |  |             |   |
|-------------|--|-------------|---|
| <b>6.1</b>  | Introduction   | 6.11.1      | Instance Variables and Constructor                                |
| <b>6.2</b>  | Test-Driving the Cannon Game App                                     | 6.11.2      | Method align  |
| <b>6.3</b>  | Technologies Overview  | 6.11.3      | Method fireCannonball   |
| 6.3.1       | Using the Resource Folder res/raw                                    | 6.11.4      | Method draw   |
| 6.3.2       | Activity and Fragment Lifecycle Methods                              | 6.11.5      | Methods getCannonball and removeCannonball                        |
| 6.3.3       | Overriding View Method onTouchEvent                                  | <b>6.12</b> | Cannonball Subclass of GameElement                                |
| 6.3.4       | Adding Sound with SoundPool and AudioManager                         | 6.12.1      | Instance Variables and Constructor                                |
| 6.3.5       | Frame-by-Frame Animation with Threads, SurfaceView and SurfaceHolder | 6.12.2      | Methods getRadius, collidesWith, isOnScreen, and reverseVelocityX |
| 6.3.6       | Simple Collision Detection   | 6.12.3      | Method update   |
| 6.3.7       | Immersive Mode   | 6.12.4      | Method draw   |
| <b>6.4</b>  | Building the GUI and Resource Files                                  | <b>6.13</b> | CannonView Subclass of SurfaceView                                |
| 6.4.1       | Creating the Project   | 6.13.1      | package and import Statements                                     |
| 6.4.2       | Adjusting the Theme to Remove the App Title and App Bar              | 6.13.2      | Instance Variables and Constants                                  |
| 6.4.3       | strings.xml  | 6.13.3      | Constructor   |
| 6.4.4       | Colors   | 6.13.4      | Overriding View Method onSizeChanged                              |
| 6.4.5       | Adding the Sounds to the App   | 6.13.5      | Methods getScreenWidth, getScreenHeight, and playSound            |
| 6.4.6       | Adding Class MainActivityFragment                                    | 6.13.6      | Method newGame  |
| 6.4.7       | Editing activity_main.xml  | 6.13.7      | Method updatePositions  |
| 6.4.8       | Adding the CannonView to fragment_main.xml                           | 6.13.8      | Method alignAndFireCannonball                                     |
| <b>6.5</b>  | Overview of This App's Classes                                       | 6.13.9      | Method showGameOverDialog   |
| <b>6.6</b>  | MainActivity Subclass of Activity                                    | 6.13.10     | Method drawGameElements   |
| <b>6.7</b>  | MainActivityFragment Subclass of Fragment                            | 6.13.11     | Method testForCollisions  |
| <b>6.8</b>  | Class GameElement  | 6.13.12     | Methods stopGame and releaseResources                             |
| 6.8.1       | Instance Variables and Constructor                                   | 6.13.13     | Implementing the SurfaceHolder.Callback Methods                   |
| 6.8.2       | Methods update, draw, and playSound                                  | 6.13.14     | Overriding View Method onTouchEvent                               |
| <b>6.9</b>  | Blocker Subclass of GameElement                                      | 6.13.15     | CannonThread: Using a Thread to Create a Game Loop                |
| <b>6.10</b> | Target Subclass of GameElement                                       | 6.13.16     | Methods hideSystemBars and showSystemBars                         |
| <b>6.11</b> | Cannon Class   | <b>6.14</b> | Wrap-Up   |

## 6.1 Introduction

The Cannon Game<sup>1</sup> app challenges you to destroy nine targets before a ten-second time limit expires (Fig. 6.1). The game consists of four types of visual components—a *cannon* that you control, a *cannonball*, nine *targets* and a *blocker* that defends the targets. You aim

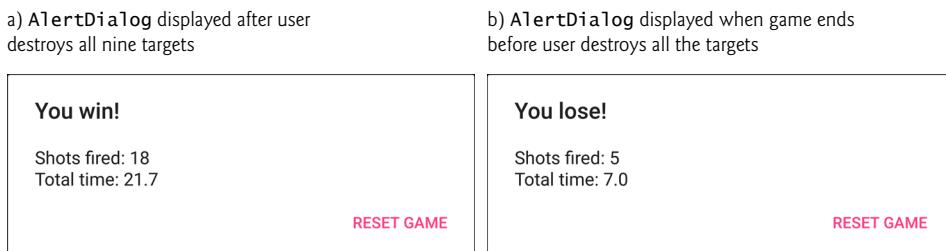
1. We'd like to thank Prof. Hugues Bersini—author of a French-language object-oriented programming book for Éditions Eyrolles, Secteur Informatique—for sharing with us his suggested refactoring of our original Cannon Game app. We used this as inspiration for our own refactoring in the latest versions of this app in this book and *iOS® 8 for Programmers: An App-Driven Approach*.

and fire the cannon by *touching* the screen—the cannon then aims at the touched point and fires the cannonball in a straight line in that direction.



**Fig. 6.1** | Completed Cannon Game app.

Each time you destroy a target, a three-second time bonus is *added* to your remaining time, and each time you hit the blocker, a two-second time penalty is *subtracted* from your remaining time. You win by destroying all nine target sections before you run out of time—if the timer reaches zero, you lose. At the end of the game, the app displays an `AlertDialog` indicating whether you won or lost, and shows the number of shots fired and the elapsed time (Fig. 6.2).



**Fig. 6.2** | Cannon Game app `AlertDialogs` showing a win and a loss.

When you fire the cannon, the game plays a *firing sound*. When a cannonball hits a target, a *glass-breaking sound* plays and that target disappears. When the cannonball hits the blocker, a *hit sound* plays and the cannonball bounces back. The blocker cannot be destroyed. Each of the targets and the blocker move *vertically* at different speeds, changing direction when they hit the top or bottom of the screen.

[*Note:* The Android Emulator performs slowly on some computers. For the best experience, you should test this app on an Android device. On a slow emulator, the cannonball will sometimes appear to pass through the blocker or targets.]

## 6.2 Test-Driving the Cannon Game App

### *Opening and Running the App*

Open Android Studio and open the **Cannon Game** app from the **CannonGame** folder in the book’s examples folder, then execute the app in the AVD or on a device. This builds the project and runs the app.

### *Playing the Game*

Tap the screen to aim and fire the cannon. You can fire a cannonball only if there is not another cannonball on the screen. If you’re running on an AVD, the mouse is your “finger.” Destroy all of the targets as fast as you can—the game ends if the timer runs out or you destroy all nine targets.

## 6.3 Technologies Overview

This section presents the new technologies that we use in the **Cannon Game** app in the order they’re encountered in the chapter.

### 6.3.1 Using the Resource Folder `res/raw`

Media files, such as the sounds used in the **Cannon Game** app, are placed in the app’s resource folder `res/raw`. Section 6.4.5 discusses how to create this folder. You’ll copy the app’s sound files into it.

### 6.3.2 Activity and Fragment Lifecycle Methods

We introduced Activity and Fragment lifecycle methods in Section 5.3.1. This app uses Fragment lifecycle method `onDestroy`. When an Activity is shut down, its `onDestroy` method is called, which in turn calls the `onDestroy` methods of all the Fragments hosted by the Activity. We use this method in the `MainActivityFragment` to release the `CannonView`’s sound resources.



#### Error-Prevention Tip 6.1

*Method `onDestroy` is not guaranteed to be called, so it should be used only to release resources, not to save data. The Android documentation recommends that you save data in methods `onPause` or `onSaveInstanceState`.*

### 6.3.3 Overriding View Method `onTouchEvent`

Users interact with this app by touching the device’s screen. A touch aligns the cannon to face the touch point on the screen, then fires the cannon. To process simple touch events for the `CannonView`, you’ll override `View` method `onTouchEvent` (Section 6.13.14), then use constants from class `MotionEvent` (package `android.view`) to test which type of event occurred and process it accordingly.

### 6.3.4 Adding Sound with `SoundPool` and `AudioManager`

An app’s sound effects are managed with a `SoundPool` (package `android.media`), which can be used to *load*, *play* and *unload* sounds. Sounds are played using one of Android’s audio streams for *alarms*, *music*, *notifications*, *phone rings*, *system sounds*, *phone calls* and

more. You'll configure and create a `SoundPool` object using a `SoundPool.Builder` object. You'll also use an `AudioAttributes.Builder` object to create an `AudioAttributes` object that will be associated with the `SoundPool`. We call the `AudioAttributes`'s `setUsage` method to designate the audio as game audio. The Android documentation recommends that games use the *music audio stream* to play sounds, because that stream's volume can be controlled via the device's volume buttons. In addition, we use the `Activity`'s `setVolumeControlStream` method to allow the game's volume to be controlled with the device's volume buttons. The method receives a constant from class `AudioManager` (package `android.media`), which provides access to the device's volume and phone-ringer controls.

### 6.3.5 Frame-by-Frame Animation with Threads, `SurfaceView` and `SurfaceHolder`

This app *performs its animations manually* by updating the game elements from a separate thread of execution. To do this, we use a subclass of `Thread` with a `run` method that directs our custom `CannonView` to update the positions of the game's elements, then draws them. The `run` method drives the *frame-by-frame animations*—this is known as the **game loop**.

All updates to an app's user interface must be performed in the GUI thread of execution, because GUI components are not thread safe—updates performed outside the GUI thread can corrupt the GUI. Games, however, often require complex logic that should be performed in separate threads of execution, and those threads often need to draw to the screen. For such cases, Android provides class `SurfaceView`—a subclass of `View` that provides a dedicated drawing area in which other threads can display graphics on the screen in a thread-safe manner.



#### Performance Tip 6.1

*It's important to minimize the amount of work you do in the GUI thread to ensure that the GUI remains responsive and does not display ANR (Application Not Responding) dialogs.*

You manipulate a `SurfaceView` via an object of class `SurfaceHolder`, which enables you to obtain a `Canvas` on which you can draw graphics. Class `SurfaceHolder` also provides methods that give a thread *exclusive access* to the `Canvas` for drawing—only one thread at a time can draw to a `SurfaceView`. Each `SurfaceView` subclass should implement the interface `SurfaceHolder.Callback`, which contains methods that are called when the `SurfaceView` is *created, changed* (e.g., its size or orientation changes) or *destroyed*.

### 6.3.6 Simple Collision Detection

The `CannonView` performs simple *collision detection* to determine whether the cannonball has collided with any of the `CannonView`'s edges, with the blocker or with a section of the target. These techniques are presented in Section 6.13.11.

Game-development frameworks typically provide more sophisticated “pixel-perfect” collision-detection capabilities. Many such frameworks are available (free and fee-based) for developing the simplest 2D games to the most complex 3D console-style games (such as games for Sony's PlayStation® and Microsoft's Xbox®). Figure 6.3 lists a few game-development frameworks—there are dozens more. Many support multiple platforms, including Android and iOS. Some require C++ or other programming languages.

### Game-development frameworks

AndEngine—<http://www.andengine.org>  
 Cocos2D—<http://code.google.com/p/cocos2d-android>  
 GameMaker—<http://www.yoyogames.com/studio>  
 libgdx—<https://libgdx.badlogicgames.com>  
 Unity—<http://www.unity3d.com>  
 Unreal Engine—<http://www.unrealengine.com>

**Fig. 6.3** | Game-development frameworks.

### 6.3.7 Immersive Mode

To immerse users in games, game developers often use full-screen themes, such as

`Theme.Material.Light.NoActionBar.Fullscreen`

that display only the bottom system bar. In landscape orientation on phones, that system bar appears at the screen's right edge.

In Android 4.4 (KitKat), Google added support for full-screen *immersive mode* (Section 6.13.16), which enables an app to take advantage of the entire screen. When an app is in immersive mode, the user can swipe down from the top of the screen to display the system bars temporarily. If the user does not interact with the system bars, they disappear after a few seconds.

## 6.4 Building the GUI and Resource Files

In this section, you'll create the app's resource files, GUI layout files and classes.

### 6.4.1 Creating the Project

For this app, you'll add a **Fragment** and its layout manually—much of the autogenerated code in the **Blank Activity** template with a **Fragment** is not needed in the **Cannon Game**. Create a new project using the **Empty Activity** template. In the **Create New Project** dialog's **New Project** step, specify

- **Application name:** Cannon Game
- **Company Domain:** `deitel.com` (or specify your own domain name)

In the layout editor, select **Nexus 6** from the virtual-device drop-down list (Fig. 2.11). Once again, we'll use this device as the basis for our design. Also, delete the **Hello world!** **TextView** from `activity_main.xml`. As you've done previously, add an app icon to your project.

### Configure the App for Landscape Orientation

The **Cannon** game is designed for only landscape orientation. Follow the steps you performed in Section 3.7 to set the screen orientation, but this time set `android:screenOrientation` to `landscape` rather than `portrait`.

### 6.4.2 Adjusting the Theme to Remove the App Title and App Bar

As we noted in Section 6.3.7, game developers often use full-screen themes, such as

```
Theme.Material.Light.NoActionBar.Fullscreen
```

that display only the bottom system bar, which in landscape orientation appears at the screen's right edge. The AppCompat themes do not include a full-screen theme by default, but you can modify the app's theme to achieve this. To do so:

1. Open `styles.xml`.
2. Add the following lines to the `<style>` element:

```
<item name="windowNoTitle">true</item>
<item name="windowActionBar">false</item>
<item name="android:windowFullscreen">true</item>
```

The first line indicates that the title (usually the app's name) should not be displayed. The second indicates that the app bar should not be displayed. The last line indicates that the app should use the full screen.

### 6.4.3 strings.xml

You created `String` resources in earlier chapters, so we show here only a table of the `String` resource names and corresponding values (Fig. 6.4). Double click `strings.xml` in the `res/values` folder, then click the **Open editor** link to display the **Translations Editor** for creating these `String` resources.

| Key                                | Value                                   |
|------------------------------------|---|
| <code>results_format</code>        | Shots fired: %1\$d\nTotal time: %2\$.1f |
| <code>reset_game</code>            | Reset Game                              |
| <code>win</code>                   | You win!                                |
| <code>lose</code>                  | You lose!                               |
| <code>time_remaining_format</code> | Time remaining: %.1f seconds            |

**Fig. 6.4** | String resources used in the Cannon Game app.

### 6.4.4 Colors

This app draws targets of alternating colors on the Canvas. For this app, we added the following dark blue and yellow color resources to `colors.xml`:

```
<color name="dark">#1976D2</color>
<color name="light">#FFE100</color>
```

### 6.4.5 Adding the Sounds to the App

As we mentioned previously, sound files are stored in the app's `res/raw` folder. This app uses three sound files—`blocker_hit.wav`, `target_hit.wav` and `cannon_fire.wav`—which are located with the book's examples in the `sounds` folder. To add these files to your project:

1. Right click the app's res folder, then select New > Android resource directory, to open the New Resource Directory dialog
2. In the Resource type drop-down, select raw. The Directory name will automatically change to raw.
3. Click OK to create the folder.
4. Copy and paste the sound files into the res/raw folder. In the Copy dialog that appears, click OK.

#### 6.4.6 Adding Class MainActivityFragment

Next, you'll add class MainActivityFragment to the project:

1. In the Project window, right click the com.deitel.cannongame node and select New > Fragment > Fragment (Blank).
2. For Fragment Name specify MainActivityFragment and for Fragment Layout Name specify fragment\_main.
3. Uncheck the checkboxes for Include fragment factory methods? and Include interface callbacks?

By default, fragment\_main.xml contains a FrameLayout that displays a TextView. A **FrameLayout** is designed to display one View, but can also be used to layer views. Remove the TextView—in this app, the FrameLayout will display the CannonView.

#### 6.4.7 Editing activity\_main.xml

In this app, MainActivity's layout displays only MainActivityFragment. Edit the layout as follows:

1. Open activity\_main.xml in the layout editor and switch to the Text tab.
2. Change RelativeLayout to fragment and remove the padding properties so that the fragment element will fill the entire screen.
3. Switch to Design view, select fragment in the Component Tree, then set the id to fragment.
4. Set the name to com.deitel.cannongame.MainActivityFragment—rather than typing this, you can click the ellipsis button to the right of the name property's value field, then select the class from the Fragments dialog that appears.

Recall that the layout editor's Design view can show a preview of a fragment displayed in a particular layout. If you do not specify which fragment to preview in MainActivity's layout, the layout editor displays a "Rendering Problems" message. To specify the fragment to preview, right click the fragment—either in Design view or in the Component Tree and click Choose Preview Layout.... Then, in the Resources dialog, select the name of the fragment layout.

#### 6.4.8 Adding the CannonView to fragment\_main.xml

You'll now add the CannonView to fragment\_main.xml. You first must create CannonView.java, so that you can select class CannonView when placing a CustomView in the layout. Follow these steps to create CannonView.java and add the CannonView to the layout:

1. Expand the `java` folder in the Project window.
2. Right click package `com.deitel.cannongame`'s folder, then select **New > Java Class**.
3. In the **Create New Class** dialog that appears, enter `CannonView` in the **Name** field, then click **OK**. The file will open in the editor automatically.
4. In `CannonView.java`, indicate that `CannonView` extends `SurfaceView`. If the `import` statement for the `android.view.SurfaceView` class does not appear, place the cursor at the end of the class name `SurfaceView`. Click the red bulb menu (💡) that appears above the beginning of the line and select **Import Class**.
5. Place the cursor at the end of `SurfaceView` if you have not already done so. Click the red bulb menu that appears and select **Create constructor matching super**. Choose the two-argument constructor in the list in the **Choose Super Class Constructors** dialog that appears, then click **OK**. The IDE will add the constructor to the file automatically.
6. Switch back to `fragment_main.xml`'s **Design** view in the layout editor.
7. Click **CustomView** in the **Custom** section of the **Palette**.
8. In the **Views** dialog that appears, select `CannonView (com.deitel.cannongame)`, then click **OK**.
9. Hover over and click the `FrameLayout` in the **Component Tree**. The **view (CustomView)**—which is a `CannonView`—should appear in the **Component Tree** within the `FrameLayout`.
10. Ensure that **view (CustomView)** is selected in the **Component Tree** window. In the **Properties** window, set `layout:width` and `layout:height` to `match_parent`.
11. In the **Properties** window, change the `id` from `view` to `cannonView`.
12. Save and close `fragment_main.xml`.

## 6.5 Overview of This App's Classes

This app consists of eight classes:

- `MainActivity` (the `Activity` subclass; Section 6.6)—Hosts the `MainActivity-Fragment`.
- `MainActivityFragment` (Section 6.7)—Displays the `CannonView`.
- `GameElement` (Section 6.8)—The superclass for items that move up and down (`Blocker` and `Target`) or across (`Cannonball`) the screen.
- `Blocker` (Section 6.9)—Represents a blocker, which makes destroying targets more challenging.
- `Target` (Section 6.10)—Represents a target that can be destroyed by a cannonball.
- `Cannon` (Section 6.11)—Represents the cannon, which fires a cannonball each time the user touches the screen.
- `Cannonball` (Section 6.12)—Represents a cannonball that the cannon fires when the user touches the screen.

- CannonView (Section 6.13)—Contains the game’s logic and coordinates the behaviors of the Blocker, Targets, Cannonball and Cannon.

You must create the classes GameElement, Blocker, Target, Cannonball and Cannon. For each class, right click the package folder com.deitel.cannongame in the project’s app/java folder and select **New > Java Class**. In the **Create New Class** dialog, enter the name of the class in the **Name** field and click **OK**.

## 6.6 MainActivity Subclass of Activity

Class **MainActivity** (Fig. 6.5) is the host for the Cannon Game app’s **MainActivityFragment**. In this app, we override only the **Activity** method **onCreate**, which inflates the GUI. We deleted the autogenerated **MainActivity** methods that managed its menu, because the menu is not used in this app.

---

```

1 // MainActivity.java
2 // MainActivity displays the MainActivityFragment
3 package com.deitel.cannongame;
4
5 import android.support.v7.app.AppCompatActivity;
6 import android.os.Bundle;
7
8 public class MainActivity extends AppCompatActivity {
9     // called when the app first launches
10    @Override
11    protected void onCreate(Bundle savedInstanceState) {
12        super.onCreate(savedInstanceState);
13        setContentView(R.layout.activity_main);
14    }
15 }
```

---

**Fig. 6.5** | **MainActivity** class displays the **MainActivityFragment**.

## 6.7 MainActivityFragment Subclass of Fragment

Class **MainActivityFragment** (Fig. 6.6) overrides four **Fragment** methods:

- **onCreateView** (lines 17–28)—As you learned in Section 4.3.3, this method is called after a **Fragment**’s **onCreate** method to build and return a **View** containing the **Fragment**’s GUI. Lines 22–23 inflate the GUI. Line 26 gets a reference to the **MainActivityFragment**’s **CannonView** so that we can call its methods.
- **onActivityCreated** (lines 31–37)—This method is called after the **Fragment**’s host **Activity** is created. Line 36 calls the **Activity**’s **setVolumeControlStream** method to allow the game’s volume to be controlled by the device’s volume buttons. There are seven sound streams identified by **AudioManager** constants, but the music stream (**AudioManager.STREAM\_MUSIC**) is recommended for sound in games, because this stream’s volume can be controlled via the device’s buttons.
- **onPause** (lines 40–44)—When the **MainActivity** is sent to the *background* (and thus, paused), **MainActivityFragment**’s **onPause** method executes. Line 43 calls the **CannonView**’s **stopGame** method (Section 6.13.12) to stop the game loop.

- `onDestroy` (lines 47–51)—When the `MainActivity` is destroyed, its `onDestroy` method calls `MainActivityFragment`'s `onDestroy`. Line 50 calls the `CannonView`'s `releaseResources` method to release the sound resources (Section 6.13.12).

```
1 // MainActivityFragment.java
2 // MainActivityFragment creates and manages a CannonView
3 package com.deitel.cannongame;
4
5 import android.media.AudioManager;
6 import android.os.Bundle;
7 import android.support.v4.app.Fragment;
8 import android.view.LayoutInflater;
9 import android.view.View;
10 import android.view.ViewGroup;
11
12 public class MainActivityFragment extends Fragment {
13     private CannonView cannonView; // custom view to display the game
14
15     // called when Fragment's view needs to be created
16     @Override
17     public View onCreateView(LayoutInflater inflater, ViewGroup container,
18         Bundle savedInstanceState) {
19         super.onCreateView(inflater, container, savedInstanceState);
20
21         // inflate the fragment_main.xml layout
22         View view =
23             inflater.inflate(R.layout.fragment_main, container, false);
24
25         // get a reference to the CannonView
26         cannonView = (CannonView) view.findViewById(R.id.cannonView);
27         return view;
28     }
29
30     // set up volume control once Activity is created
31     @Override
32     public void onActivityCreated(Bundle savedInstanceState) {
33         super.onActivityCreated(savedInstanceState);
34
35         // allow volume buttons to set game volume
36         getActivity().setVolumeControlStream(AudioManager.STREAM_MUSIC);
37     }
38
39     // when MainActivity is paused, terminate the game
40     @Override
41     public void onPause() {
42         super.onPause();
43         cannonView.stopGame(); // terminates the game
44     }
45
46     // when MainActivity is paused, MainActivityFragment releases resources
47     @Override
48     public void onDestroy() {
```

**Fig. 6.6** | `MainActivityFragment` creates and manages the `CannonView`. (Part I of 2.)

---

```

49         super.onDestroy();
50         cannonView.releaseResources();
51     }
52 }
```

---

**Fig. 6.6** | MainActivityFragment creates and manages the CannonView. (Part 2 of 2.)

## 6.8 Class GameElement

Class **GameElement** (Fig. 6.7)—the superclass of the **Blocker**, **Target** and **Cannonball**—contains the common data and functionality of an object that moves in the **Cannon Game** app.

---

```

1 // GameElement.java
2 // Represents a rectangle-bounded game element
3 package com.deitel.cannongame;
4
5 import android.graphics.Canvas;
6 import android.graphics.Paint;
7 import android.graphics.Rect;
8
9 public class GameElement {
10     protected CannonView view; // the view that contains this GameElement
11     protected Paint paint = new Paint(); // Paint to draw this GameElement
12     protected Rect shape; // the GameElement's rectangular bounds
13     private float velocityY; // the vertical velocity of this GameElement
14     private int soundId; // the sound associated with this GameElement
15
16     // public constructor
17     public GameElement(CannonView view, int color, int soundId, int x,
18         int y, int width, int length, float velocityY) {
19         this.view = view;
20         paint.setColor(color);
21         shape = new Rect(x, y, x + width, y + length); // set bounds
22         this.soundId = soundId;
23         this.velocityY = velocityY;
24     }
25
26     // update GameElement position and check for wall collisions
27     public void update(double interval) {
28         // update vertical position
29         shape.offset(0, (int) (velocityY * interval));
30
31         // if this GameElement collides with the wall, reverse direction
32         if (shape.top < 0 && velocityY < 0 ||
33             shape.bottom > view.getScreenHeight() && velocityY > 0)
34             velocityY *= -1; // reverse this GameElement's velocity
35     }
36 }
```

---

**Fig. 6.7** | GameElement class represents a rectangle-bounded game element. (Part I of 2.)

---

```

37  // draws this GameElement on the given Canvas
38  public void draw(Canvas canvas) {
39      canvas.drawRect(shape, paint);
40  }
41
42  // plays the sound that corresponds to this type of GameElement
43  public void playSound() {
44      view.playSound(soundId);
45  }
46 }
```

---

**Fig. 6.7** | GameElement class represents a rectangle-bounded game element. (Part 2 of 2.)

### 6.8.1 Instance Variables and Constructor

The GameElement constructor receives a reference to the CannonView (Section 6.13), which implements the game’s logic and draws the game elements. The constructor receives an int representing the GameElement’s 32-bit color, and an int representing the ID of a sound that’s associated with this GameElement. The CannonView stores all of the sounds in the game and provides an ID for each. The constructor also receives

- ints for the x and y position of the GameElement’s upper-left corner
- ints for its width and height, and
- an initial vertical velocity, velocityY, of this GameElement.

Line 20 sets the paint object’s color, using the int representation of the color passed to the constructor. Line 21 calculates the GameElement’s bounds and stores them in a Rect object that represents a rectangle.

### 6.8.2 Methods update, draw, and playSound

A GameElement has the following methods:

- **update** (lines 27–35)—In each iteration of the game loop, this method is called to update the GameElement’s position. Line 29 updates the vertical position of shape, based on the vertical velocity (velocityY) and the elapsed time between calls to update, which the method receives as the parameter interval. Lines 32–34 check whether this GameElement is colliding with the top or bottom edge of the screen and, if so, reverse its vertical velocity.
- **draw** (lines 38–40)—This method is called when a GameElement needs to be redrawn on the screen. The method receives a Canvas and draws this GameElement as a rectangle on the screen—we’ll override this method in class Cannonball to draw a circle instead. The GameElement’s paint instance variable specifies the rectangle’s color, and the GameElement’s shape specifies the rectangle’s bounds on the screen.
- **playSound** (lines 43–45)—Every game element has an associated sound that can be played by calling method playSound. This method passes the value of the soundId instance variable to the CannonView’s playSound method. Class CannonView loads and maintains references to the game’s sounds.

## 6.9 Blocker Subclass of GameElement

Class `Blocker` (Fig. 6.8)—a subclass of `GameElement`—represents the blocker, which makes it more difficult for the player to destroy targets. Class `Blocker`'s `missPenalty` is subtracted from the remaining game time if the Cannonball collides with the `Blocker`. The `getMissPenalty` method (lines 17–19) returns the `missPenalty`—this method is called from `CannonView`'s `testForCollisions` method when subtracting the `missPenalty` from the remaining time (Section 6.13.11). The `Blocker` constructor (lines 9–14) passes its arguments and the ID for the blocker-hit sound (`CannonView.BLOCKER_SOUND_ID`) to the superclass constructor (line 11), then initializes `missPenalty`.

---

```

1 // Blocker.java
2 // Subclass of GameElement customized for the Blocker
3 package com.deitel.cannongame;
4
5 public class Blocker extends GameElement {
6     private int missPenalty; // the miss penalty for this Blocker
7
8     // constructor
9     public Blocker(CannonView view, int color, int missPenalty, int x,
10                 int y, int width, int length, float velocityY) {
11         super(view, color, CannonView.BLOCKER_SOUND_ID, x, y, width, length,
12               velocityY);
13         this.missPenalty = missPenalty;
14     }
15
16     // returns the miss penalty for this Blocker
17     public int getMissPenalty() {
18         return missPenalty;
19     }
20 }
```

---

**Fig. 6.8** | Blocker subclass of `GameElement`.

## 6.10 Target Subclass of GameElement

Class `Target` (Fig. 6.9)—a subclass of `GameElement`—represents a target that the player can destroy. Class `Target`'s `hitPenalty` is added to the remaining game time if the Cannonball collides with a `Target`. The `getHitReward` method (lines 17–19) returns the `hitReward`—this method is called from `CannonView`'s `testForCollisions` method when adding the `hitReward` to the remaining time (Section 6.13.11). The `Target` constructor (lines 9–14) passes its arguments and the ID for the target-hit sound (`CannonView.TARGET_SOUND_ID`) to the super constructor (line 11), then initializes `hitReward`.

---

```

1 // Target.java
2 // Subclass of GameElement customized for the Target
3 package com.deitel.cannongame;
4
```

---

**Fig. 6.9** | Target subclass of `GameElement`. (Part I of 2.)

---

```

5  public class Target extends GameElement {
6      private int hitReward; // the hit reward for this target
7
8      // constructor
9      public Target(CannonView view, int color, int hitReward, int x, int y,
10         int width, int length, float velocityY) {
11         super(view, color, CannonView.TARGET_SOUND_ID, x, y, width, length,
12             velocityY);
13         this.hitReward = hitReward;
14     }
15
16     // returns the hit reward for this Target
17     public int getHitReward() {
18         return hitReward;
19     }
20 }
```

---

**Fig. 6.9** | Target subclass of GameElement. (Part 2 of 2.)

## 6.11 Cannon Class

The Cannon class (Figs. 6.10–6.14) represents the cannon in the **Cannon Game** app. The cannon has a base and a barrel, and it can fire a cannonball.

### 6.11.1 Instance Variables and Constructor

The Cannon constructor (Fig. 6.10) has four parameters. It receives

- the CannonView that this Cannon is in (view),
- the radius of the Cannon’s base (baseRadius),
- the length of the Cannon’s barrel (barrelLength) and
- the width of the Cannon’s barrel (barrelWidth).

Line 25 sets the width of the Paint object’s stroke so that the barrel will be drawn with the given barrelWidth. Line 27 aligns the Cannon’s barrel to be initially parallel with the top and bottom edges of the screen. The Cannon class has a Point barrelEnd that’s used to draw the barrel, barrelAngle to store the current angle of the barrel, and cannonball to store the Cannonball that was most recently fired if it’s still on the screen.

---

```

1  // Cannon.java
2  // Represents Cannon and fires the Cannonball
3  package com.deitel.cannongame;
4
5  import android.graphics.Canvas;
6  import android.graphics.Color;
7  import android.graphics.Paint;
8  import android.graphics.Point;
9
```

---

**Fig. 6.10** | Cannon instance variables and constructor. (Part 1 of 2.)

---

```

10  public class Cannon {
11      private int baseRadius; // Cannon base's radius
12      private int barrelLength; // Cannon barrel's length
13      private Point barrelEnd = new Point(); // endpoint of Cannon's barrel
14      private double barrelAngle; // angle of the Cannon's barrel
15      private Cannonball cannonball; // the Cannon's Cannonball
16      private Paint paint = new Paint(); // Paint used to draw the cannon
17      private CannonView view; // view containing the Cannon
18
19      // constructor
20      public Cannon(CannonView view, int baseRadius, int barrelLength,
21          int barrelWidth) {
22          this.view = view;
23          this.baseRadius = baseRadius;
24          this.barrelLength = barrelLength;
25          paint.setStrokeWidth(barrelWidth); // set width of barrel
26          paint.setColor(Color.BLACK); // Cannon's color is Black
27          align(Math.PI / 2); // Cannon barrel facing straight right
28      }
29

```

---

**Fig. 6.10** | Cannon instance variables and constructor. (Part 2 of 2.)

### 6.11.2 Method align

Method `align` (Fig. 6.11) aims the cannon. The method receives as an argument the barrel angle in radians. We use the `cannonLength` and the `barrelAngle` to determine the *x*- and *y*-coordinate values for the endpoint of the cannon’s barrel, `barrelEnd`—this is used to draw a line from the cannon base’s center at the left edge of the screen to the cannon’s barrel endpoint. Line 32 stores the `barrelAngle` so that the ball can be fired at angle later.

---

```

30      // aligns the Cannon's barrel to the given angle
31      public void align(double barrelAngle) {
32          this.barrelAngle = barrelAngle;
33          barrelEnd.x = (int) (barrelLength * Math.sin(barrelAngle));
34          barrelEnd.y = (int) (-barrelLength * Math.cos(barrelAngle)) +
35              view.getScreenHeight() / 2;
36      }
37

```

---

**Fig. 6.11** | Cannon method `align`.

### 6.11.3 Method fireCannonball

The `fireCannonball` method (Fig. 6.12) fires a `Cannonball` across the screen at the Cannon’s current trajectory (`barrelAngle`). Lines 41–46 calculate the horizontal and vertical components of the `Cannonball`’s velocity. Lines 49–50 calculate the radius of the `Cannonball`, which is `CannonView.CANNONBALL_RADIUS_PERCENT` of the screen height. Lines 53–56 “load the cannon” (that is, construct a new `Cannonball` and position it inside the Cannon). Finally, we play the `Cannonball`’s firing sound (line 58).

---

```

38     // creates and fires Cannonball in the direction Cannon points
39     public void fireCannonball() {
40         // calculate the Cannonball velocity's x component
41         int velocityX = (int) (CannonView.CANNONBALL_SPEED_PERCENT *
42             view.getScreenWidth() * Math.sin(barrelAngle));
43
44         // calculate the Cannonball velocity's y component
45         int velocityY = (int) (CannonView.CANNONBALL_SPEED_PERCENT *
46             view.getScreenWidth() * -Math.cos(barrelAngle));
47
48         // calculate the Cannonball's radius
49         int radius = (int) (view.getHeight() *
50             CannonView.CANNONBALL_RADIUS_PERCENT);
51
52         // construct Cannonball and position it in the Cannon
53         cannonball = new Cannonball(view, Color.BLACK,
54             CannonView.CANNON_SOUND_ID, -radius,
55             view.getHeight() / 2 - radius, radius, velocityX,
56             velocityY);
57
58         cannonball.playSound(); // play fire Cannonball sound
59     }
60

```

---

**Fig. 6.12** | Cannon method fireCannonball.

#### 6.11.4 Method draw

The draw method (Fig. 6.13) draws the Cannon on the screen. We draw the Cannon in two parts. First we draw the Cannon’s barrel, then the Cannon’s base.

---

```

61     // draws the Cannon on the Canvas
62     public void draw(Canvas canvas) {
63         // draw cannon barrel
64         canvas.drawLine(0, view.getHeight() / 2, barrelEnd.x,
65             barrelEnd.y, paint);
66
67         // draw cannon base
68         canvas.drawCircle(0, (int) view.getHeight() / 2,
69             (int) baseRadius, paint);
70     }
71

```

---

**Fig. 6.13** | Cannon method draw.

##### Drawing the Cannon Barrel with Canvas Method drawLine

We use Canvas’s **drawLine** method to display the Cannon barrel (lines 64–65). This method receives five parameters—the first four represent the  $x$ - $y$  coordinates of the line’s start and end, and the last is the Paint object specifying the line’s characteristics, such as its thickness. Recall that `paint` was configured to draw the barrel with the thickness given in the constructor (Fig. 6.10, line 25).

### Drawing the Cannon Base with Canvas Method `drawCircle`

Lines 68–69 use Canvas's `drawCircle` method to draw the Cannon's half-circle base by drawing a circle that's centered at the left edge of the screen. Because a circle is displayed based on its center point, half of this circle is drawn off the left side of the `SurfaceView`.

#### 6.11.5 Methods `getCannonball` and `removeCannonball`

Figure 6.14 shows the `getCannonball` and `removeCannonball` methods. The `getCannonball` method (lines 73–75) returns the current `Cannonball` instance, which `Cannon` stores. A `cannonball` value of `null` means that currently no `Cannonball` exists in the game. The `CannonView` uses this method to avoid firing a `Cannonball` if another `Cannonball` is already on the screen (Section 6.13.8, Fig. 6.26). The `removeCannonball` method (lines 78–80 of Fig. 6.14) removes the `CannonBall` from the game by setting `cannonball` to `null`. The `CannonView` uses this method to remove the `Cannonball` from the game when it destroys a `Target` or after it leaves the screen (Section 6.13.11, Fig. 6.29).

---

```

72     // returns the Cannonball that this Cannon fired
73     public Cannonball getCannonball() {
74         return cannonball;
75     }
76
77     // removes the Cannonball from the game
78     public void removeCannonball() {
79         cannonball = null;
80     }
81 }
```

---

**Fig. 6.14** | CannonView methods `getCannonball` and `removeCannonball`.

## 6.12 Cannonball Subclass of GameElement

The `Cannonball` subclass of `GameElement` (Sections 6.12.1–6.12.4) represents a cannonball fired from the cannon.

### 6.12.1 Instance Variables and Constructor

The `Cannonball` constructor (Fig. 6.15) receives the cannonball's `radius` rather than `width` and `height` in the `GameElement` constructor. Lines 15–16 call `super` with `width` and `height` values calculated from the `radius`. The constructor also receives the horizontal velocity of the `Cannonball`, `velocityX`, in addition to its vertical velocity, `velocityY`. Line 18 initializes `onScreen` to `true` because the `Cannonball` is initially on the screen.

---

```

1  // Cannonball.java
2  // Represents the Cannonball that the Cannon fires
3  package com.deitel.cannongame;
4
5  import android.graphics.Canvas;
6  import android.graphics.Rect;
```

---

**Fig. 6.15** | `Cannonball` instance variables and constructor. (Part I of 2.)

---

```

7
8  public class Cannonball extends GameElement {
9      private float velocityX;
10     private boolean onScreen;
11
12     // constructor
13     public Cannonball(CannonView view, int color, int soundId, int x,
14         int y, int radius, float velocityX, float velocityY) {
15         super(view, color, soundId, x, y,
16             2 * radius, 2 * radius, velocityY);
17         this.velocityX = velocityX;
18         onScreen = true;
19     }
20

```

**Fig. 6.15** | Cannonball instance variables and constructor. (Part 2 of 2.)

### 6.12.2 Methods `getRadius`, `collidesWith`, `isOnScreen`, and `reverseVelocityX`

Method `getRadius` (Fig. 6.16, lines 22–24) returns the Cannonball’s radius by finding half the distance between the `shape.right` and `shape.left` bounds of the Cannonball’s shape. Method `isOnScreen` (lines 32–34) returns `true` if the Cannonball is on the screen.

---

```

21     // get Cannonball's radius
22     private int getRadius() {
23         return (shape.right - shape.left) / 2;
24     }
25
26     // test whether Cannonball collides with the given GameElement
27     public boolean collidesWith(GameElement element) {
28         return (Rect.intersects(shape, element.shape) && velocityX > 0);
29     }
30
31     // returns true if this Cannonball is on the screen
32     public boolean isOnScreen() {
33         return onScreen;
34     }
35
36     // reverses the Cannonball's horizontal velocity
37     public void reverseVelocityX() {
38         velocityX *= -1;
39     }
40

```

**Fig. 6.16** | Cannonball methods `getRadius`, `collidesWith`, `isOnScreen` and `reverseVelocityX`.

**Checking for Collisions with Another GameElement with the `collidesWith` Method**  
The `collidesWith` method (line 27–29) checks whether the cannonball has *collided* with the given `GameElement`. We perform simple *collision detection*, based on the rectangular

boundary of the Cannonball. Two conditions must be met if the Cannonball is colliding with the GameElement:

- The Cannonball's bounds, which are stored in the shape Rect, must intersect the bounds of the given GameElement's shape. Rect's intersects method is used to check if the bounds of the Cannonball and the given GameElement intersect.
- The Cannonball must be moving horizontally towards the given GameElement. The Cannonball travels from left to right (unless it hits the blocker). If velocityX (the horizontal velocity) is positive, the Cannonball is moving left-to-right toward the given GameElement.

### *Reversing the Cannonball's Horizontal Velocity with reverseVelocityX*

The reverseVelocityX method reverses the horizontal velocity of the Cannonball by multiplying velocityX by -1. If the collidesWith method returns true, CannonView method testForCollisions calls reverseVelocityX to reverse the ball's horizontal velocity, so the cannonball bounces back toward the cannon (Section 6.13.11).

#### 6.12.3 Method update

The update method (Fig. 6.17) first calls the superclass's update method (line 44) to update the Cannonball's vertical velocity and to check for vertical collisions. Line 47 uses Rect's offset method to horizontally translate the bounds of this Cannonball. We multiply its horizontal velocity (velocityX) by the amount of time that passed (interval) to determine the translation amount. Lines 50–53 set onScreen to false if the Cannonball hits one of the screen's edges.

---

```

41   // updates the Cannonball's position
42   @Override
43   public void update(double interval) {
44       super.update(interval); // updates Cannonball's vertical position
45
46       // update horizontal position
47       shape.offset((int) (velocityX * interval), 0);
48
49       // if Cannonball goes off the screen
50       if (shape.top < 0 || shape.left < 0 ||
51           shape.bottom > view.getScreenHeight() ||
52           shape.right > view.getScreenWidth())
53           onScreen = false; // set it to be removed
54   }
55

```

---

Fig. 6.17 | Overridden GameElement method update.

#### 6.12.4 Method draw

The draw method (Fig. 6.18) overrides GameElement's draw method and uses Canvas's **drawCircle** method to draw the Cannonball in its current position. The first two arguments represent the coordinates of the circle's *center*. The third argument is the circle's *radius*. The last argument is the Paint object specifying the circle's drawing characteristics.

---

```

56    // draws the Cannonball on the given canvas
57    @Override
58    public void draw(Canvas canvas) {
59        canvas.drawCircle(shape.left + getRadius(),
60            shape.top + getRadius(), getRadius(), paint);
61    }
62 }
```

---

**Fig. 6.18** | Overridden GameElement method draw.

## 6.13 CannonView Subclass of SurfaceView

Class CannonView (Figs. 6.19–6.33) is a custom subclass of View that implements the Cannon Game’s logic and draws game objects on the screen.

### 6.13.1 package and import Statements

Figure 6.19 lists the package statement and the import statements for class CannonView. Section 6.3 discussed the key new classes and interfaces that class CannonView uses. We’ve highlighted them in Fig. 6.19.

---

```

1 // CannonView.java
2 // Displays and controls the Cannon Game
3 package com.deitel.cannongame;
4
5 import android.app.Activity;
6 import android.app.AlertDialog;
7 import android.app.Dialog;
8 import android.app.DialogFragment;
9 import android.content.Context;
10 import android.content.DialogInterface;
11 import android.graphics.Canvas;
12 import android.graphics.Color;
13 import android.graphics.Paint;
14 import android.graphics.Point;
15 import android.media.AudioAttributes;
16 import android.media.SoundPool;
17 import android.os.Build;
18 import android.os.Bundle;
19 import android.util.AttributeSet;
20 import android.util.Log;
21 import android.util.SparseIntArray;
22 import android.view.MotionEvent;
23 import android.view.SurfaceHolder;
24 import android.view.SurfaceView;
25 import android.view.View;
26
27 import java.util.ArrayList;
28 import java.util.Random;
29 }
```

---

**Fig. 6.19** | CannonView class’s package and import statements. (Part 1 of 2.)

```
30 public class CannonView extends SurfaceView  
31     implements SurfaceHolder.Callback {  
32
```

Fig. 6.19 | CannonView class's package and import statements. (Part 2 of 2.)

### 6.13.2 Instance Variables and Constants

Figure 6.20 lists the large number of class CannonView's constants and instance variables. We'll explain each as we encounter it in the discussion. Many of the constants are used in calculations that scale the game elements' sizes based on the screen's dimensions.

```
33     private static final String TAG = "CannonView"; // for logging errors  
34  
35     // constants for game play  
36     public static final int MISS_PENALTY = 2; // seconds deducted on a miss  
37     public static final int HIT_REWARD = 3; // seconds added on a hit  
38  
39     // constants for the Cannon  
40     public static final double CANNON_BASE_RADIUS_PERCENT = 3.0 / 40;  
41     public static final double CANNON_BARREL_WIDTH_PERCENT = 3.0 / 40;  
42     public static final double CANNON_BARREL_LENGTH_PERCENT = 1.0 / 10;  
43  
44     // constants for the Cannonball  
45     public static final double CANNONBALL_RADIUS_PERCENT = 3.0 / 80;  
46     public static final double CANNONBALL_SPEED_PERCENT = 3.0 / 2;  
47  
48     // constants for the Targets  
49     public static final double TARGET_WIDTH_PERCENT = 1.0 / 40;  
50     public static final double TARGET_LENGTH_PERCENT = 3.0 / 20;  
51     public static final double TARGET_FIRST_X_PERCENT = 3.0 / 5;  
52     public static final double TARGET_SPACING_PERCENT = 1.0 / 60;  
53     public static final double TARGET_PIECES = 9;  
54     public static final double TARGET_MIN_SPEED_PERCENT = 3.0 / 4;  
55     public static final double TARGET_MAX_SPEED_PERCENT = 6.0 / 4;  
56  
57     // constants for the Blocker  
58     public static final double BLOCKER_WIDTH_PERCENT = 1.0 / 40;  
59     public static final double BLOCKER_LENGTH_PERCENT = 1.0 / 4;  
60     public static final double BLOCKER_X_PERCENT = 1.0 / 2;  
61     public static final double BLOCKER_SPEED_PERCENT = 1.0;  
62  
63     // text size 1/18 of screen width  
64     public static final double TEXT_SIZE_PERCENT = 1.0 / 18;  
65  
66     private CannonThread cannonThread; // controls the game loop  
67     private Activity activity; // to display Game Over dialog in GUI thread  
68     private boolean dialogIsDisplayed = false;  
69  
70     // game objects  
71     private Cannon cannon;
```

Fig. 6.20 | CannonView class's static and instance variables. (Part 1 of 2.)

---

---

```

72     private Blocker blocker;
73     private ArrayList<Target> targets;
74
75     // dimension variables
76     private int screenWidth;
77     private int screenHeight;
78
79     // variables for the game loop and tracking statistics
80     private boolean gameOver; // is the game over?
81     private double timeLeft; // time remaining in seconds
82     private int shotsFired; // shots the user has fired
83     private double totalElapsedTime; // elapsed seconds
84
85     // constants and variables for managing sounds
86     public static final int TARGET_SOUND_ID = 0;
87     public static final int CANNON_SOUND_ID = 1;
88     public static final int BLOCKER_SOUND_ID = 2;
89     private SoundPool soundPool; // plays sound effects
90     private SparseIntArray soundMap; // maps IDs to SoundPool
91
92     // Paint variables used when drawing each item on the screen
93     private Paint textPaint; // Paint used to draw text
94     private Paint backgroundPaint; // Paint used to clear the drawing area
95

```

**Fig. 6.20** | CannonView class's static and instance variables. (Part 2 of 2.)

### 6.13.3 Constructor

Figure 6.21 shows class CannonView's constructor. When a View is inflated, its constructor is called with a Context and an AttributeSet as arguments. The Context is the Activity that displays the MainActivityFragment containing the CannonView, and the **Attribute-Set** (package android.util) contains the CannonView attribute values that are set in the layout's XML document. These arguments are passed to the superclass constructor (line 96) to ensure that the custom View is properly configured with the values of any standard View attributes specified in the XML. Line 99 stores a reference to the MainActivity so we can use it at the end of a game to display an AlertDialog from the GUI thread. Though we chose to store the Activity reference, we can access this at any time by calling the inherited View method getContext.

---

```

96     // constructor
97     public CannonView(Context context, AttributeSet attrs) {
98         super(context, attrs); // call superclass constructor
99         activity = (Activity) context; // store reference to MainActivity
100
101        // register SurfaceHolder.Callback Listener
102        getHolder().addCallback(this);
103

```

**Fig. 6.21** | CannonView constructor. (Part 1 of 2.)

```

104    // configure audio attributes for game audio
105    AudioAttributes.Builder attrBuilder = new AudioAttributes.Builder();
106    attrBuilder.setUsage(AudioAttributes.USAGE_GAME);
107
108    // initialize SoundPool to play the app's three sound effects
109    SoundPool.Builder builder = new SoundPool.Builder();
110    builder.setMaxStreams(1);
111    builder.setAudioAttributes(attrBuilder.build());
112    soundPool = builder.build();
113
114    // create Map of sounds and pre-load sounds
115    soundMap = new SparseIntArray(3); // create new SparseIntArray
116    soundMap.put(TARGET_SOUND_ID,
117        soundPool.load(context, R.raw.target_hit, 1));
118    soundMap.put(CANNON_SOUND_ID,
119        soundPool.load(context, R.raw.cannon_fire, 1));
120    soundMap.put(BLOCKER_SOUND_ID,
121        soundPool.load(context, R.raw.blocker_hit, 1));
122
123    textPaint = new Paint();
124    backgroundPaint = new Paint();
125    backgroundPaint.setColor(Color.WHITE);
126}
127

```

**Fig. 6.21** | CannonView constructor. (Part 2 of 2.)

### Registering the `SurfaceHolder.Callback` Listener

Line 102 registers this (i.e., the CannonView) as the `SurfaceHolder.Callback` that receives method calls when the `SurfaceView` is *created*, *updated* and *destroyed*. Inherited `SurfaceView` method `getHolder` returns the `SurfaceHolder` object for managing the `SurfaceView`, and `SurfaceHolder` method `addCallback` stores the object that implements interface `SurfaceHolder.Callback`.

### Configuring the `SoundPool` and Loading the Sounds

Lines 105–121 configure the sounds that we use in the app. First we create an `AudioAttributes.Builder` object (line 105) and call the `setUsage` method (line 106), which receives a constant that represents what the audio will be used for. For this app, we use the `AudioAttribute.USAGE_GAME` constant, which indicates that the audio is being used as game audio. Next, we create a `SoundPool.Builder` object (line 109), which will enable us to create the `SoundPool` that's used to load and play the app's sound effects. Next, we call `SoundPool.Builder`'s `setMaxStreams` method (line 110), which takes an argument that represents the maximum number of simultaneous sound streams that can play at once. We play only one sound at a time, so we pass 1. Some more complex games might play many sounds at the same time. We then call `AudioAttributes.Builder`'s `setAudioAttributes` method (line 111) to use the audio attributes with the `SoundPool` object after creating it.

Line 115 creates a `SparseIntArray` (`soundMap`), which maps integer keys to integer values. `SparseIntArray` is similar to—but more efficient than—a `HashMap<Integer, Integer>` for small numbers of key-value pairs. In this case, we map the sound keys (defined in Fig. 6.20, lines 86–88) to the loaded sounds' IDs, which are represented by the

return values of the SoundPool's **load** method (called in Fig. 6.21, lines 117, 119 and 121). Each sound ID can be used to *play* a sound (and later to return its resources to the system). SoundPool method **load** receives three arguments—the application's Context, a resource ID representing the sound file to load and the sound's priority. According to the documentation for this method, the last argument is not currently used and should be specified as 1.

#### *Creating the Paint Objects Used to Draw the Background and Timer Text*

Lines 123–124 create the **Paint** objects that are used when drawing the game's background and **Time remaining** text. The text color defaults to black and line 125 sets the background color to white.

#### 6.13.4 Overriding View Method **onSizeChanged**

Figure 6.22 overrides class **View**'s **onSizeChanged** method, which is called whenever the **View**'s size changes, including when the **View** is first added to the **View** hierarchy as the layout is inflated. This app always displays in landscape mode, so **onSizeChanged** is called only once when the activity's **onCreate** method inflates the GUI. The method receives the **View**'s new width and height and its old width and height. The first time this method is called, the old width and height are 0. Lines 138–139 configure the **textPaint** object, which is used to draw the **Time remaining** text. Line 138 sets the size of the text to be **TEXT\_SIZE\_PERCENT** of the height of the screen (**screenHeight**). We arrived at the value for **TEXT\_SIZE\_PERCENT** and the other scaling factors in Fig. 6.20 via trial and error, choosing values that made the game elements look nice on the screen.

---

```

128    // called when the size of the SurfaceView changes,
129    // such as when it's first added to the View hierarchy
130    @Override
131    protected void onSizeChanged(int w, int h, int oldw, int oldh) {
132        super.onSizeChanged(w, h, oldw, oldh);
133
134        screenWidth = w; // store CannonView's width
135        screenHeight = h; // store CannonView's height
136
137        // configure text properties
138        textPaint.setTextSize((int) (TEXT_SIZE_PERCENT * screenHeight));
139        textPaint.setAntiAlias(true); // smoothes the text
140    }
141

```

---

**Fig. 6.22** | Overriding View method **onSizeChanged**.

#### 6.13.5 Methods **getScreenWidth**, **getScreenHeight**, and **playSound**

In Fig. 6.23, the methods **getScreenWidth** and **getScreenHeight** return the width and height of the screen, which are updated in the **onSizeChanged** method (Fig. 6.22). Using **soundPool**'s **play** method, the **playSound** method (lines 153–155) plays the sound in **soundMap** with the given **soundId**, which was associated with the sound when **soundMap**

was constructed (Fig. 6.21, lines 113–119). The soundId is used as the soundMap key to locate the sound's ID in the SoundPool. An object of class GameElement can call the playSound method to play its sound.

---

```

142 // get width of the game screen
143 public int getScreenWidth() {
144     return screenWidth;
145 }
146
147 // get height of the game screen
148 public int getScreenHeight() {
149     return screenHeight;
150 }
151
152 // plays a sound with the given soundId in soundMap
153 public void playSound(int soundId) {
154     soundPool.play(soundMap.get(soundId), 1, 1, 1, 0, 1f);
155 }
156

```

---

**Fig. 6.23** | CannonView methods getScreenWidth, getScreenHeight and playSound.

### 6.13.6 Method newGame

Method newGame (Fig. 6.24) resets the instance variables that are used to control the game. Lines 160–163 create a new Cannon object with

- a base radius of CANNON\_BASE\_RADIUS\_PERCENT of the screen height,
- a barrel length of CANNON\_BARREL\_LENGTH\_PERCENT of the screen width and
- a barrel width of CANNON\_BARREL\_WIDTH\_PERCENT of the screen height.

---

```

157 // reset all the screen elements and start a new game
158 public void newGame() {
159     // construct a new Cannon
160     cannon = new Cannon(this,
161         (int) (CANNON_BASE_RADIUS_PERCENT * screenHeight),
162         (int) (CANNON_BARREL_LENGTH_PERCENT * screenWidth),
163         (int) (CANNON_BARREL_WIDTH_PERCENT * screenHeight));
164
165 Random random = new Random(); // for determining random velocities
166 targets = new ArrayList<>(); // construct a new Target list
167
168 // initialize targetX for the first Target from the left
169 int targetX = (int) (TARGET_FIRST_X_PERCENT * screenWidth);
170
171 // calculate Y coordinate of Targets
172 int targetY = (int) ((0.5 - TARGET_LENGTH_PERCENT / 2) *
173     screenHeight);
174

```

---

**Fig. 6.24** | CannonView method newGame. (Part I of 2.)

```

175     // add TARGET_PIECES Targets to the Target list
176     for (int n = 0; n < TARGET_PIECES; n++) {
177
178         // determine a random velocity between min and max values
179         // for Target n
180         double velocity = screenHeight * (random.nextDouble() *
181             (TARGET_MAX_SPEED_PERCENT - TARGET_MIN_SPEED_PERCENT) +
182             TARGET_MIN_SPEED_PERCENT);
183
184         // alternate Target colors between dark and light
185         int color = (n % 2 == 0) ?
186             getResources().getColor(R.color.dark,
187                 getContext().getTheme()) :
188             getResources().getColor(R.color.light,
189                 getContext().getTheme());
190
191         velocity *= -1; // reverse the initial velocity for next Target
192
193         // create and add a new Target to the Target list
194         targets.add(new Target(this, color, HIT_REWARD, targetX, targetY,
195             (int) (TARGET_WIDTH_PERCENT * screenWidth),
196             (int) (TARGET_LENGTH_PERCENT * screenHeight),
197             (int) velocity));
198
199         // increase the x coordinate to position the next Target more
200         // to the right
201         targetX += (TARGET_WIDTH_PERCENT + TARGET_SPACING_PERCENT) *
202             screenWidth;
203     }
204
205     // create a new Blocker
206     blocker = new Blocker(this, Color.BLACK, MISS_PENALTY,
207         (int) (BLOCKER_X_PERCENT * screenWidth),
208         (int) ((0.5 - BLOCKER_LENGTH_PERCENT / 2) * screenHeight),
209         (int) (BLOCKER_WIDTH_PERCENT * screenWidth),
210         (int) (BLOCKER_LENGTH_PERCENT * screenHeight),
211         (float) (BLOCKER_SPEED_PERCENT * screenHeight));
212
213     timeLeft = 10; // start the countdown at 10 seconds
214
215     shotsFired = 0; // set the initial number of shots fired
216     totalElapsedTime = 0.0; // set the time elapsed to zero
217
218     if (gameOver) { // start a new game after the last game ended
219         gameOver = false; // the game is not over
220         cannonThread = new CannonThread(getHolder()); // create thread
221         cannonThread.start(); // start the game loop thread
222     }
223
224     hideSystemBars();
225 }
226

```

Fig. 6.24 | CannonView method newGame. (Part 2 of 2.)

Line 165 creates a new Random object that's used to randomize the Target velocities. Line 166 creates a new ArrayList of Targets. Line 169 initializes targetX to the number of pixels from the left that the first Target will be positioned on the screen. The first Target is positioned TARGET\_FIRST\_X\_PERCENT of the way across the screen. Lines 172–173 initialize targetY with a value to vertically center all Targets on the screen. Lines 176–203 construct TARGET\_PIECES (9) new Targets and add them to targets. Lines 180–182 set the velocity of the new Target to a random value between the screen height percentages TARGET\_MIN\_SPEED\_PERCENT and TARGET\_MAX\_SPEED\_PERCENT. Lines 185–189 set the color of the new Target to alternate between the R.color.dark and R.color.light colors and alternate between positive and negative vertical velocities. Line 191 reverses the target velocity for each new target so that some targets move up to start and some move down. The new Target is constructed and added to targets (lines 194–197). The Target is given a width of TARGET\_WIDTH\_PERCENT of the screen width and a height of TARGET\_HEIGHT\_PERCENT of the screen height. Finally, targetX is incremented to position the next Target.

A new Blocker is constructed and stored in blocker in lines 206–211. The Blocker is positioned BLOCKER\_X\_PERCENT of the screen width from the left and is vertically centered on the screen to start the game. The Blocker's width is BLOCKER\_WIDTH\_PERCENT of the screen width and the Blocker's height is BLOCKER\_HEIGHT\_PERCENT of the screen height. The Blocker's speed is BLOCKER\_SPEED\_PERCENT of the screen height.

If variable gameOver is true, which occurs only *after* the first game completes, line 219 resets gameOver and lines 220–221 create a new CannonThread and call its start method to begin the *game loop* that controls the game. Line 224 calls method hideSystemBars (Section 6.13.16) to put the app in immersive mode—this hides the system bars and enables the user to display them at any time by swiping down from the top of the screen.

### 6.13.7 Method updatePositions

Method updatePositions (Fig. 6.25) is called by the CannonThread's run method (Section 6.13.15) to update the on-screen elements' positions and to perform simple *collision detection*. The new locations of the game elements are calculated based on the elapsed time in milliseconds between the previous and current animation frames. This enables the game to update the amount by which each game element moves, based on the device's *refresh rate*. We discuss this in more detail when we cover game loops in Section 6.13.15.

---

```

227 // called repeatedly by the CannonThread to update game elements
228 private void updatePositions(double elapsedTimeMS) {
229     double interval = elapsedTimeMS / 1000.0; // convert to seconds
230
231     // update cannonball's position if it is on the screen
232     if (cannon.getcannonball() != null)
233         cannon.getcannonball().update(interval);
234
235     blocker.update(interval); // update the blocker's position
236
237     for (GameElement target : targets)
238         target.update(interval); // update the target's position

```

---

**Fig. 6.25** | CannonView method updatePositions. (Part I of 2.)

---

```

239
240     timeLeft -= interval; // subtract from time left
241
242     // if the timer reached zero
243     if (timeLeft <= 0) {
244         timeLeft = 0.0;
245         gameOver = true; // the game is over
246         cannonThread.setRunning(false); // terminate thread
247         showGameOverDialog(R.string.lose); // show the losing dialog
248     }
249
250     // if all pieces have been hit
251     if (targets.isEmpty()) {
252         cannonThread.setRunning(false); // terminate thread
253         showGameOverDialog(R.string.win); // show winning dialog
254         gameOver = true;
255     }
256 }
257

```

---

**Fig. 6.25** | CannonView method updatePositions. (Part 2 of 2.)

### *Elapsed Time Since the Last Animation Frame*

Line 229 converts the elapsed time since the last animation frame from milliseconds to seconds. This value is used to modify the positions of various game elements.

### *Updating the Cannonball, Blocker and Target Positions*

To update the positions of the GameElements, lines 232–238 call the update methods of the Cannonball (if there is one on the screen), the Blocker and all of the remaining Targets. The update method receives the time elapsed since the previous frame so that the positions can be updated by the correct amount for the interval.

### *Updating the Time Left and Determining Whether Time Ran Out*

We decrease timeLeft by the time that has passed since the prior animation frame (line 240). If timeLeft has reached zero, the game is over, so we set timeLeft to 0.0 just in case it was negative; otherwise, sometimes a negative final time would display on the screen. Then we set gameOver to true, terminate the CannonThread by calling its setRunning method with the argument false and call method showGameOverDialog with the String resource ID representing the losing message.

#### **6.13.8 Method alignAndFireCannonball**

When the user touches the screen, method onTouchEvent (Section 6.13.14) calls alignAndFireCannonball (Fig. 6.26). Lines 267–272 calculate the angle necessary to aim the cannon at the touch point. Line 275 calls Cannon's align method to aim the cannon with trajectory angle. Finally, if the Cannonball exists and is on the screen, lines 280–281 fire the Cannonball and increment shotsFired.

```
258 // aligns the barrel and fires a Cannonball if a Cannonball is not
259 // already on the screen
260 public void alignAndFireCannonball(MotionEvent event) {
261     // get the location of the touch in this view
262     Point touchPoint = new Point((int) event.getX(),
263         (int) event.getY());
264
265     // compute the touch's distance from center of the screen
266     // on the y-axis
267     double centerMinusY = (screenHeight / 2 - touchPoint.y);
268
269     double angle = 0; // initialize angle to 0
270
271     // calculate the angle the barrel makes with the horizontal
272     angle = Math.atan2(touchPoint.x, centerMinusY);
273
274     // point the barrel at the point where the screen was touched
275     cannon.align(angle);
276
277     // fire Cannonball if there is not already a Cannonball on screen
278     if (cannon.getCanvasball() == null ||
279         !cannon.getCanvasball().isOnScreen()) {
280         cannon.fireCannonball();
281         ++shotsFired;
282     }
283 }
284 }
```

---

Fig. 6.26 | CannonView method alignAndFireCannonball.

### 6.13.9 Method showGameOverDialog

When the game ends, the showGameOverDialog method (Fig. 6.27) displays a Dialog-Fragment (using the techniques you learned in Section 4.7.10) containing an Alert-Dialog that indicates whether the player won or lost, the number of shots fired and the total time elapsed. The call to method setPositiveButton (lines 301–311) creates a reset button for starting a new game.

```
285 // display an AlertDialog when the game ends
286 private void showGameOverDialog(final int messageId) {
287     // DialogFragment to display game stats and start new game
288     final DialogFragment gameResult =
289         new DialogFragment() {
290             // create an AlertDialog and return it
291             @Override
292             public Dialog onCreateDialog(Bundle bundle) {
293                 // create dialog displaying String resource for messageId
294                 AlertDialog.Builder builder =
295                     new AlertDialog.Builder(getActivity());
296                 builder.setTitle(getResources().getString(messageId));
297             }
298         };
299         gameResult.show(getFragmentManager(), "gameOver");
300     }
301     // setPositiveButton to start a new game
302     builder.setPositiveButton("Reset", new DialogInterface.OnClickListener() {
303         @Override
304         public void onClick(DialogInterface dialog, int which) {
305             Intent intent = new Intent(Intent.ACTION_MAIN);
306             intent.addCategory(Intent.CATEGORY_HOME);
307             intent.setFlags(Intent.FLAG_ACTIVITY_NEW_TASK);
308             startActivity(intent);
309         }
310     });
311     builder.setNegativeButton("Exit", new DialogInterface.OnClickListener() {
312         @Override
313         public void onClick(DialogInterface dialog, int which) {
314             finish();
315         }
316     });
317     builder.show();
318 }
```

---

Fig. 6.27 | CannonView method showGameOverDialog. (Part I of 2.)

```

298         // display number of shots fired and total time elapsed
299         builder.setMessage(getResources().getString(
300             R.string.results_format, shotsFired, totalElapsedTime));
301         builder.setPositiveButton(R.string.reset_game,
302             new DialogInterface.OnClickListener() {
303                 // called when "Reset Game" Button is pressed
304                 @Override
305                 public void onClick(DialogInterface dialog,
306                     int which) {
307                         dialogIsDisplayed = false;
308                         newGame(); // set up and start a new game
309                     }
310                 });
311             );
312         );
313         return builder.create(); // return the AlertDialog
314     };
315 };
316
317 // in GUI thread, use FragmentManager to display the DialogFragment
318 activity.runOnUiThread(
319     new Runnable() {
320         public void run() {
321             showSystemBars(); // exit immersive mode
322             dialogIsDisplayed = true;
323             gameResult.setCancelable(false); // modal dialog
324             gameResult.show(activity.getFragmentManager(), "results");
325         }
326     }
327 );
328 }
329

```

**Fig. 6.27** | CannonView method `showGameOverDialog`. (Part 2 of 2.)

The `onClick` method of the Button's listener indicates that the dialog is no longer displayed and calls `newGame` to set up and start a new game. A dialog must be displayed from the GUI thread, so lines 318–327 call Activity method `runOnUiThread` to specify a `Runnable` that should execute in the GUI thread as soon as possible. The argument is an object of an anonymous inner class that implements `Runnable`. The `Runnable`'s `run` method calls method `showSystemBars` (Section 6.13.16) to remove the app from immersive mode, then indicates that the dialog is displayed and displays it.

### 6.13.10 Method `drawGameElements`

The method `drawGameElements` (Fig. 6.28) draws the Cannon, Cannonball, Blocker and Targets on the `SurfaceView` using the `Canvas` that the `CannonThread` (Section 6.13.15) obtains from the `SurfaceView`'s `SurfaceHolder`.

#### *Clearing the Canvas with Method `drawRect`*

First, we call `Canvas`'s **`drawRect` method** (lines 333–334) to clear the `Canvas` so that the game elements can be displayed in their new positions. The method receives the rectangle's

```
330 // draws the game to the given Canvas
331 public void drawGameElements(Canvas canvas) {
332     // clear the background
333     canvas.drawRect(0, 0, canvas.getWidth(), canvas.getHeight(),
334         backgroundPaint);
335
336     // display time remaining
337     canvas.drawText(getResources().getString(
338         R.string.time_remaining_format, timeLeft), 50, 100, textPaint);
339
340     cannon.draw(canvas); // draw the cannon
341
342     // draw the GameElements
343     if (cannon.getCannonball() != null &&
344         cannon.getCannonball().isOnScreen())
345         cannon.getCannonball().draw(canvas);
346
347     blocker.draw(canvas); // draw the blocker
348
349     // draw all of the Targets
350     for (GameElement target : targets)
351         target.draw(canvas);
352 }
353
```

---

**Fig. 6.28** | CannonView method `drawGameElements`.

upper-left *x*-*y* coordinates, width and height, and the `Paint` object that specifies the drawing characteristics—recall that `backgroundPaint` sets the drawing color to white.

#### *Displaying the Time Remaining with Canvas Method `drawText`*

Next, we call `Canvas`'s **`drawText` method** (lines 337–338) to display the time remaining in the game. We pass as arguments the `String` to be displayed, the *x*- and *y*-coordinates at which to display it and the `textPaint` (configured in Fig. 6.22, lines 138–139) to describe how the text should be rendered (that is, the text's font size, color and other attributes).

#### *Drawing the Cannon, Cannonball, Blocker and Targets with the `draw` Method*

Lines 339–350 draw the Cannon, the Cannonball (if it is on the screen), the Blocker, and each of the Targets. Each of these elements is drawn by calling its `draw` method and passing in `canvas`.

### 6.13.11 Method `testForCollisions`

The `testForCollisions` method (Fig. 6.29) checks whether the `Cannonball` is colliding with any of the `Targets` or with the `Blocker`, and applies certain effects in the game if a collision occurs. Lines 359–360 check whether a `Cannonball` is on the screen. If so, line 362 calls the `Cannonball`'s `collidesWith` method to determine whether the `Cannonball` is colliding with a `Target`. If there is a collision, line 363 calls the `Target`'s `playSound` method to play the target-hit sound, line 366 increments `timeLeft` by the hit reward associated with the `Target`, and lines 368–369 remove the `Cannonball` and `Target` from the screen. Line 370 decrements `n` to ensure the target that's now in position `n` gets tested for a colli-

sion. Line 376 destroys the Cannonball associated with Cannon if it's not on the screen. If the Cannonball is still on the screen, lines 380–381 call `collidesWith` again to determine whether the Cannonball is colliding with the Blocker. If so, line 382 calls the Blocker's `playSound` method to play the blocker-hit sound, line 385 reverses the cannonball's horizontal velocity by calling class Cannonball's `reverseVelocityX` method, and line 388 decrements `timeLeft` by the miss penalty associated with the Blocker.

```

354     // checks if the ball collides with the Blocker or any of the Targets
355     // and handles the collisions
356     public void testForCollisions() {
357         // remove any of the targets that the Cannonball
358         // collides with
359         if (cannon.get Cannonball() != null &&
360             cannon.get Cannonball().isOnScreen()) {
361             for (int n = 0; n < targets.size(); n++) {
362                 if (cannon.get Cannonball().collidesWith(targets.get(n))) {
363                     targets.get(n).playSound(); // play Target hit sound
364
365                 // add hit rewards time to remaining time
366                 timeLeft += targets.get(n).getHitReward();
367
368                 cannon.removeCannonball(); // remove Cannonball from game
369                 targets.remove(n); // remove the Target that was hit
370                 --n; // ensures that we don't skip testing new target n
371                 break;
372             }
373         }
374     }
375     else { // remove the Cannonball if it should not be on the screen
376         cannon.removeCannonball();
377     }
378
379     // check if ball collides with blocker
380     if (cannon.get Cannonball() != null &&
381         cannon.get Cannonball().collidesWith(blocker)) {
382         blocker.playSound(); // play Blocker hit sound
383
384         // reverse ball direction
385         cannon.get Cannonball().reverseVelocityX();
386
387         // deduct blocker's miss penalty from remaining time
388         timeLeft -= blocker.getMissPenalty();
389     }
390 }
391

```

**Fig. 6.29** | CannonView method `testForCollisions`.

### 6.13.12 Methods `stopGame` and `releaseResources`

Class `MainActivityFragment`'s `onPause` and `onDestroy` methods (Section 6.13) call class `CannonView`'s `stopGame` and `releaseResources` methods (Fig. 6.30), respectively. Method `stopGame` (lines 393–396) is called from the main Activity to stop the game when the

Activity's `onPause` method is called—for simplicity, we don't store the game's state in this example. Method `releaseResources` (lines 399–402) calls the SoundPool's `release` method to release the resources associated with the SoundPool.

---

```

392 // stops the game: called by CannonGameFragment's onPause method
393 public void stopGame() {
394     if (cannonThread != null)
395         cannonThread.setRunning(false); // tell thread to terminate
396 }
397
398 // release resources: called by CannonGame's onDestroy method
399 public void releaseResources() {
400     soundPool.release(); // release all resources used by the SoundPool
401     soundPool = null;
402 }
403

```

---

**Fig. 6.30** | CannonView methods `stopGame` and `releaseResources`.

### 6.13.13 Implementing the SurfaceHolder.Callback Methods

Figure 6.31 implements the `surfaceChanged`, `surfaceCreated` and `surfaceDestroyed` methods of interface `SurfaceHolder.Callback`. Method `surfaceChanged` has an empty body in this app because the app is *always* displayed in landscape orientation. This method is called when the `SurfaceView`'s size or orientation changes, and would typically be used to redisplay graphics based on those changes.

---

```

404 // called when surface changes size
405 @Override
406 public void surfaceChanged(SurfaceHolder holder, int format,
407     int width, int height) { }

408
409 // called when surface is first created
410 @Override
411 public void surfaceCreated(SurfaceHolder holder) {
412     if (!dialogIsDisplayed) {
413         newGame(); // set up and start a new game
414         cannonThread = new CannonThread(holder); // create thread
415         cannonThread.setRunning(true); // start game running
416         cannonThread.start(); // start the game loop thread
417     }
418 }
419
420 // called when the surface is destroyed
421 @Override
422 public void surfaceDestroyed(SurfaceHolder holder) {
423     // ensure that thread terminates properly
424     boolean retry = true;
425     cannonThread.setRunning(false); // terminate cannonThread
426

```

---

**Fig. 6.31** | Implementing the `SurfaceHolder.Callback` methods. (Part 1 of 2.)

---

```

427     while (retry) {
428         try {
429             cannonThread.join(); // wait for cannonThread to finish
430             retry = false;
431         }
432         catch (InterruptedException e) {
433             Log.e(TAG, "Thread interrupted", e);
434         }
435     }
436 }
437

```

---

**Fig. 6.31** | Implementing the `SurfaceHolder.Callback` methods. (Part 2 of 2.)

Method `surfaceCreated` (lines 410–418) is called when the `SurfaceView` is created—e.g., when the app first loads or when it resumes from the background. We use `surfaceCreated` to create and start the `CannonThread` to begin the game loop. Method `surfaceDestroyed` (lines 421–436) is called when the `SurfaceView` is destroyed—e.g., when the app terminates. We use `surfaceDestroyed` to ensure that the `CannonThread` terminates properly. First, line 425 calls `CannonThread`'s `setRunning` method with `false` as an argument to indicate that the thread should *stop*, then lines 427–435 wait for the thread to *terminate*. This ensures that no attempt is made to draw to the `SurfaceView` once `surfaceDestroyed` completes execution.

### 6.13.14 Overriding View Method `onTouchEvent`

In this example, we override `View` method `onTouchEvent` (Fig. 6.32) to determine when the user touches the screen. The `MotionEvent` parameter contains information about the event that occurred. Line 442 uses the `MotionEvent`'s `getAction` method to determine which type of touch event occurred. Then, lines 445–446 determine whether the user touched the screen (`MotionEvent.ACTION_DOWN`) or dragged a finger across the screen (`MotionEvent.ACTION_MOVE`). In either case, line 448 calls the `cannonView`'s `alignAndFireCannonball` method to aim and fire the cannon toward that touch point. Line 451 then returns `true` to indicate that the touch event was handled.

---

```

438     // called when the user touches the screen in this activity
439     @Override
440     public boolean onTouchEvent(MotionEvent e) {
441         // get int representing the type of action which caused this event
442         int action = e.getAction();
443
444         // the user touched the screen or dragged along the screen
445         if (action == MotionEvent.ACTION_DOWN ||
446             action == MotionEvent.ACTION_MOVE) {
447             // fire the cannonball toward the touch point
448             alignAndFireCannonball(e);
449         }
450

```

---

**Fig. 6.32** | Overriding View method `onTouchEvent`. (Part 1 of 2.).

---

```

451     return true;
452 }
453

```

**Fig. 6.32** | Overriding View method onTouchEvent. (Part 2 of 2.).

### 6.13.15 CannonThread: Using a Thread to Create a Game Loop

Figure 6.33 defines a subclass of Thread which updates the game. The thread maintains a reference to the SurfaceView's SurfaceHolder (line 456) and a boolean indicating whether the thread is *running*.

---

```

454 // Thread subclass to control the game loop
455 private class CannonThread extends Thread {
456     private SurfaceHolder surfaceHolder; // for manipulating canvas
457     private boolean threadIsRunning = true; // running by default
458
459     // initializes the surface holder
460     public CannonThread(SurfaceHolder holder) {
461         surfaceHolder = holder;
462         setName("CannonThread");
463     }
464
465     // changes running state
466     public void setRunning(boolean running) {
467         threadIsRunning = running;
468     }
469
470     // controls the game loop
471     @Override
472     public void run() {
473         Canvas canvas = null; // used for drawing
474         long previousFrameTime = System.currentTimeMillis();
475
476         while (threadIsRunning) {
477             try {
478                 // get Canvas for exclusive drawing from this thread
479                 canvas = surfaceHolder.lockCanvas(null);
480
481                 // lock the surfaceHolder for drawing
482                 synchronized(surfaceHolder) {
483                     long currentTime = System.currentTimeMillis();
484                     double elapsedTimeMS = currentTime - previousFrameTime;
485                     totalElapsedTime += elapsedTimeMS / 1000.0;
486                     updatePositions(elapsedTimeMS); // update game state
487                     testForCollisions(); // test for GameElement collisions
488                     drawGameElements(canvas); // draw using the canvas
489                     previousFrameTime = currentTime; // update previous time
490                 }
491             }
492         }
493     }

```

**Fig. 6.33** | Nested class CannonThread manages the game loop, updating the game elements every TIME\_INTERVAL milliseconds. (Part 1 of 2.)

---

```

492         finally {
493             // display canvas's contents on the CannonView
494             // and enable other threads to use the Canvas
495             if (canvas != null)
496                 surfaceHolder.unlockCanvasAndPost(canvas);
497         }
498     }
499 }
500 }
```

---

**Fig. 6.33** | Nested class CannonThread manages the game loop, updating the game elements every TIME\_INTERVAL milliseconds. (Part 2 of 2.)

The class’s `run` method (lines 471–499) drives the *frame-by-frame animations*—this is known as the *game loop*. Each update of the game elements on the screen is performed, based on the number of milliseconds that have passed since the last update. Line 474 gets the system’s current time in milliseconds when the thread begins running. Lines 476–498 loop until `threadIsRunning` is `false`.

First we obtain the `Canvas` for drawing on the `SurfaceView` by calling `SurfaceHolder` method `lockCanvas` (line 479). Only one thread at a time can draw to a `SurfaceView`. To ensure this, you must first *lock* the `SurfaceHolder` by specifying it as the expression in the parentheses of a `synchronized` block (line 482). Next, we get the current time in milliseconds, then calculate the elapsed time and add that to the total time so far—this will be used to help display the amount of time left in the game. Line 486 calls method `updatePositions` to move all the game elements, passing the elapsed time in milliseconds as an argument. This ensures that the game operates at the same speed *regardless of how fast the device is*. If the time between frames is larger (i.e., the device is slower), the game elements will move further when each frame of the animation is displayed. If the time between frames is smaller (i.e., the device is faster), the game elements will move less when each frame of the animation is displayed. Line 487 calls `testForCollisions` to determine whether the `Cannonball` collided with the `Blocker` or a `Target`:

- If a collision occurs with the `Blocker`, `testForCollisions` reverses the `Cannonball`’s velocity.
- If a collision occurs with a `Target`, `testForCollisions` removes the `Cannonball`.

Finally, line 488 calls the `drawGameElements` method to draw the game elements using the `SurfaceView`’s `Canvas`, and line 489 stores the `currentTime` as the `previousFrameTime` to prepare to calculate the elapsed time between this animation frame and the *next*.

### 6.13.16 Methods `hideSystemBars` and `showSystemBars`

This app uses *immersive mode*—at any time during game play, the user can view the system bars by swiping down from the top of the screen. Immersive mode is available only on devices running Android 4.4 or higher. So, methods `hideSystemBars` and `showSystemBars` (Fig. 6.34) first check whether the device’s Android version—`Build.VERSION.SDK_INT`—is greater than or equal to `Build.VERSION_CODES.KITKAT`—the constant for Android 4.4 (API level 19). If so, both methods use `View` method `setSystemUiVisibility` to configure the system bars and app bar (though we already hid the app bar by modifying this app’s

theme). To hide the system bars and app bar and place the UI into immersive mode, you pass to `setSystemUiVisibility` the constants that are combined via the bitwise OR (`|`) operator in lines 505–510. To show the system bars and app bar, you pass to `setSystemUiVisibility` the constants that are combined in lines 517–519. These combinations of View constants ensure that the `CannonView` is *not* resized each time the system bars and app bar are hidden and redisplayed. Instead, the system bars and app bar *overlay* the `CannonView`—that is, part of the `CannonView` is temporarily hidden when the system bars are on the screen. For more information on immersive mode, visit

<http://developer.android.com/training/system-ui/immersive.html>

---

```

501 // hide system bars and app bar
502 private void hideSystemBars() {
503     if (Build.VERSION.SDK_INT >= Build.VERSION_CODES.KITKAT)
504         setSystemUiVisibility(
505             View.SYSTEM_UI_FLAG_LAYOUT_STABLE |
506             View.SYSTEM_UI_FLAG_LAYOUT_HIDE_NAVIGATION |
507             View.SYSTEM_UI_FLAG_LAYOUT_FULLSCREEN |
508             View.SYSTEM_UI_FLAG_HIDE_NAVIGATION |
509             View.SYSTEM_UI_FLAG_FULLSCREEN |
510             View.SYSTEM_UI_FLAG_IMMERSIVE);
511 }
512
513 // show system bars and app bar
514 private void showSystemBars() {
515     if (Build.VERSION.SDK_INT >= Build.VERSION_CODES.KITKAT)
516         setSystemUiVisibility(
517             View.SYSTEM_UI_FLAG_LAYOUT_STABLE |
518             View.SYSTEM_UI_FLAG_LAYOUT_HIDE_NAVIGATION |
519             View.SYSTEM_UI_FLAG_LAYOUT_FULLSCREEN);
520 }
521 }
```

---

Fig. 6.34 | `DoodleView` methods `hideSystemBars` and `showSystemBars`.

## 6.14 Wrap-Up

In this chapter, you created the **Cannon Game** app, which challenges the player to destroy nine targets before a 10-second time limit expires. The user aims and fires the cannon by touching the screen. To draw on the screen from a separate thread, you created a custom view by extending class `SurfaceView`. You learned that custom component class names must be fully qualified in the XML layout element that represents the component. We presented additional `Fragment` lifecycle methods. You learned that method `onPause` is called when a `Fragment` is paused and method `onDestroy` is called when the `Fragment` is destroyed. You handled touches by overriding `View`'s `onTouchEvent` method. You added sound effects to the app's `res/raw` folder and managed them with a `SoundPool`. You also used the system's `AudioManager` service to obtain the device's current music volume and use it as the playback volume.

This app manually performs its animations by updating the game elements on a `SurfaceView` from a separate thread of execution. To do this, you extended class `Thread` and

created a `run` method that displays graphics by calling methods of class `Canvas`. You used the `SurfaceView`'s `SurfaceHolder` to obtain the appropriate `Canvas`. You also learned how to build a game loop that controls a game, based on the amount of time that has elapsed between animation frames, so that the game will operate at the same overall speed on all devices, regardless of their processor speeds. Finally, you used immersive mode to enable the app to use the entire screen.

In Chapter 7, you'll build the `WeatherViewer` app. You'll use web services to interact with the 16-day weather forecast web service from `OpenWeatherMap.org`. Like many of today's web services, the `OpenWeatherMap.org` web service will return the forecast data in JavaScript Object Notation (JSON) format. You'll process the response using the `JSONObject` and `JSONArray` classes from the `org.json` package. You'll then display the daily forecast in a `ListView`.

# 7

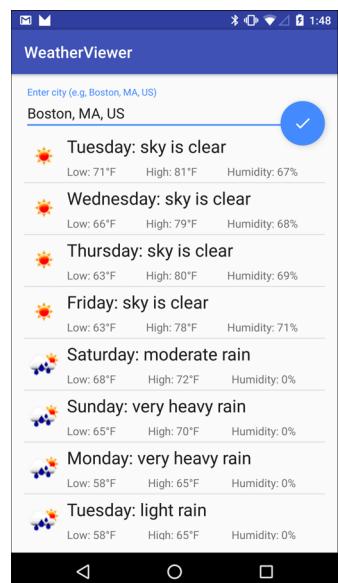
# WeatherViewer App

REST Web Services, AsyncTask, HttpURLConnection, Processing JSON Responses, JSONObject, JSONArray, ListView, ArrayAdapter, ViewHolder Pattern, TextInputLayout, FloatingActionButton

## Objectives

In this chapter you'll:

- Use the free [OpenWeatherMap.org](http://OpenWeatherMap.org) REST web services to get a 16-day weather forecast for a city specified by the user.
- Use an `AsyncTask` and an `HttpURLConnection` to invoke a REST web service or to download an image in a separate thread and deliver results to the GUI thread.
- Process a JSON response using package `org.json` classes `JSONObject`s and `JSONArray`s.
- Define an `ArrayAdapter` that specifies the data to display in a `ListView`.
- Use the `ViewHolder` pattern to reuse views that scroll off the screen in a `ListView`, rather than creating new views.
- Use the material design components `TextInputLayout`, `Snackbar` and `FloatingActionButton` from the Android Design Support Library.



**Outline**

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| 7.4.7      | list_item.xml  |              |  |

## 7.1 Introduction

The **WeatherViewer** app (Fig. 7.1) uses the free [OpenWeatherMap.org](http://openweathermap.org) REST web services to obtain a specified city's 16-day weather forecast. The app receives the weather data in *JSON (JavaScript Object Notation)* data format. The list of weather data is displayed in a *ListView*—a view that displays a scrollable list of items. In this app, you'll use a custom list-item format to display:

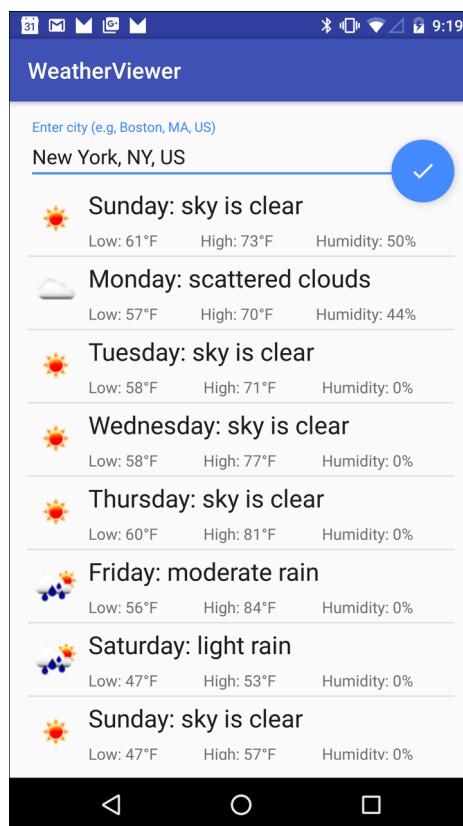
- a weather-condition icon
- the day of the week with a text description of that day's weather
- the day's low and high temperatures (in °F), and
- the humidity percentage.

The preceding items represent a subset of the returned forecast data. For details of the data returned by the 16-day weather forecast API, visit:

<http://openweathermap.org/forecast16>

For a list of all weather data APIs provided by OpenWeatherMap.org, visit:

<http://openweathermap.org/api>



**Fig. 7.1** | Weather Viewer app displaying the New York, NY, US weather forecast.

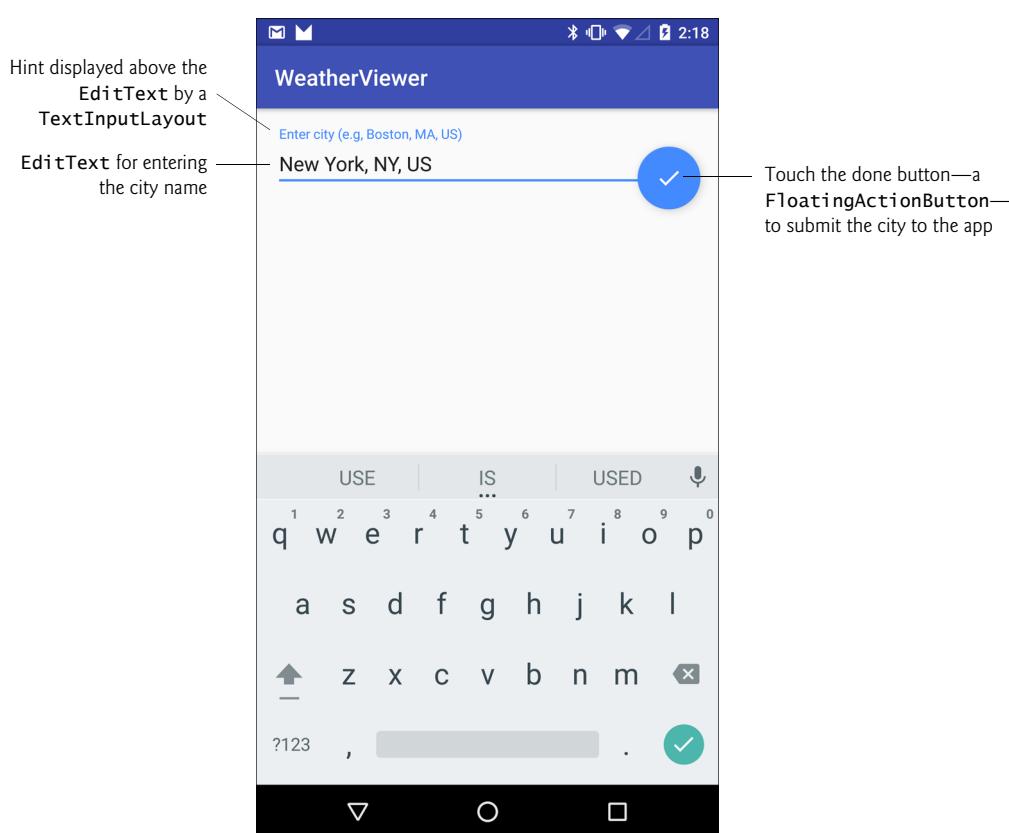
## 7.2 Test-Driving the WeatherViewer App

### *Opening and Running the App*

Open Android Studio and open the **WeatherViewer** app from the **WeatherViewer** folder in the book's examples folder. Before running this app, you must add your own **OpenWeatherMap.org** API key. See Section 7.3.1 for information on how to obtain your key and where you should place it in the project. *This is required before you can run the app.* After adding your API key to the project, execute the app in the AVD or on a device.

### *Viewing a City's 16-Day Weather Forecast*

When the app first executes, the **EditText** at the top of the user interface receives the focus and the virtual keyboard displays so you can enter a city name (Fig. 7.2). You should consider following the city with a comma and the country code. In this case, we entered **New York, NY, US** to locate the weather for New York, NY in the United States. Once you've entered the city, touch the circular **FloatingActionButton** containing the done icon (✓) to submit the city to the app, which then requests that city's 16-day weather forecast (shown in Fig. 7.1).



**Fig. 7.2** | Entering a city.

## 7.3 Technologies Overview

This section introduces the features you'll use to build the **WeatherViewer** app.

### 7.3.1 Web Services

This chapter introduces web services, which promote software portability and reusability in applications that operate over the Internet. A **web service** is a software component that can be accessed over a network.

The machine on which a web service resides is the **web service host**. The client—in this case the **WeatherViewer** app—sends a request over a network to the web service host, which processes the request and returns a response over the network to the client. This distributed computing benefits systems in various ways. For example, an app can access data on demand via a web service, rather than storing the data directly on the device. Similarly, an app lacking the processing power to perform specific computations could use a web service to take advantage of another system's superior resources.

### *REST Web Services*

**Representational State Transfer (REST)** refers to an architectural style for implementing web services—often called **RESTful web services**. Many of today’s most popular free and fee-based web services are RESTful. Though REST itself is not a standard, RESTful web services use web standards, such as HyperText Transfer Protocol (HTTP), which is used by web browsers to communicate with web servers. Each method in a RESTful web service is identified by a unique URL. So, when the server receives a request, it immediately knows what operation to perform. Such web services can be used in an app or even entered directly into a web browser’s address bar.

### *Web Services Often Require an API Key*

Using a web service often requires a unique **API key** from the web service’s provider. When your app makes a request to the web service, the API key enables the provider to:

- confirm that you have permission to use the web service and
- track your usage—many web services limit the total number of requests you can make in a specific timeframe (e.g., per second, per minute, per hour, etc.).

Some web services require authentication before the web service gives the app an API key—in effect, you log into the web service programmatically, before being allowed to use the web service.

### *OpenWeatherMap.org Web Services*

The OpenWeatherMap.org web services we use in the **WeatherViewer** app are free, but OpenWeatherMap.org limits the number of web service requests—these limits are currently 1200 requests-per-minute and 1.7 million requests-per-day. OpenWeatherMap.org is a *freemium* service—in addition to the free tier that you’ll use in this app, they offer paid tiers with higher request limits, more frequent data updates and other features. For additional information about the OpenWeatherMap.org web services, visit:

<http://openweathermap.org/api>

### *OpenWeatherMap.org Web Service License*

OpenWeatherMap.org uses a creative commons public license for its web services. For the license terms, visit:

<http://creativecommons.org/licenses/by-sa/2.0/>

For more information about the license terms, see the Licenses section at

<http://openweathermap.org/terms>

### *Obtaining an OpenWeatherMap.org API Key*

Before running this app, you must obtain your own OpenWeatherMap.org API key from

<http://openweathermap.org/register>

After registering, copy the hexadecimal API key from the confirmation web page, then replace `YOUR_API_KEY` in `strings.xml` with the key.

### 7.3.2 JavaScript Object Notation (JSON) and the org.json Package

**JavaScript Object Notation (JSON)** is an alternative to XML for representing data. JSON is a text-based data-interchange format used to represent objects in JavaScript as collections of name/value pairs represented as **Strings**. JSON is a simple format that makes objects easy to create, read and parse and, because it's much less verbose than XML, allows programs to transmit data efficiently across the Internet. Each JSON object is represented as a list of property names and values contained in curly braces, in the following format:

```
{propertyName1: value1, propertyName2: value2}
```

Each property name is a **String**. Arrays are represented in JSON with square brackets in the following format:

```
[value1, value2, value3]
```

Each array element can be a **String**, number, JSON object, **true**, **false** or **null**. Figure 7.3 sample JSON returned by OpenWeatherMap.org's daily forecast web service used in this app—this particular sample contains two days of weather data (lines 15–57).

---

```

1   {
2     "city": {
3       "id": 5128581,
4       "name": "New York",
5       "coord": {
6         "lon": -74.005966,
7         "lat": 40.714272
8       },
9       "country": "US",
10      "population": 0
11    },
12    "cod": "200",
13    "message": 0.0102,
14    "cnt": 2,
15    "list": [{} // you'll use this array of objects to get the daily weather
16      "dt": 1442419200,
17      "temp": {
18        "day": 79.9,
19        "min": 71.74,
20        "max": 82.53,
21        "night": 71.85,
22        "eve": 82.53,
23        "morn": 71.74
24      },
25      "pressure": 1037.39,
26      "humidity": 64,
27      "weather": [
28        {
29          "id": 800,
30          "main": "Clear",
31          "description": "sky is clear",
32          "icon": "01d"
33        },
34      ]
35    ],
36    "sys": {
37      "country": "US",
38      "sunrise": 1442419200,
39      "sunset": 1442419200
40    }
41  }
42
```

---

**Fig. 7.3** | Sample JSON from the OpenWeatherMap.org daily forecast web service. (Part I of 2.)

```
33     "speed": 0.92,
34     "deg": 250,
35     "clouds": 0
36 }, { // end of first array element and beginning of second one
37     "dt": 1442505600,
38     "temp": {
39         "day": 79.92,
40         "min": 66.72,
41         "max": 83.1,
42         "night": 70.79,
43         "eve": 81.99,
44         "morn": 66.72
45     },
46     "pressure": 1032.46,
47     "humidity": 62,
48     "weather": [
49         {
50             "id": 800,
51             "main": "Clear",
52             "description": "sky is clear",
53             "icon": "01d"
54         },
55         "speed": 1.99,
56         "deg": 224,
57         "clouds": 0
58     ] // end of second array element and end of array
}
```

**Fig. 7.3** | Sample JSON from the OpenWeatherMap.org daily forecast web service. (Part 2 of 2.)

There are many properties in the JSON object returned by the daily forecast. We use only the "list" property—an array of JSON objects representing the forecasts for up to 16 days (7 by default, unless you specify otherwise). Each "list" array element contains many properties of which we use:

- "dt"—a long integer containing the date/time stamp represented as the number of seconds since January 1, 1970 GMT. We convert this into a day name.
- "temp"—a JSON object containing double properties representing the day's temperatures. We use only the minimum ("min") and maximum ("max") temperatures, but the web service also returns the average daytime ("day"), nighttime ("night"), evening ("eve") and morning ("morn") temperatures.
- "humidity"—an int representing the humidity percentage.
- "weather"—a JSON object containing several properties, including a description of the conditions ("description") and the name of an icon that represents the conditions ("icon").

### **org.json Package**

You'll use the following classes from the **org.json package** to process the JSON data that the app receives (Section 7.7.6):

- **JSONObject**—One of this class's constructors converts a **String** of JSON data into a **JSONObject** containing a **Map<String, Object>** that maps the JSON keys

to their corresponding values. You access the JSON properties in your code via `JSONObject`'s `get` methods, which enable you to obtain a JSON key's value as one of the types `JSONObject`, `JSONArray`, `Object`, `boolean`, `double`, `int`, `long` or `String`.

- **JSONArray**—This class represents a JSON array and provides methods for accessing its elements. The "list" property in the OpenWeatherMap.org response will be manipulated as a `JSONArray`.

### 7.3.3 HttpURLConnection Invoking a REST Web Service

To invoke the OpenWeatherMap.org daily forecast web service, you'll convert the web service's URL String into a URL object, then use the URL to open an `HttpURLConnection` (Section 7.7.5). This will make the HTTP request to the web service. To receive the JSON response, you'll read all the data from the `HttpURLConnection`'s `InputStream` and place it in a `String`. We'll show you how to convert that to a `JSONObject` for processing.

### 7.3.4 Using AsyncTask to Perform Network Requests Outside the GUI Thread

You should perform *long-running operations* or operations that *block* execution until they complete (e.g., network, file and database access) *outside* the GUI thread. This helps maintain application responsiveness and avoid *Activity Not Responding (ANR)* dialogs that appear when Android thinks the GUI is not responsive. Recall from Chapter 6, however, that updates to an app's user interface must be performed in the GUI thread, because GUI components are not thread safe.

To perform long-running tasks that result in updates to the GUI, Android provides class **AsyncTask** (package `android.os`), which performs the long-running operation in one thread and delivers the results to the GUI thread. The details of creating and manipulating threads are handled for you by class `AsyncTask`, as are communicating the results from the `AsyncTask` to the GUI thread. We'll use two `AsyncTask` subclasses in this app—one will invoke the OpenWeatherMap.org web service (Section 7.7.5) and the other will download a weather-condition image (Section 7.6.5).

### 7.3.5 ListView, ArrayAdapter and the View-Holder Pattern

This app displays the weather data in a `ListView` (package `android.widget`)—a scrollable list of items. `ListView` is a subclass of **AdapterView** (package `android.widget`), which represents a view that gets its data from a data source via an **Adapter** object (package `android.widget`). In this app, we use a subclass of **ArrayAdapter** (package `android.widget`) to create an object that populates the `ListView` using data from an `ArrayList` collection object (Section 7.6). When the app updates the `ArrayList` with weather data, we'll call the `ArrayAdapter`'s `notifyDataSetChanged` method to indicate that the underlying data in the `ArrayList` has changed. The adapter then notifies the `ListView` to update its list of displayed items. This is known as **data binding**. Several types of `AdapterViews` can be bound to data using an `Adapter`. In Chapter 9, you'll learn how to bind database data to a `ListView`. For more details on data binding in Android and several tutorials, visit

<http://developer.android.com/guide/topics/ui/binding.html>

### View-Holder Pattern

By default, a `ListView` can display one or two `TextViews`. In this app, you'll customize the `ListView` items to display an `ImageView` and several `TextViews` in a custom layout. Creating custom `ListView` items involves the expensive runtime overhead of creating new objects dynamically. For large lists with complex list-item layouts and for which the user is scrolling rapidly, this overhead can prevent smooth scrolling. To reduce this overhead, as `ListView` items scroll off the screen, Android reuses those list items for the new ones that are scrolling onto the screen. For complex item layouts, you can take advantage of the existing GUI components in the reused list items to increase a `ListView`'s performance.

To do this, we introduce the **view-holder pattern** in which you create a class (typically named `ViewHolder`) containing instance variables for the views that display a `ListView` item's data. When a `ListView` item is created, you also create a `ViewHolder` object and initialize its instance variables with references to the item's nested views. You then store that `ViewHolder` object with the `ListView` item, which is a `View`. Class `View`'s `setTag` method allows you to add any `Object` to a `View`. This `Object` is then available to you via the `View`'s `getTag` method. We'll specify as the tag the `ViewHolder` object that contains references to the `ListView` item's nested views.

As a new item is about to scroll onto the screen, the `ListView` checks whether a reusable view is available. If not, we inflate the new item's view from a layout XML file, then store references to the GUI components in a `ViewHolder` object. Then we'll use `setTag` to set that `ViewHolder` object as the tag for the `ListView` item. If there is a reusable item available, we'll get that item's tag with `getTag`, which will return the existing `ViewHolder` object that was created previously for that `ListView` item. Regardless of how we obtain the `ViewHolder` object, we'll then display data in the `ViewHolder`'s referenced views.

### 7.3.6 FloatingActionButton

Users touch buttons to initiate actions. With material design in Android 5.0, Google introduced the **floating action button** (Google refers to this as the “FAB”) as a button that floats over the app's user interface—that is, it has a higher material-design elevation than the rest of the user interface—and that specifies an important action. For example, a contacts app might use a floating action button containing a + icon to promote the action for adding a new contact. In this app, we use a floating action button containing a done icon (✓) to enable the user to submit a city to the app and obtain that city's forecast. With Android 6.0 and the new Android Design Support Library, Google formalized the floating action button as class `FloatingActionButton` (package `android.support.design.widget`). In Android Studio 1.4, Google reimplemented the app templates to use material design, and most new template include a `FloatingActionButton` by default.

`FloatingActionButton` is a subclass of `ImageView`, which enables a `FloatingActionButton` to display an image. The material design guidelines suggest that you position a `FloatingActionButton` at least 16dp from the edges of a phone device and at least 24dp from the edges of a tablet device—the default app templates configure this for you. For more details about how and when you should use a `FloatingActionButton`, visit:

<https://www.google.com/design/spec/components/buttons-floating-action-button.html>

### 7.3.7 TextInputLayout

In this app, you'll use an `EditText` to enable the user to enter the city for which you'd like to obtain a weather forecast. To help the user understand an `EditText`'s purpose, you can provide hint text that's displayed when the `EditText` is empty. Once the user starts entering text, the hint disappears—possibly causing the user to forget the `EditText`'s purpose.

The Android Design Support Library's `TextInputLayout` (package `android.support.design.widget`) solves this problem. In a `TextInputLayout`, when the `EditText` receives the focus, the `TextInputLayout` animates the hint text from its original size to a smaller size that's displayed above the `EditText` so that the user can enter data and see the hint (Fig. 7.2). In this app, the `EditText` receives the focus as the app begins executing, so the `TextInputLayout` immediately moves the hint above the `EditText`.

### 7.3.8 Snackbar

A `Snackbar` (package `android.support.design.widget`) is a material design component similar in concept to a `Toast`. In addition to appearing on the screen for a specified time limit, `Snackbars` are also interactive. Users can swipe them away to dismiss them. A `Snackbar` also can have an associated action to perform when the user touches the `Snackbar`. In this app, we'll use a `Snackbar` to display informational messages.

## 7.4 Building the App's GUI and Resource Files

In this section, we review the new features in the GUI and resource files for the `WeatherViewer` app.

### 7.4.1 Creating the Project

Create a new project using the template `Blank Activity`. In the `Create New Project` dialog's `New Project` step, specify:

- **Application name:** `WeatherViewer`
- **Company Domain:** `deitel.com` (or specify your own domain name)

For the remaining steps in the `Create New Project` dialog, use the same settings as in Section 2.3. Follow the steps in Section 2.5.2 to add an app icon to your project. Also, follow the steps in Section 4.4.3 to configure Java SE 7 support for the project.

### 7.4.2 AndroidManifest.xml

The `WeatherViewer` is designed for only portrait orientation. Follow the steps you performed in Section 3.7 to set the `android:screenOrientation` property to `portrait`. In addition, add the following Internet-access permission to the `<manifest>` element before its nested `<application>` element:

```
<uses-permission android:name="android.permission.INTERNET" />
```

This allows the app to access the Internet, which is required to invoke a web service.

#### *Permissions That Are Automatically Granted in Android 6.0*

The new Android 6.0 permissions model (introduced in Chapter 5) automatically grants the Internet permission at installation time, because Internet access is considered a funda-

mental capability in today’s apps. In Android 6.0, the Internet permission and many others that, according to Google, are not “great risk to the user’s privacy or security” are granted automatically at installation time—these permissions are grouped into the category **PROTECTION\_NORMAL**. For a complete list of such permissions, visit:

<https://developer.android.com/preview/features/runtime-permissions.html#best-practices>

Android does not ask users to grant such permissions, nor can users revoke such permissions from the app. For this reason, your code does not need to check whether the app has a given **PROTECTION\_NORMAL** permission. You must still request these permissions in `AndroidManifest.xml`, however, for backward compatibility with earlier Android versions.

### 7.4.3 strings.xml

Double click `strings.xml` in the `res/values` folder, then click the **Open editor** link to display the **Translations Editor** and create the String resources in Fig. 7.4.

| Key                                  | Value   |
|--------------------------------------|---|
| <code>api_key</code>                 | <i>Use your own OpenWeatherMap.org API key for this resource’s value.</i> |
| <code>web_service_url</code>         | <code>http://api.openweathermap.org/data/2.5/forecast/daily?q=</code>     |
| <code>invalid_url</code>             | Invalid URL   |
| <code>weather_condition_image</code> | A graphical representation of the weather conditions                      |
| <code>high_temp</code>               | High: %s  |
| <code>low_temp</code>                | Low: %s   |
| <code>day_description</code>         | %1\$s: %2\$s  |
| <code>humidity</code>                | Humidity: %s  |
| <code>hint_text</code>               | Enter city (e.g., Boston, MA, US)   |
| <code>read_error</code>              | Unable to read weather data   |
| <code>connect_error</code>           | Unable to connect to OpenWeatherMap.org                                   |

**Fig. 7.4** | String resources used in the **WeatherViewer** app.

### 7.4.4 colors.xml

The Android Studio **Blank Activity** template customizes the app’s primary, dark primary and accent colors. In this app, we changed the template’s accent color (`colorAccent`) to a blue shade (hexadecimal value `#448AFF`) in `colors.xml`.

### 7.4.5 activity\_main.xml

The Android Studio **Blank Activity** template breaks `MainActivity`’s GUI into two files:

- `activity_main.xml` defines the activity’s Toolbar (the app bar replacement in an `AppCompatActivity`) and a `FloatingActionButton`, which is positioned in the bottom-right corner by default.
- `content_main.xml` defines the rest of `MainActivity`’s GUI and is included in the `activity_main.xml` file via an `<include>` element.

Make the following changes to `activity_main.xml` for this app:

1. Add the `id coordinatorLayout` to the `CoordinatorLayout`—you'll use this to specify the layout in which a Snackbar will be displayed.
2. Add the material design done (✓) button to the project via the **Vector Asset Studio** (as you did in Section 4.4.9), then specify this new icon for the predefined `FloatingActionButton`'s `src` property.
3. Edit the layout's XML to configure several `FloatingActionButton` properties that are not available via the **Properties** window. Change the `layout_gravity` from `bottom|end` to `top|end` so that the `FloatingActionButton` appears at the top right of the user interface.
4. To move the button to overlap the `EditText`'s right edge, define a new dimension resource named `fab_margin_top` with the value `90dp`. Using this dimension resource and the `fab_margin` dimension resource defined by the **Blank Activity** template to define the following `FloatingActionButton` margins:

```
    android:layout_marginTop="@dimen/fab_margin_top"
    android:layout_marginEnd="@dimen/fab_margin"
    android:layout_marginBottom="@dimen/fab_margin"
    android:layout_marginStart="@dimen/fab_margin"
```

5. Finally, remove the `FloatingActionButton`'s `layout_margin` that was pre-defined by the **Blank Activity** template.

#### 7.4.6 `content_main.xml`

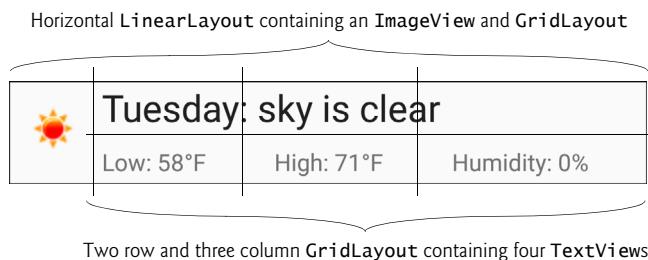
This layout is included into `activity_main.xml` and defines `MainActivity`'s primary GUI. Perform the following steps:

1. Remove the default `TextView` defined by the **Blank Activity** template and change the `RelativeLayout` to a vertical `LinearLayout`.
2. Next, insert a `TextInputLayout`. In the layout editor's **Design** view, click **Custom View** in the **Custom** section. In the dialog that appears, begin typing `TextInputLayout` to search the list of custom GUI components. Once the IDE highlights `TextInputLayout`, click **OK**, then in the **Component Tree**, click the `LinearLayout` to insert the `TextInputLayout` as a nested layout.
3. To add an `EditText` to the `TextInputLayout`, switch to the layout editor's **Text** view, then change the `TextInputLayout` element's closing `>/` to `>`, position the cursor to the right of the `>`, press *Enter* and type `</`. The IDE will auto-complete the closing tag. Between the `TextInputLayout`'s starting and ending tags, type `<EditText`. The IDE will show an auto-complete window with `EditText` selected. Press *Enter* to insert an `EditText`, then set its `layout_width` to `match_parent` and `layout_height` to `wrap_content`. In **Design** view, set the `EditText`'s `id` to `locationEditText`, check its `singleLine` property's checkbox and set its `hint` property to the String resource `hint_text`.
4. To complete the layout, drag a `ListView` onto the `LinearLayout` in the **Component Tree**. Set its `layout_width` to `match_parent`, its `layout_height` to `0dp`, its `layout_weight` to `1` and its `id` to `weatherListView`. Recall that the `layout_height` value

0dp is recommended by the IDE for more efficient rendering when using the `layout_weight` to determine a View's height.

#### 7.4.7 `list_item.xml`

You'll now add the `list_item.xml` layout to the project and define the custom layout for displaying weather data in a `ListView` item (Fig. 7.5). This layout will be inflated by the `WeatherArrayAdapter` to create the user interface for new `ListView` items (Section 7.6.4).



**Fig. 7.5** | Layout for one day's weather displayed in a `ListView` item.

**Step 1: Creating the Layout File and Customizing the `LinearLayout`'s Orientation**  
Create the `list_item.xml` layout file by performing the following steps:

1. Right click the project's layout folder, and select New > Layout resource file.
2. Enter `list_item.xml` in the File name field of the New Resource File dialog.
3. Ensure that `LinearLayout` is specified in the Root element field, then click OK. The `list_item.xml` file will appear in the layout directory in the Project window and will open in the layout editor.
4. Select the `LinearLayout` and change its orientation to `horizontal`—this layout will consist of an `ImageView` and a `GridLayout` containing the other views.

**Step 2: Adding the `ImageView` for Displaying a Weather-Condition Icon**

Perform the following steps to add and configure the `ImageView`:

1. Drag an `ImageView` from the **Palette** onto the `LinearLayout` in the **Component Tree**.
2. Set the `id` to `conditionImageView`.
3. Set the `layout_width` to `50dp`—define the dimension resource `image_side_length` for this value.
4. Set the `layout_height` to `match_parent`—the `ImageView`'s height will match the `ListView` item's height.
5. Set the `contentDescription` to the `String` resource `weather_condition_image` that you created in Section 7.4.3.
6. Set the `scaleType` to `fitCenter`—the icon will fit within the `ImageView`'s bounds and be centered horizontally and vertically.

***Step 3: Adding the GridLayout for Displaying the TextViews***

Perform the following steps to add and configure the GridLayout:

1. Drag a **GridLayout** from the **Palette** onto the **LinearLayout** in the **Component Tree**.
2. Set the **columnCount** to 3 and the **rowCount** to 2.
3. Set the **layout:width** to **0dp**—this GridLayout’s width will be determined by the **layout:weight**.
4. Set the **layout:height** to **match\_parent**—the GridLayout’s height will match the **ListView** item’s height.
5. Set the **layout:weight** to 1—the GridLayout’s width will occupy all remaining horizontal space in its parent **LinearLayout**.
6. Check the **useDefaultMargins** property to add the default spacing between the GridLayout’s cells.

***Step 4: Adding the TextViews***

Perform the following steps to add and configure the four TextViews:

1. Drag a **Large Text** onto the GridLayout in the **Component Tree** and set its **id** to **dayTextView**, its **layout:column** to 0 and its **layout:columnSpan** to 3.
2. Drag three **Plain TextViews** onto the GridLayout in the **Component Tree** and set their **ids** to **lowTextView**, **hiTextView** and **humidityTextView**, respectively. Set each of these TextViews’ **layout:row** to 1 and **layout:columnWeight** to 1. These TextViews will all appear in the GridLayout’s second row and, because they all have the same **layout:columnWeight**, the columns will be sized equally.
3. Set **lowTextView**’s **layout:column** to 0, **hiTextView**’s **layout:column** to 1 and **humidityTextView**’s **layout:column** to 2.

This completes the **list\_item.xml** layout. You do not need to change the **text** property of any of the TextViews—their text will be set programmatically.

## 7.5 Class Weather

This app consists of three classes that are discussed in Sections 7.5–7.7:

- Class **Weather** (this section) represents one day’s weather data. Class **MainActivity** will convert the JSON weather data into an **ArrayList<Weather>**.
- Class **WeatherArrayAdapter** (Section 7.6) defines a custom **ArrayAdapter** sub-class for binding the **ArrayList<Weather>** to the **MainActivity**’s **ListView**. **ListView** items are indexed from 0 and each **ListView** item’s nested views are populated with data from the **Weather** object at the same index in the **ArrayList<Weather>**.
- Class **MainActivity** (Section 7.7) defines the app’s user interface and the logic for interacting with the [OpenWeatherMap.org](http://OpenWeatherMap.org) daily forecast web service and processing the JSON response.

In this section, we focus on class **Weather**.

### 7.5.1 package Statement, import Statements and Instance Variables

Figure 7.6 contains the package statement, import statements and class Weather’s instance variables. You’ll use classes from the `java.text` and `java.util` packages (lines 5–8) to convert the timestamp for each day’s weather into that day’s name (Monday, Tuesday, etc.). The instance variables are declared `final`, because they do not need to be modified after they’re initialized. We also made them `public`—recall that Java Strings are immutable, so even though the instance variables are `public`, their values cannot change.

---

```

1 // Weather.java
2 // Maintains one day's weather information
3 package com.deitel.weatherviewer;
4
5 import java.text.NumberFormat;
6 import java.text.SimpleDateFormat;
7 import java.util.Calendar;
8 import java.util.TimeZone;
9
10 class Weather {
11     public final String dayOfWeek;
12     public final String minTemp;
13     public final String maxTemp;
14     public final String humidity;
15     public final String description;
16     public final String iconURL;
17 }
```

---

**Fig. 7.6** | Weather class package statement, import statements and instance variables.

### 7.5.2 Constructor

The Weather constructor (Fig. 7.7) initializes the class’s instance variables:

- The `NumberFormat` object creates `Strings` from numeric values. Lines 22–23 configure the object to round floating-point values to whole numbers.
- Line 25 calls our utility method `convertTimeStampToDay` (Section 7.5.3) to get the `String` day name and initialize `dayOfWeek`.
- Lines 26–27 format the day’s minimum and maximum temperature values as whole numbers using the `numberFormat` object. We append `°F` to the end of each formatted `String`, as we’ll request Fahrenheit temperatures—the Unicode escape sequence `\u00B0` represents the degree symbol (`°`). The OpenWeatherMap.org APIs also support Kelvin (the default) and Celsius temperature formats.
- Lines 28–29 get a `NumberFormat` for locale-specific percentage formatting, then use it to format the humidity percentage. The web service returns this percentage as a whole number, so we divide that by 100.0 for formatting—in the U.S. locale, 1.00 is formatted as 100%, 0.5 is formatted as 50%, etc.
- Line 30 initializes the weather condition description.
- Lines 31–32 create a URL `String` representing the weather condition image for the day’s weather—this will be used to download the image.

```

18 // constructor
19 public Weather(long timeStamp, double minTemp, double maxTemp,
20     double humidity, String description, String iconName) {
21     // NumberFormat to format double temperatures rounded to integers
22     NumberFormat numberFormat = NumberFormat.getInstance();
23     numberFormat.setMaximumFractionDigits(0);
24
25     this.dayOfWeek = convertTimeStampToDay(timeStamp);
26     this.minTemp = numberFormat.format(minTemp) + "\u00B0F";
27     this.maxTemp = numberFormat.format(maxTemp) + "\u00B0F";
28     this.humidity =
29         NumberFormat.getPercentInstance().format(humidity / 100.0);
30     this.description = description;
31     this.iconURL =
32         "http://openweathermap.org/img/w/" + iconName + ".png";
33 }
34

```

**Fig. 7.7** | Weather class constructor.

### 7.5.3 Method convertTimeStampToDate

Utility method `convertTimeStampToDate` (Fig. 7.8) receives as its argument a long value representing the number of seconds since January 1, 1970 GMT—the standard way time is represented on Linux systems (Android is based on Linux). To perform the conversion:

- Line 37 gets a `Calendar` object for manipulating dates and times, then line 38 calls method `setTimeInMillis` to set the time using the `timestamp` argument. The `timestamp` is in seconds so we multiply by 1000 to convert it to milliseconds.
- Line 39 gets the default `TimeZone` object, which we use to adjust the time, based on the device's time zone (lines 42–43).
- Line 46 creates a `SimpleDateFormat` that formats a `Date` object. The constructor argument "`EEEE`" formats the `Date` as just the day name (Monday, Tuesday, etc.). For a complete list of formats, visit:

[http://developer.android.com/reference/java/text/  
SimpleDateFormat.html](http://developer.android.com/reference/java/text/SimpleDateFormat.html)

- Line 47 formats and returns the day name. `Calendar`'s `getTime` method returns a `Date` object containing the time. This `Date` is passed to the `SimpleDateFormat`'s `format` method to get the day name.

```

35 // convert timestamp to a day's name (e.g., Monday, Tuesday, ...)
36 private static String convertTimeStampToDate(long timeStamp) {
37     Calendar calendar = Calendar.getInstance(); // create Calendar
38     calendar.setTimeInMillis(timeStamp * 1000); // set time
39     TimeZone tz = TimeZone.getDefault(); // get device's time zone
40

```

**Fig. 7.8** | Weather method `convertTimeStampToDate`. (Part 1 of 2.)

---

```

41     // adjust time for device's time zone
42     calendar.add(Calendar.MILLISECOND,
43         tz.getOffset(calendar.getTimeInMillis()));
44
45     // SimpleDateFormat that returns the day's name
46     SimpleDateFormat dateFormatter = new SimpleDateFormat("EEEE");
47     return dateFormatter.format(calendar.getTime());
48 }
49 }
```

---

**Fig. 7.8** | Weather method convertTimeStampToDay. (Part 2 of 2.)

## 7.6 Class WeatherArrayAdapter

Class WeatherArrayAdapter defines a subclass of ArrayAdapter for binding an ArrayList<Weather> to the MainActivity’s ListView.

### 7.6.1 package Statement and import Statements

Figure 7.9 contains WeatherArrayAdapter’s package statement and import statements. We’ll discuss the imported types as we encounter them.

This app’s ListView items require a custom layout. Each item contains an image (the weather-condition icon) and text representing the day, weather description, low temperature, high temperature and humidity. To map weather data to ListView items, we extend class ArrayAdapter (line 23) so that we can override ArrayAdapter method getView to configure a custom layout for each ListView item.

---

```

1 // WeatherArrayAdapter.java
2 // An ArrayAdapter for displaying a List<Weather>'s elements in a ListView
3 package com.deitel.weatherviewer;
4
5 import android.content.Context;
6 import android.graphics.Bitmap;
7 import android.graphics.BitmapFactory;
8 import android.os.AsyncTask;
9 import android.view.LayoutInflater;
10 import android.view.View;
11 import android.view.ViewGroup;
12 import android.widget.ArrayAdapter;
13 import android.widget.ImageView;
14 import android.widget.TextView;
15
16 import java.io.InputStream;
17 import java.net.HttpURLConnection;
18 import java.net.URL;
19 import java.util.HashMap;
20 import java.util.List;
21 import java.util.Map;
22
23 class WeatherArrayAdapter extends ArrayAdapter<Weather> {
```

---

**Fig. 7.9** | WeatherArrayAdapter class package statement and import statements.

## 7.6.2 Nested Class ViewHolder

Nested class `ViewHolder` (Fig. 7.10) defines instance variables that class `WeatherArrayAdapter` accesses directly when manipulating `ViewHolder` objects. When a `ListView` item is created, we'll associate a new `ViewHolder` object with that item. If there's an existing `ListView` item that's being reused, we'll simply obtain that item's `ViewHolder` object.

---

```

24  // class for reusing views as list items scroll off and onto the screen
25  private static class ViewHolder {
26      ImageView conditionImageView;
27      TextView dayTextView;
28      TextView lowTextView;
29      TextView hiTextView;
30      TextView humidityTextView;
31  }
32

```

---

**Fig. 7.10** | Nested class `ViewHolder`.

## 7.6.3 Instance Variable and Constructor

Figure 7.11 defines class `WeatherArrayAdapter`'s instance variable and constructor. We use the instance variable `bitmaps` (line 34)—a `Map<String, Bitmap>`—to cache previously loaded weather-condition images, so they do not need to be re-downloaded as the user scrolls through the weather forecast. The cached images will remain in memory until Android terminates the app. The constructor (lines 37–39) simply calls the superclass's three-argument constructor, passing the `Context` (i.e., the activity in which the `ListView` is displayed) and the `List<Weather>` (the `List` of data to display) as the first and third arguments. The second superclass constructor argument represents a layout resource ID for a layout that contains a `TextView` in which a `ListView` item's data is displayed. The argument `-1` indicates that we use a custom layout in this app, so we can display more than just one `TextView`.

---

```

33  // stores already downloaded Bitmaps for reuse
34  private Map<String, Bitmap> bitmaps = new HashMap<>();
35
36  // constructor to initialize superclass inherited members
37  public WeatherArrayAdapter(Context context, List<Weather> forecast) {
38      super(context, -1, forecast);
39  }
40

```

---

**Fig. 7.11** | `WeatherArrayAdapter` class instance variable and constructor.

## 7.6.4 Overridden ArrayAdapter Method `getView`

Method `getView` (Fig. 7.12) is called to get the `View` that displays a `ListView` item's data. Overriding this method enables you to map data to a custom `ListView` item. The method receives the `ListView` item's position, the `View` (`convertView`) representing that `ListView` item and that `ListView` item's parent as arguments. By manipulating `convertView`, you can customize the `ListView` item's contents. Line 45 calls the inherited `ArrayAdapter` method `getItem` to get from the `List<Weather>` the `Weather` object that will be displayed.

Line 47 defines the `ViewHolder` variable that will be set to a new `ViewHolder` object or an existing one, depending on whether method `getView`'s `convertView` argument is `null`.

```
41 // creates the custom views for the ListView's items
42 @Override
43 public View getView(int position, View convertView, ViewGroup parent) {
44     // get Weather object for this specified ListView position
45     Weather day = getItem(position);
46
47     ViewHolder viewHolder; // object that references list item's views
48
49     // check for reusable ViewHolder from a ListView item that scrolled
50     // offscreen; otherwise, create a new ViewHolder
51     if (convertView == null) { // no reusable ViewHolder, so create one
52         viewHolder = new ViewHolder();
53         LayoutInflator inflater = LayoutInflator.from(getContext());
54         convertView =
55             inflater.inflate(R.layout.list_item, parent, false);
56         viewHolder.conditionImageView =
57             (ImageView) convertView.findViewById(R.id.conditionImageView);
58         viewHolder.dayTextView =
59             (TextView) convertView.findViewById(R.id.dayTextView);
60         viewHolder.lowTextView =
61             (TextView) convertView.findViewById(R.id.lowTextView);
62         viewHolder.hiTextView =
63             (TextView) convertView.findViewById(R.id.hiTextView);
64         viewHolder.humidityTextView =
65             (TextView) convertView.findViewById(R.id.humidityTextView);
66         convertView.setTag(viewHolder);
67     }
68     else { // reuse existing ViewHolder stored as the list item's tag
69         viewHolder = (ViewHolder) convertView.getTag();
70     }
71
72     // if weather condition icon already downloaded, use it;
73     // otherwise, download icon in a separate thread
74     if (bitmaps.containsKey(day.iconURL)) {
75         viewHolder.conditionImageView.setImageBitmap(
76             bitmaps.get(day.iconURL));
77     }
78     else {
79         // download and display weather condition image
80         new LoadImageTask(viewHolder.conditionImageView).execute(
81             day.iconURL);
82     }
83
84     // get other data from Weather object and place into views
85     Context context = getContext(); // for loading String resources
86     viewHolder.dayTextView.setText(context.getString(
87         R.string.day_description, day.dayOfWeek, day.description));
88     viewHolder.lowTextView.setText(
89         context.getString(R.string.low_temp, day.minTemp));
```

Fig. 7.12 | Overridden ArrayAdapter method `getView`. (Part 1 of 2.)

```

90     viewHolder.hiTextView.setText(
91         context.getString(R.string.high_temp, day.maxTemp));
92     viewHolder.humidityTextView.setText(
93         context.getString(R.string.humidity, day.humidity));
94
95     return convertView; // return completed List item to display
96 }
97

```

**Fig. 7.12** | Overridden ArrayAdapter method getView. (Part 2 of 2.)

If convertView is null, line 52 creates a new ViewHolder object to store references to a new ListView item's views. Next, line 53 gets the Context's LayoutInflater, which we use in lines 54–55 to inflate the ListView item's layout. The first argument is the layout to inflate (R.layout.list\_item), the second is the layout's parent ViewGroup to which the layout's views will be attached and the last argument is a boolean indicating whether the views should be attached automatically. In this case, the third argument is false, because the ListView calls method getView to obtain the item's View, then attaches it to the ListView. Lines 56–65 get references to the views in the newly inflated layout and set the ViewHolder's instance variables. Line 66 sets the new ViewHolder object as the ListView item's tag to store the ViewHolder with the ListView item for future use.

If convertView is not null, the ListView is reusing a ListView item that scrolled off the screen. In this case, line 69 gets the current ListView item's tag, which is the ViewHolder that was previously attached to that ListView item.

After creating or getting the ViewHolder, lines 74–93 set the data for the ListItem's views. Lines 74–82 determine if the weather-condition image was previously downloaded, in which case the bitmaps object will contain a key for the Weather object's iconURL. If so, lines 75–76 get the existing Bitmap from bitmaps and set the conditionImageView's image. Otherwise, lines 80–81 create a new LoadImageTask (Section 7.6.5) to download the image in a separate thread. The task's execute method receives the iconURL and initiates the task. Lines 86–93 set the Strings for the ListView item's TextViews. Finally, line 95 returns the ListView item's configured View.



### Software Engineering Observation 7.1

*Every time an AsyncTask is required, you must create a new object of your AsyncTask type—each AsyncTask can be executed only once.*

## 7.6.5 AsyncTask Subclass for Downloading Images in a Separate Thread

Nested class LoadImageTask (Fig. 7.13) extends class AsyncTask and defines how to download a weather-condition image in a separate thread, then return the image to the GUI thread for display in the ListView item's ImageView.

```

98     // AsyncTask to load weather condition icons in a separate thread
99     private class LoadImageTask extends AsyncTask<String, Void, Bitmap> {
100         private ImageView imageView; // displays the thumbnail

```

**Fig. 7.13** | AsyncTask subclass for downloading images in a separate thread. (Part I of 2.)

```
101 // store ImageView on which to set the downloaded Bitmap
102 public LoadImageTask(ImageView imageView) {
103     this.imageView = imageView;
104 }
105
106 // load image; params[0] is the String URL representing the image
107 @Override
108 protected Bitmap doInBackground(String... params) {
109     Bitmap bitmap = null;
110     HttpURLConnection connection = null;
111
112     try {
113         URL url = new URL(params[0]); // create URL for image
114
115         // open an HttpURLConnection, get its InputStream
116         // and download the image
117         connection = (HttpURLConnection) url.openConnection();
118
119         try (InputStream inputStream = connection.getInputStream()) {
120             bitmap = BitmapFactory.decodeStream(inputStream);
121             bitmaps.put(params[0], bitmap); // cache for later use
122         }
123         catch (Exception e) {
124             e.printStackTrace();
125         }
126     }
127     catch (Exception e) {
128         e.printStackTrace();
129     }
130     finally {
131         connection.disconnect(); // close the HttpURLConnection
132     }
133
134     return bitmap;
135 }
136
137 // set weather condition image in list item
138 @Override
139 protected void onPostExecute(Bitmap bitmap) {
140     imageView.setImageBitmap(bitmap);
141 }
142
143 }
144 }
```

---

**Fig. 7.13** | AsyncTask subclass for downloading images in a separate thread. (Part 2 of 2.)

AsyncTask is a generic type that requires three type parameters:

- The first is the variable-length parameter-list type (`String`) for AsyncTask’s `doInBackground` method, which you *must* overload (lines 108–136). When you call the task’s `execute` method, it creates a thread in which `doInBackground` performs the task. This app passes the weather-condition icon’s URL `String` as the argument to the AsyncTask’s `execute` method (Fig. 7.12, lines 80–81).

- The second is the variable-length parameter-list type for the `AsyncTask`'s `onProgressUpdate` method. This method executes in the GUI thread and is used to receive *intermediate updates* of the specified type from a long-running task. Overriding this method is optional. We don't use it in this example, so we specify type `Void` here and ignore this type parameter.
- The third is the type of the task's result (`Bitmap`), which is passed to `AsyncTask`'s `onPostExecute` method (139–143). This method executes in the GUI thread and enables the `ListView` item's `ImageView` to display the `AsyncTask`'s results. The `ImageView` to update is specified as an argument to class `LoadImageTask`'s constructor (lines 103–105) and stored in the instance variable at line 100.

A key benefit of using an `AsyncTask` is that it handles the details of creating threads and executing its methods on the appropriate threads for you, so that you do not have to interact with the threading mechanism directly.

### *Downloading the Weather-Condition Image*

Method `doInBackground` uses an `HttpURLConnection` to download the weather-condition image. Line 114 converts the URL String that was passed to the `AsyncTask`'s `execute` method (`params[0]`) into a `URL` object. Next, line 118 calls class `URL`'s method `openConnection` to get an `HttpURLConnection`—the cast is required, because the method returns a `URLConnection`. Method `openConnection` requests the content specified by `URL`. Line 120 gets the `HttpURLConnection`'s `InputStream`, which we pass to `BitmapFactory` method `decodeStream` to read the image's bytes and return a `Bitmap` object containing the image (line 121). Line 122 caches the downloaded image in the `bitmaps` `Map` for potential reuse and line 132 calls `HttpURLConnection`'s inherited method `disconnect` to close the connection and release its resources. Line 135 returns the downloaded `Bitmap`, which is then passed to `onPostExecute`—in the GUI thread—to display the image.

## 7.7 Class MainActivity

Class `MainActivity` defines the app's user interface, the logic for interacting with the `OpenWeatherMap.org` daily forecast web service and the logic for processing the JSON response from the web service. The nested `AsyncTask` subclass `GetWeatherTask` performs the web service request in a separate thread (Section 7.7.5). `MainActivity` does not require a menu in this app, so we removed the methods `onCreateOptionsMenu` and `onOptionsItemSelected` from the autogenerated code.

### 7.7.1 package Statement and import Statements

Figure 7.14 contains `MainActivity`'s package statement and `import` statements. We'll discuss the imported types as we encounter them.

---

```

1 // MainActivity.java
2 // Displays a 16-dayOfWeek weather forecast for the specified city
3 package com.deitel.weatherviewer;
```

---

**Fig. 7.14** | Class `MainActivity`'s package statement and `import` statements. (Part 1 of 2.)

```
4 import android.content.Context;
5 import android.os.AsyncTask;
6 import android.os.Bundle;
7 import android.support.design.widget.FloatingActionButton;
8 import android.support.design.widget.Snackbar;
9 import android.support.v7.app.AppCompatActivity;
10 import android.support.v7.widget.Toolbar;
11 import android.view.View;
12 import android.view.inputmethod.InputMethodManager;
13 import android.widget.EditText;
14 import android.widget.ListView;
15
16
17 import org.json.JSONArray;
18 import org.json.JSONException;
19 import org.json.JSONObject;
20
21 import java.io.BufferedReader;
22 import java.io.IOException;
23 import java.io.InputStreamReader;
24 import java.net.HttpURLConnection;
25 import java.net.URL;
26 import java.net.URLEncoder;
27 import java.util.ArrayList;
28 import java.util.List;
29
```

**Fig. 7.14** | Class MainActivity's package statement and import statements. (Part 2 of 2.)

---

## 7.7.2 Instance Variables

Class MainActivity (Fig. 7.15) extends class AppCompatActivity and defines three instance variables:

- weatherList (line 32) is an ArrayList<Weather> that stores the Weather objects—each represents one day in the daily forecast.
- weatherArrayAdapter will refer to a WeatherArrayAdapter object (Section 7.6) that binds the weatherList to the ListView's items.
- weatherListView will refer to MainActivity's ListView.

---

```
30 public class MainActivity extends AppCompatActivity {
31     // List of Weather objects representing the forecast
32     private List<Weather> weatherList = new ArrayList<>();
33
34     // ArrayAdapter for binding Weather objects to a ListView
35     private WeatherArrayAdapter weatherArrayAdapter;
36     private ListView weatherListView; // displays weather info
37
```

**Fig. 7.15** | Class MainActivity's instance variables.

---

### 7.7.3 Overridden Activity Method onCreate

Overridden method `onCreate` (Fig. 7.15) configures `MainActivity`'s GUI. Lines 41–45 were generated by Android Studio when you chose the **Blank Activity** template while creating this project. These lines inflate the GUI, create the app's Toolbar and attach the Toolbar to the activity. Recall that an `AppCompatActivity` must provide its own Toolbar, because app bars (formerly called action bars) are not supported in early versions of Android.

Lines 48–50 configure the `weatherListView`'s `ListAdapter`—in this case, an object of the `WeatherArrayAdapter` subclass of  `ArrayAdapter`. `ListView` method `setAdapter` connects the `WeatherArrayAdapter` to the `ListView` for populating the `ListView`'s items.

```

38     // configure Toolbar, ListView and FAB
39     @Override
40     protected void onCreate(Bundle savedInstanceState) {
41         super.onCreate(savedInstanceState);
42         // autogenerated code to inflate layout and configure Toolbar
43         setContentView(R.layout.activity_main);
44         Toolbar toolbar = (Toolbar) findViewById(R.id.toolbar);
45         setSupportActionBar(toolbar);
46
47         // create ArrayAdapter to bind weatherList to the weatherListView
48         weatherListView = (ListView) findViewById(R.id.weatherListView);
49         weatherArrayAdapter = new WeatherArrayAdapter(this, weatherList);
50         weatherListView.setAdapter(weatherArrayAdapter);
51
52         // configure FAB to hide keyboard and initiate web service request
53         FloatingActionButton fab =
54             (FloatingActionButton) findViewById(R.id.fab);
55         fab.setOnClickListener(new View.OnClickListener() {
56             @Override
57             public void onClick(View view) {
58                 // get text from locationEditText and create web service URL
59                 EditText locationEditText =
60                     (EditText) findViewById(R.id.locationEditText);
61                 URL url = createURL(locationEditText.getText().toString());
62
63                 // hide keyboard and initiate a GetWeatherTask to download
64                 // weather data from OpenWeatherMap.org in a separate thread
65                 if (url != null) {
66                     dismissKeyboard(locationEditText);
67                     GetWeatherTask getLocalWeatherTask = new GetWeatherTask();
68                     getLocalWeatherTask.execute(url);
69                 }
70                 else {
71                     Snackbar.make(findViewById(R.id.coordinatorLayout),
72                         R.string.invalid_url, Snackbar.LENGTH_LONG).show();
73                 }
74             }
75         });
76     }
77 }
```

**Fig. 7.16** | Overridden Activity method `onCreate`.

Lines 53–75 configure the `FloatingActionButton` from the `Blank Activity` template. The `onClick` listener method was autogenerated by Android Studio, but we reimplemented its body for this app. We get a reference to the app's `EditText` then use it in line 61 to get the user's input. We pass that to method `createUrl` (Section 7.7.4) to create the URL representing the web service request that will return the city's weather forecast.

If the URL is created successfully, line 66 programmatically hides the keyboard by calling method `dismissKeyboard` (Section 7.7.4). Line 67 then creates a new `GetWeatherTask` to obtain the weather forecast in a separate thread and line 68 executes the task, passing the URL of the web service request as an argument to `AsyncTask` method `execute`. If the URL is not created successfully, lines 71–72 create a `Snackbar` indicating that the URL was invalid.

#### 7.7.4 Methods `dismissKeyboard` and `createUrl`

Figure 7.17 contains `MainActivity` methods `dismissKeyboard` and `createUrl`. Method `dismissKeyboard` (lines 79–83) is called to hide the soft keyboard when the user touches the `FloatingActionButton` to submit a city to the app. Android provides a service for managing the keyboard programmatically. You can obtain a reference to this service (and many other Android services) by calling the inherited `Context` method `getSystemService` with the appropriate constant—`Context.INPUT_METHOD_SERVICE` in this case. This method can return objects of many different types, so you must cast its return value to the appropriate type—`InputMethodManager` (package `android.view.inputmethod`). To dismiss the keyboard, call `InputMethodManager` method `hideSoftInputFromWindow` (line 82).

---

```

78     // programmatically dismiss keyboard when user touches FAB
79     private void dismissKeyboard(View view) {
80         InputMethodManager imm = (InputMethodManager) getSystemService(
81             Context.INPUT_METHOD_SERVICE);
82         imm.hideSoftInputFromWindow(view.getWindowToken(), 0);
83     }
84
85     // create openweathermap.org web service URL using city
86     private URL createURL(String city) {
87         String apiKey = getString(R.string.api_key);
88         String baseUrl = getString(R.string.web_service_url);
89
90         try {
91             // create URL for specified city and imperial units (Fahrenheit)
92             String urlString = baseUrl + URLEncoder.encode(city, "UTF-8") +
93                 "&units=imperial&cnt=16&APPID=" + apiKey;
94             return new URL(urlString);
95         }
96         catch (Exception e) {
97             e.printStackTrace();
98         }
99
100        return null; // URL was malformed
101    }
102

```

---

**Fig. 7.17** | `MainActivity` methods `dismissKeyboard` and `createUrl`.

Method `createUrl` (lines 86–101) assembles the `String` representation of the URL for the web service request (lines 92–93). Then line 94 attempts to create and return a `URL` object initialized with the `URL String`. In line 93, we add parameters to the web service query

```
&units=imperial&cnt=16&APPID=
```

The `units` parameter can be `imperial` (for Fahrenheit temperatures), `metric` (for Celsius) or `standard` (for Kelvin)—`standard` is the default if you do not include the `units` parameter. The `cnt` parameter specifies how many days should be included in the forecast. The maximum is 16 and the default is 7—providing an invalid number of days results in a seven-day forecast. Finally the `APPID` parameter is for your `OpenWeatherMap.org` API key, which we load into the app from the `String` resource `api_key`. By default, the forecast is returned in JSON format, but you can add the `mode` parameter with the value `XML` or `HTML`, to receive XML formatted data or a web page, respectively.

## 7.7.5 AsyncTask Subclass for Invoking a Web Service

Nested `AsyncTask` subclass `GetWeatherTask` (Fig. 7.18) performs the web service request and processes the response in a separate thread, then passes the forecast information as a `JSONObject` to the GUI thread for display.

---

```

103    // makes the REST web service call to get weather data and
104    // saves the data to a local HTML file
105    private class GetWeatherTask
106        extends AsyncTask<URL, Void, JSONObject> {
107
108        @Override
109        protected JSONObject doInBackground(URL... params) {
110            HttpURLConnection connection = null;
111
112            try {
113                connection = (HttpURLConnection) params[0].openConnection();
114                int response = connection.getResponseCode();
115
116                if (response == HttpURLConnection.HTTP_OK) {
117                    StringBuilder builder = new StringBuilder();
118
119                    try (BufferedReader reader = new BufferedReader(
120                        new InputStreamReader(connection.getInputStream()))) {
121
122                        String line;
123
124                        while ((line = reader.readLine()) != null) {
125                            builder.append(line);
126                        }
127                    }
128                    catch (IOException e) {
129                        Snackbar.make(findViewById(R.id.coordinatorLayout),
130                            R.string.read_error, Snackbar.LENGTH_LONG).show();
131                        e.printStackTrace();
132                    }
133                }
134            }
135        }
136    }

```

---

**Fig. 7.18** | `AsyncTask` subclass for invoking a web service. (Part I of 2.)

```
133             return new JSONObject(builder.toString());
134         }
135     }
136     else {
137         Snackbar.make(findViewById(R.id.coordinatorLayout),
138             R.string.connect_error, Snackbar.LENGTH_LONG).show();
139     }
140 }
141 catch (Exception e) {
142     Snackbar.make(findViewById(R.id.coordinatorLayout),
143             R.string.connect_error, Snackbar.LENGTH_LONG).show();
144     e.printStackTrace();
145 }
146 finally {
147     connection.disconnect(); // close the HttpURLConnection
148 }
149
150     return null;
151 }
152
153 // process JSON response and update ListView
154 @Override
155 protected void onPostExecute(JSONObject weather) {
156     convertJSONArrayToList(weather); // repopulate weatherList
157     weatherListAdapter.notifyDataSetChanged(); // rebind to ListView
158     weatherListView.smoothScrollToPosition(0); // scroll to top
159 }
160 }
161 }
```

---

**Fig. 7.18** | AsyncTask subclass for invoking a web service. (Part 2 of 2.)

For class `GetWeatherTask` the three generic type parameters are:

- URL for the variable-length parameter-list type of `AsyncTask`'s `doInBackground` method (lines 108–51)—the URL of the web service request is passed as the only argument to the `GetWeatherTask`'s `execute` method.
- Void for the variable-length parameter-list type for the `onProgressUpdate` method—once again, we do not use this method.
- `JSONObject` for the type of the task's result, which is passed to `onPostExecute` (154–159) in the GUI thread to display the results.

Line 113 in `doInBackground` creates the `HttpURLConnection` that's used to invoke the REST web service. As in Section 7.6.5, simply opening the connection makes the request. Line 114 gets the response code from the web server. If the response code is `HttpURLConnection.HTTP_OK`, the REST web service was invoked properly and there is a response to process. In this case, lines 119–126 get the `HttpURLConnection`'s `InputStream`, wrap it in a `BufferedReader`, read each line of text from the response and append it to a `StringBuilder`. Then, line 134 converts the JSON String in the `StringBuilder` to a `JSONObject` and return it to the GUI thread. Line 147 disconnects the `HttpURLConnection`.

If there's an error reading the weather data or connecting to the web service, lines 129–130, 137–138 or 142–143 display a `Snackbar` indicating the problem that occurred.

These problems might occur if the device loses its network access in the middle of a request or if the device does not have network access in the first place—for example, if the device is in airplane mode.

When `onPostExecute` is called in the GUI thread, line 156 calls method `convertJSONArrayToList` (Section 7.7.6) to extract the weather data from the `JSONObject` and place it in the `weatherList`. Then line 157 calls the `ArrayAdapter`'s `notifyDataSetChanged` method, which causes the `weatherListView` to update itself with the new data. Line 158 calls `ListView` method `smoothScrollToPosition` to reposition the `ListView`'s first item to the top of the `ListView`—this ensures that the new weather forecast's first day is shown at the top.

### 7.7.6 Method `convertJSONArrayToList`

In Section 7.3.2, we discussed the JSON returned by the `OpenWeatherMap.org` daily weather forecast web service. Method `convertJSONArrayToList` (Fig. 7.19) extracts this weather data from its `JSONObject` argument. First, line 164 clears the `weatherList` of any existing `Weather` objects. Processing JSON data in a `JSONObject` or `JSONArray` can result in `JSONExceptions`, so lines 168–188 are placed in a `try` block.

---

```

162    // create Weather objects from JSONObject containing the forecast
163    private void convertJSONArrayToList(JSONObject forecast) {
164        weatherList.clear(); // clear old weather data
165
166        try {
167            // get forecast's "list" JSONArray
168            JSONArray list = forecast.getJSONArray("list");
169
170            // convert each element of list to a Weather object
171            for (int i = 0; i < list.length(); ++i) {
172                JSONObject day = list.getJSONObject(i); // get one day's data
173
174                // get the day's temperatures ("temp") JSONObject
175                JSONObject temperatures = day.getJSONObject("temp");
176
177                // get day's "weather" JSONArray for the description and icon
178                JSONObject weather =
179                    day.getJSONArray("weather").getJSONObject(0);
180
181                // add new Weather object to weatherList
182                weatherList.add(new Weather(
183                    day.getLong("dt"), // date/time timestamp
184                    temperatures.getDouble("min"), // minimum temperature
185                    temperatures.getDouble("max"), // maximum temperature
186                    day.getDouble("humidity"), // percent humidity
187                    weather.getString("description"), // weather conditions
188                    weather.getString("icon"))); // icon name
189            }
190        }

```

---

**Fig. 7.19** | `MainActivity` method `convertJSONArrayToList`. (Part I of 2.)

---

```

191     catch (JSONException e) {
192         e.printStackTrace();
193     }
194 }
195 }
```

**Fig. 7.19** | MainActivity method convertJSONArraytoArrayList. (Part 2 of 2.)

Line 168 obtains the "list" JSONArray by calling JSONObject method **getJSONArray** with the name of the array property as an argument. Next, lines 171–189 create a Weather object for every element in the JSONArray. JSONArray method **length** returns the array's number of elements (line 171).

Next, line 172 gets a JSONObject representing one day's forecast from the JSONArray by calling method **getJSONObject**, which receives an index as its argument. Line 175 gets the "temp" JSON object, which contains the day's temperature data. Lines 178–179 get the "weather" JSON array, then get the array's first element which contains the day's weather description and icon.

Lines 182–188 create a Weather object and add it to the **weatherList**. Line 183 uses JSONObject method **getLong** to get the day's timestamp ("dt"), which the Weather constructor converts to the day name. Lines 184–186 call JSONObject method **getDouble** to get the minimum ("min") and maximum ("max") temperatures from the temperatures object and the "humidity" percentage from the day object. Finally, lines 187–188 use **getString** to get the weather description and the weather-condition icon Strings from the weather object.

## 7.8 Wrap-Up

In this chapter, you built the **WeatherViewer** app. The app obtained a city's 16-day weather forecast from web services provided by [OpenWeatherMap.org](#) and displayed the forecast in a **ListView**. We discussed the architectural style for implementing web services known as Representational State Transfer (REST). You learned that apps use web standards, such as HyperText Transfer Protocol (HTTP), to invoke RESTful web services and receive their responses.

The [OpenWeatherMap.org](#) web service used in this app returned the forecast as a **String** in JavaScript Object Notation (JSON) format. You learned that JSON is a text-based format in which objects are represented as collections of name/value pairs. You used the classes **JSONObject** and **JSONArray** from the **org.json** package to process the JSON data.

To invoke the web service, you converted the web service's URL **String** into a URL object. You then used the URL to open an **HttpURLConnection** that invoked the web service via an HTTP request. The app read all the data from the **HttpURLConnection**'s **InputStream** and placed it in a **String**, then converted that **String** to a **JSONObject** for processing. We demonstrated how to perform long-running operations outside the GUI thread and receive their results in the GUI thread by using **AsyncTask** objects. This is particularly important for web-service requests, which have indeterminate response times.

You displayed the weather data in a **ListView**, using a subclass of **ArrayAdapter** to supply the data for each **ListView** item. We showed how to improve a **ListView**'s perfor-

mance via the view-holder pattern by reusing existing `ListView` items' views as the items scroll off the screen.

Finally, you used several material-design features from the Android Design Support Library's—a `TextInputLayout` to keep an `EditText`'s hint on the screen even after the user began entering text, a `FloatingActionButton` to enable the user to submit input and a `Snackbar` to display an informational message to the user.

In Chapter 8, we build the **Twitter® Searches** app. Many mobile apps display lists of items, just as we did in this app. In Chapter 8, you'll do this by using a `RecyclerView` that obtains data from an `ArrayList<String>`. For large data sets, `RecyclerView` is more efficient than `ListView`. You'll also store app data as user preferences and learn how to launch the device's web browser to display a web page.

# 8

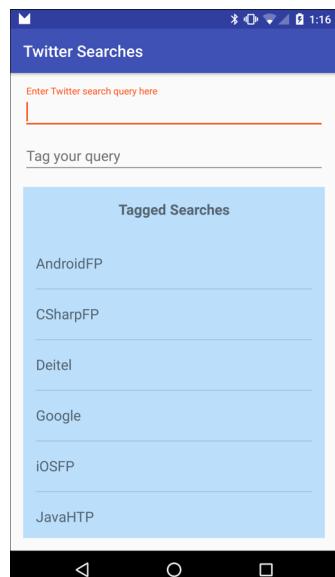
# Twitter® Searches App

SharedPreferences, SharedPreferences.Editor,  
Implicit Intents, Intent Choosers, RecyclerView,  
RecyclerView.Adapter, RecyclerView.ViewHolder,  
RecyclerView.ItemDecoration

## Objectives

In this chapter you'll:

- Use **SharedPreferences** to store key–value pairs of data associated with an app.
- Use an implicit **Intent** to open a website in a browser.
- Use an implicit **Intent** to display an intent chooser containing a list of apps that can share text.
- Display a scrolling list of items in a **RecyclerView**.
- Use a subclass of **RecyclerView.Adapter** to specify a **RecyclerView**'s data.
- Use a subclass of **RecyclerView.ViewHolder** to implement the view-holder pattern for a **RecyclerView**.
- Use a subclass of **RecyclerView.ItemDecoration** to display lines between a **RecyclerView**'s items.
- Use an **AlertDialog.Builder** object to create an **AlertDialog** that displays a list of options.



**Outline**

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| <b>8.2</b> Test-Driving the App                             | 8.5.1 package and import Statements   |
| 8.2.1 Adding a Favorite Search                              | 8.5.2 MainActivity Fields   |
| 8.2.2 Viewing Twitter Search Results                        | 8.5.3 Overridden Activity Method<br>onCreate  |
| 8.2.3 Editing a Search                                      | 8.5.4 TextWatcher Event Handler and<br>Method updateSaveFAB   |
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| 8.4.11 RecyclerView Item's Layout:<br>list_item.xml         |   |

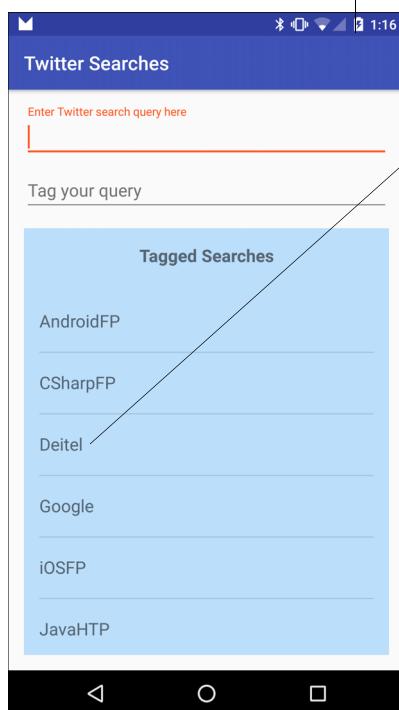
## 8.1 Introduction

Twitter's search mechanism makes it easy to follow trending topics being discussed by Twitter's 300+ million active monthly users<sup>1</sup> (there are over one billion total Twitter accounts<sup>2</sup>). Searches can be fine-tuned using Twitter's *search operators* (Section 8.2), often resulting in lengthy search strings that are time consuming and cumbersome to enter on a mobile device. The Twitter® Searches app (Fig. 8.1) allows you to save your favorite search queries with easy-to-remember short tag names (Fig. 8.1(a)) that are displayed as a scrollable list. You can then scroll through your saved searches and simply touch a tag name to quickly view tweets on a given topic (Fig. 8.1(b)). As you'll see, the app also allows you to *share*, *edit* and *delete* saved searches.

1. <https://about.twitter.com/company>.

2. <http://www.businessinsider.com/twitter-monthly-active-users-2015-7?r=UK&IR=T>.

a) App with several saved searches



Touch a tag to perform the corresponding search, or touch a tag and hold your finger in position (known as a long press) to see an *AlertDialog* with options to share, edit or delete the search

Search query that was submitted to Twitter—partially cut off here due to the length of the query and the size of the font Twitter uses to display the query

b) App after the user touches "Deitel"

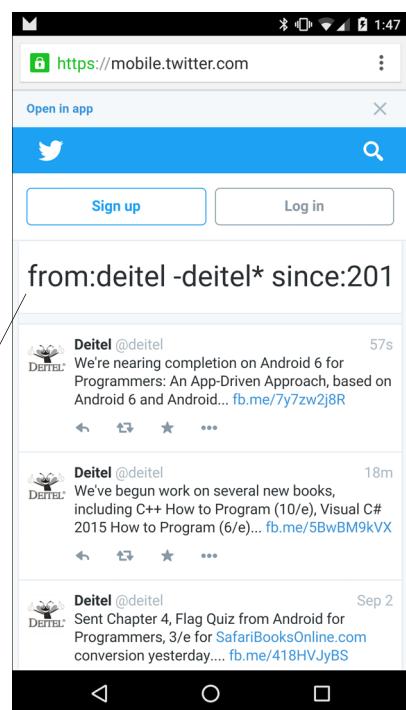


Fig. 8.1 | Twitter Searches app.

The app supports both portrait and landscape orientations. In the **Flag Quiz** app, you did this by providing separate layouts for each orientation. In the **Doodlz** app, you did this by programmatically setting the orientation. In this app, we support both orientations by designing a GUI that *dynamically* adjusts, based on the current orientation.

First, you'll test-drive the app. Then we'll overview the technologies we used to build it. Next, we'll design the app's GUI. Finally, we'll walk through the app's complete source code, discussing the new features in more detail.

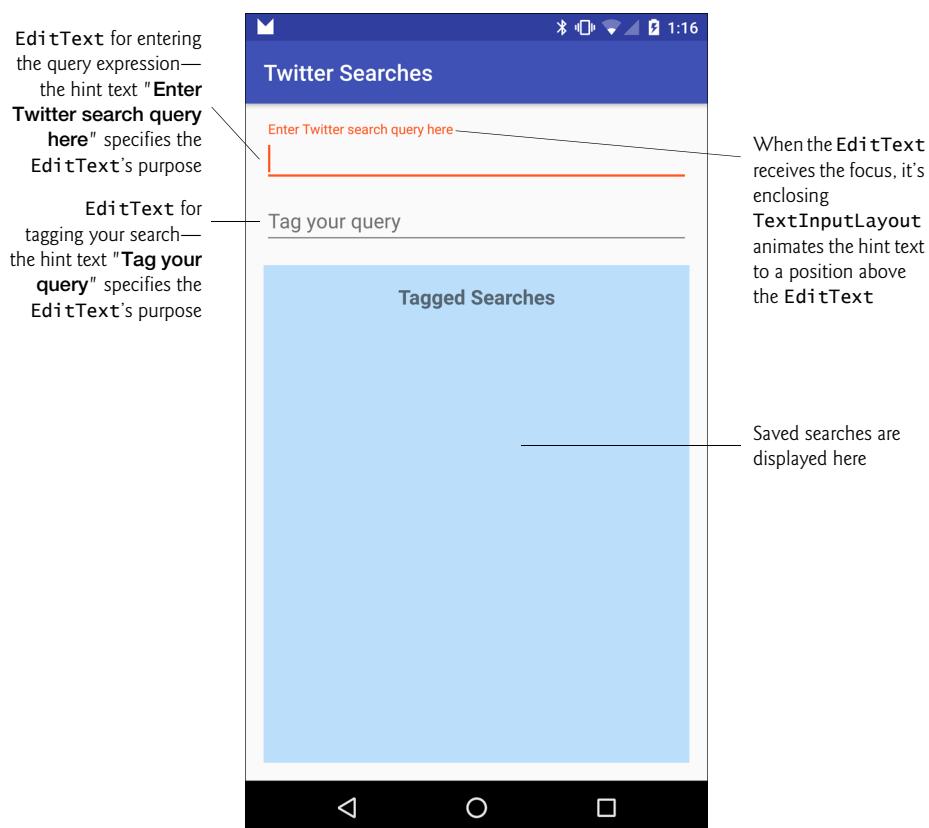
## 8.2 Test-Driving the App

### *Opening and Running the App*

Open Android Studio and open the **Twitter Searches** app from the **TwitterSearches** folder in the book's examples folder, then execute the app in the AVD or on a device. This builds the project and runs the app (Fig. 8.2).

#### 8.2.1 Adding a Favorite Search

Touch the top **EditText**, then enter `from:deitel` as the search query—the `from:` operator locates tweets from a specified Twitter account. Figure 8.3 shows several Twitter search



**Fig. 8.2** | Twitter Searches app when it first executes.

operators—multiple operators can be used to construct more complex queries. A complete list can be found at

<http://bit.ly/TwitterSearchOperators>

| Example           | Finds tweets containing  |
|-------------------|--|
| google android    | Implicit <i>logical and</i> operator—Finds tweets containing <i>google and android</i> . |
| google OR android | Logical OR operator—Finds tweets containing <i>google or android or both</i> .           |
| "how to program"  | String in quotes("")—Finds tweets containing <i>"how to program"</i> .                   |
| android ?         | ? (question mark)—Finds tweets asking questions about android.                           |
| google -android   | - (minus sign)—Finds tweets containing <i>google</i> but not <i>android</i> .            |
| android :)        | :) (happy face)—Finds <i>positive attitude</i> tweets containing android.                |
| android :(        | :( (sad face)—Finds <i>negative attitude</i> tweets containing android.                  |

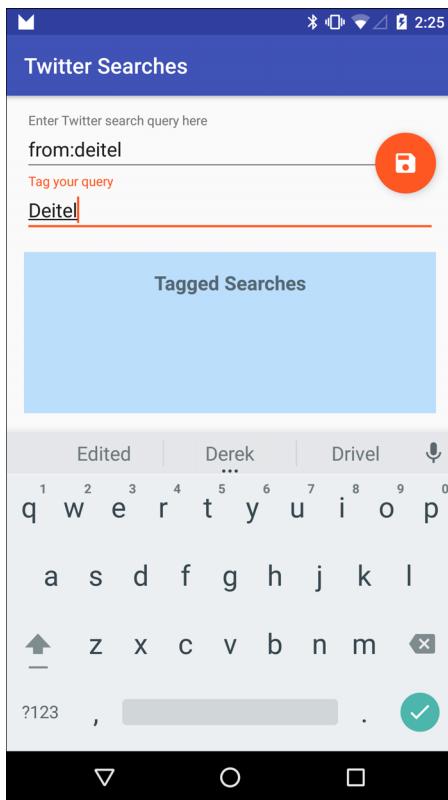
**Fig. 8.3** | Some Twitter search operators. (Part I of 2.)

| Example              | Finds tweets containing   |
|----------------------|---|
| since:2013-10-01     | Finds tweets that occurred <i>on or after</i> the specified date, which must be in the form YYYY-MM-DD. |
| near:"New York City" | Finds tweets that were sent near "New York City".   |
| from:GoogleCode      | Finds tweets from the Twitter account @GoogleCode.  |
| to:GoogleCode        | Finds tweets to the Twitter account @GoogleCode.  |

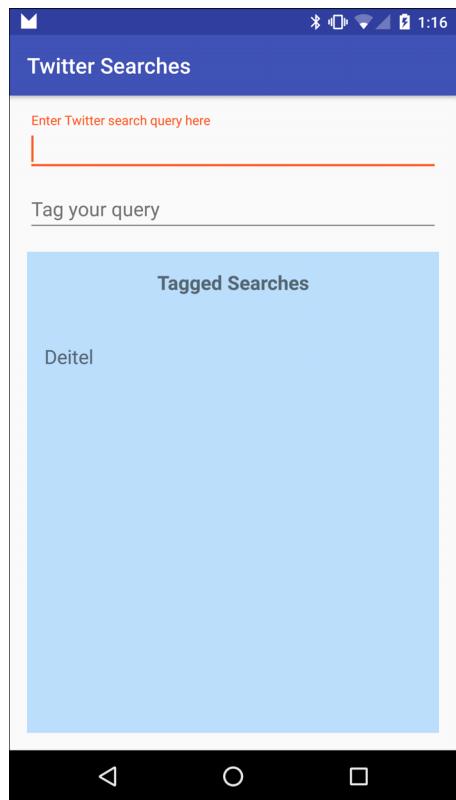
**Fig. 8.3** | Some Twitter search operators. (Part 2 of 2.)

In the bottom `EditText` enter `Deitel` as the tag for the search query (Fig. 8.4(a)). This will be the *short name* displayed in a list in the app's **Tagged Searches** section. Touch the *save* button () to save the search—the tag “Deitel” appears in the list under the **Tagged Searches** heading (Fig. 8.4(b)). When you save a search, the soft keyboard is dismissed so that you can see your list of saved searches (Section 8.5.5).

a) Entering a Twitter search and search tag



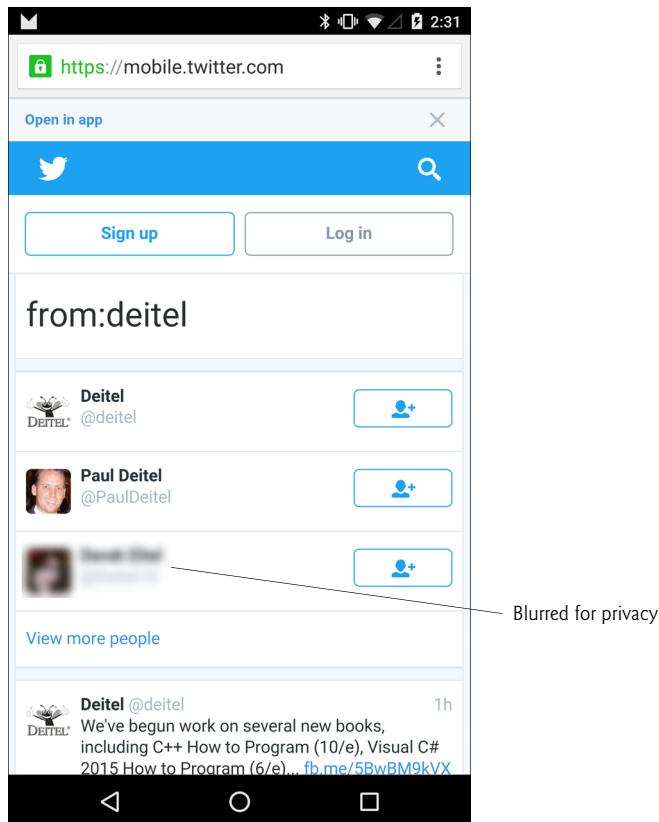
b) App after saving the search and search tag



**Fig. 8.4** | Entering a Twitter search.

### 8.2.2 Viewing Twitter Search Results

To view the search results, touch the tag “**Deitel**.” This launches the device’s web browser and passes a URL that represents the saved search to the Twitter website. Twitter obtains the search query from the URL, then returns the tweets that match the query (if any) as a web page. The web browser then displays the results page (Fig. 8.5). When you’re done viewing the results, touch the back button ( ) to return to the **Twitter Searches** app where you can save more searches, and edit, delete and share previously saved searches. For the “from:deitel” query, Twitter shows relevant user accounts containing **deitel** in the account name and recent tweets from those accounts.

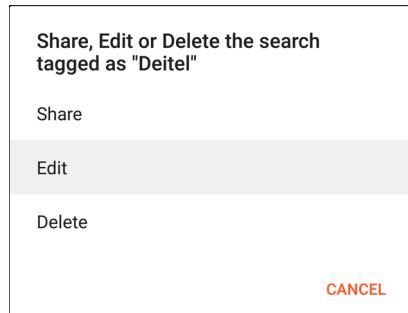


**Fig. 8.5** | Viewing search results for `from:deitel`—we blurred one Twitter account for privacy.

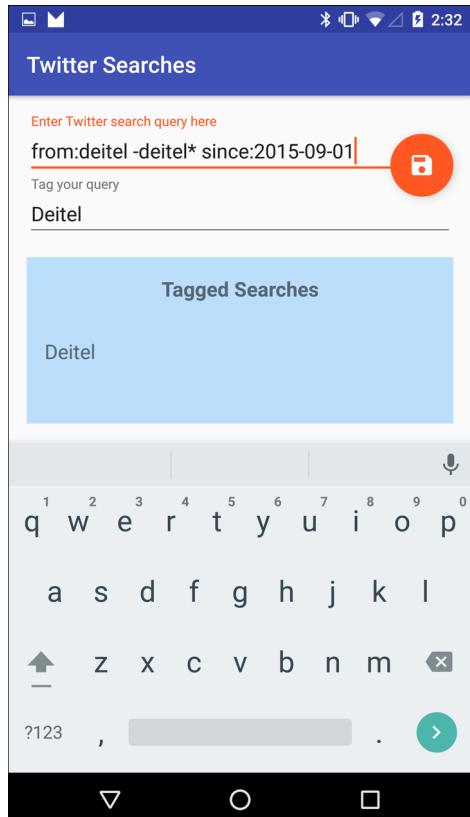
### 8.2.3 Editing a Search

You may also *share*, *edit* or *delete* a search. To see these options, *long press* the search’s tag—that is, touch the tag and keep your finger on the screen until the dialog containing **Share**, **Edit** and **Delete** options appears. If you’re using an AVD, click and hold the left mouse button on the search tag to perform a long press. When you long press “**Deitel**,” the Alert-

Dialog in Fig. 8.6(a) displays the **Share**, **Edit** and **Delete** options for the search tagged as "Deitel." If you don't wish to perform any of these tasks, touch **CANCEL**.

a) Selecting **Edit** to edit an existing search

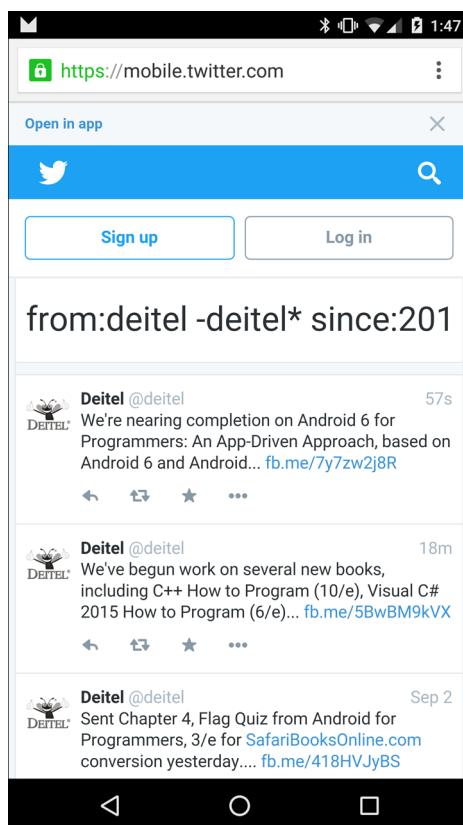
b) Editing the "Deitel" saved search

**Fig. 8.6** | Editing a saved search.

To edit the search tagged as "Deitel," touch the dialog's **Edit** option. The app then loads the search's query and tag into the `EditText`s for editing. Let's restrict our search to tweets only from the account @deitel since September 1, 2015. Add a space then

```
-deitel* since:2015-06-01
```

to the end of the query (Fig. 8.6(b)) in the top `EditText`. The `-deitel*` deletes from the results tweets from accounts that begin with "deitel" but followed by other characters. The `since:` operator restricts the search results to tweets that occurred *on or after* the specified date (in the form `yyyy-mm-dd`). Touch the *save* button ( ) to update the saved search, then view the updated results (Fig. 8.7) by touching **Deitel** in the **Tagged Searches** section of the app. [Note: Changing the tag name will create a *new* search, which is useful if you want to create a new query that's based on a previously saved query.]

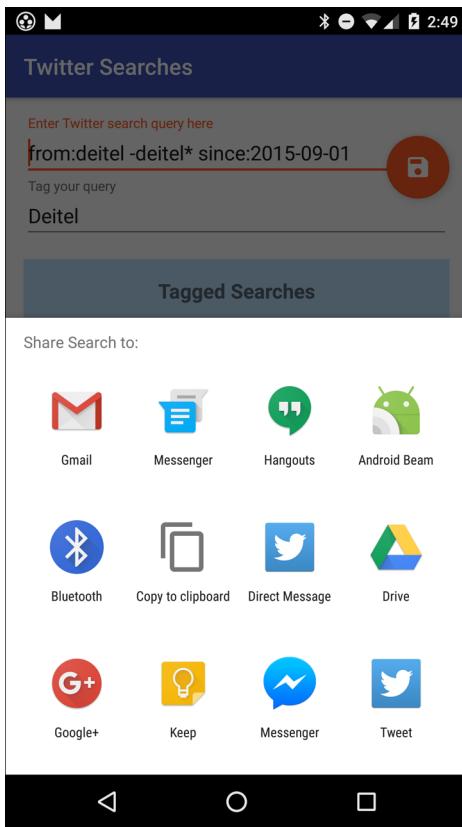
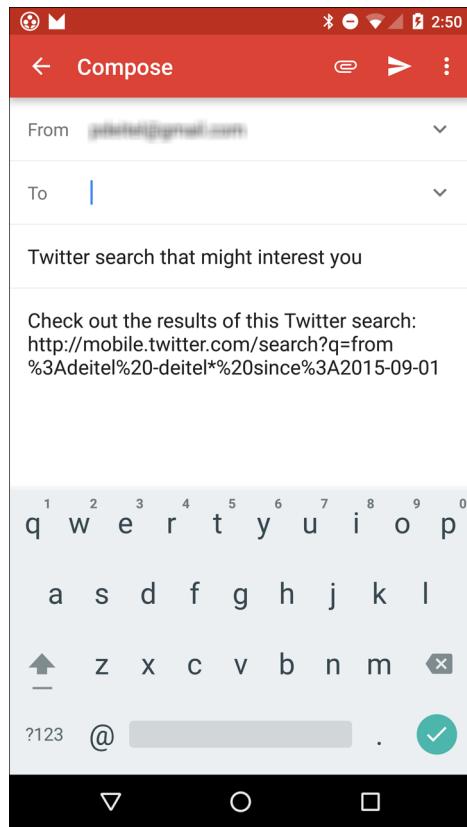


**Fig. 8.7** | Viewing the updated “Deitel” search results.

#### 8.2.4 Sharing a Search

Android makes it easy for you to share various types of information from an app via e-mail, instant messaging (SMS), Facebook, Google+, Twitter and more. In this app, you can share a favorite search by *long pressing* the search’s tag and selecting **Share** from the Alert-Dialo gthat appears. This displays a so-called **intent chooser** (Fig. 8.8(a)), which can vary, based on the type of content you’re sharing and the apps that can handle that content. In this app we’re sharing text, and the intent chooser on our phone shows many apps capable of handling text. If no apps can handle the content, the intent chooser will display a message saying so. If only one app can handle the content, that app will launch without you having to select which app to use from the intent chooser. For this test-drive, we touched **Gmail**. Figure 8.8(b) shows the **Gmail** app’s **Compose** screen with the from address, e-mail subject and body pre-populated. We blurred the **From** email address for privacy in the screen capture.

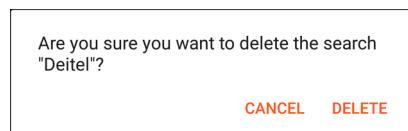
a) Intent chooser showing share options

b) Gmail app **Compose** screen for an e-mail containing the "Deitel" search

**Fig. 8.8** | Sharing a search via e-mail—the Gmail **Compose** window shows your email address by default (blurred for privacy here), positions the cursor in the **To** field so you can enter the recipient's email address and prepopulates the email's subject and content.

### 8.2.5 Deleting a Search

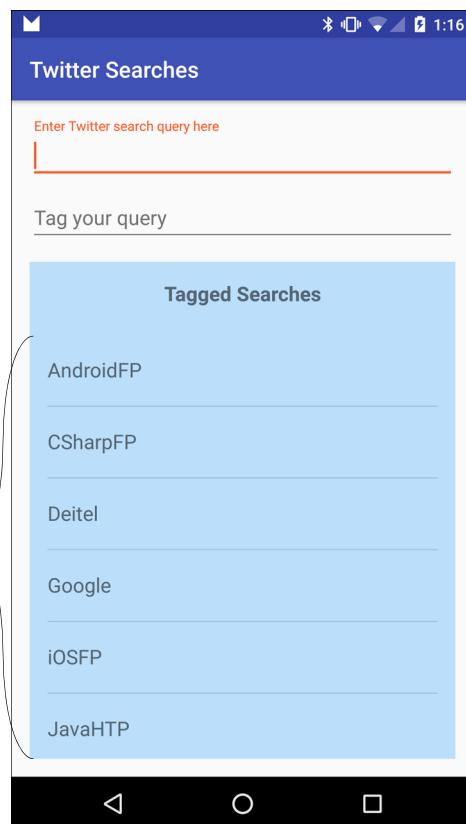
To delete a search, *long press* the search's tag and select **Delete** from the **AlertDialog** that appears. The app prompts you to confirm that you'd like to delete the search (Fig. 8.9)—touching **CANCEL** returns you to the main screen *without* deleting the search. Touching **DELETE** deletes the search.



**Fig. 8.9** | **AlertDialog** confirming a delete.

### 8.2.6 Scrolling Through Saved Searches

Figure 8.10 shows the app after we've saved several favorite searches—six of which are currently visible. The app allows you to scroll through your favorite searches if there are more than can be displayed on the screen at once. Unlike desktop apps, touch-screen apps do not typically display scrollbars to indicate scrollable areas of the screen. To scroll, simply *drag* or *flick* your finger (or the mouse in an AVD) up or down in the list of **Tagged Searches**. Also, rotate the device to *landscape* orientation to see that the GUI dynamically adjusts.



**Fig. 8.10** | App with more searches than can be displayed on the screen.

## 8.3 Technologies Overview

This section introduces the features you'll use to build the Twitter Searches app.

### 8.3.1 Storing Key–Value Data in a SharedPreferences File

Each app can have `SharedPreferences` files containing key–value pairs associated with the app—each key enables you to quickly look up a corresponding value. Chapter 4's `Flag Quiz` app stored the app's preferences in a `SharedPreferences` file on the device. That app's `PreferenceFragment` created the `SharedPreferences` file for you. In this app, you'll

create and manage a `SharedPreferences` file called `searches` in which you'll store the pairs of tags (the *keys*) and Twitter search queries (the *values*) that the user creates. Once again, you'll use a `SharedPreferences.Editor` to make changes to the tag–query pairs.



### Performance Tip 8.1

*This app does not store a lot of data, so we read the saved searches from the device in Main-Activity's `onCreate` method. Lengthy data access should not be done in the UI thread; otherwise, the app will display an Application Not Responding (ANR) dialog—typically after five seconds of preventing the user from interacting with the app. For information on designing responsive apps, see <http://developer.android.com/training/articles/perf-anr.html> and consider using `AsyncTasks` as shown in Chapter 7.*

### 8.3.2 Implicit Intents and Intent Choosers

In Chapter 4, you used an explicit Intent to launch a specific Activity in the same app. Android also supports **implicit Intents** for which you do *not* specify explicitly which component should handle the Intent. In this app you'll use two implicit Intents:

- one that launches the device's default web browser to display Twitter search results, based on a search query embedded in a URL, and
- one that enables the user to choose from a variety of apps that can share text, so the user can share a favorite Twitter search.

In either case, if the system cannot find an activity to handle the action, then method `startActivity` throws an `ActivityNotFoundException`. It's a good practice to handle this exception to prevent your app from crashing. For more information on Intents, visit

<http://developer.android.com/guide/components/intents-filters.html>

When Android receives an implicit Intent, it finds every installed app containing an Activity that can handle the given action and data type. If there is only one, Android launches the appropriate Activity in that app. If there multiple apps that can handle the Intent, Android displays a dialog from which the user can choose which app should handle the Intent. For example, when this app's user chooses a saved search and the device contains only one web browser, Android immediately launches that web browser to perform the search and display the results. If two or more web browsers are installed, however, the user must select which browser should perform this task.

### 8.3.3 RecyclerView

In Chapter 7, you used a `ListView` to display a weather forecast—a limited set of data. Many mobile apps display extensive lists of information. For example, an e-mail app displays a list of e-mails, an address-book app displays a list of contacts, a news app displays a list of headlines, etc. In each case, the user touches an item in the list to see more information—e.g., the content of the selected e-mail, the details of the selected contact or the text of the selected news story.

#### *RecyclerView vs. ListView*

In this app, you'll display the scrollable list of tagged searches using a **RecyclerView** (package `android.support.v7.widget`)—a flexible, customizable view that enables you to control how an app displays a scrolling list of data. `RecyclerView` was designed as a better

`ListView`. It provides better separation of the data's presentation from the `RecyclerView`'s capabilities for reusing views (Section 8.3.4), as well as more flexible customization options (Section 8.3.5) for presenting the `RecyclerView`'s items. For example, a `ListView`'s items are always displayed in a vertical list, whereas a `RecyclerView` has layout managers that can display the items in a vertical list or in a grid. You can even define your own custom layout manager.

### ***RecyclerView Layout Managers***

For this app, the `RecyclerView` will use a `LinearLayoutManager`—a subclass of `RecyclerView.LayoutManager`—to specify that the items will appear in a vertical list, and the list items will each display a search's tag as a `String` in a `TextView`. You also can design custom layouts for a `RecyclerView`'s items.

#### **8.3.4 RecyclerView.Adapter and RecyclerView.ViewHolder**

In Chapter 7, we used a subclass of `Adapter` to bind data to the `ListView`. We also introduced the view-holder pattern for reusing views that scroll off-screen. Recall that we created a class called `ViewHolder` (Section 8.6.2) that maintained references to the views in a `ListView` item. The `Adapter` subclass stored a `ViewHolder` object with each `ListView` item so that we could reuse the `ListView` item's views. You're not required to use this pattern, but doing so is recommended to increase the `ListView`'s scrolling performance.

`RecyclerView` formalizes the view-holder pattern by making it required. You'll create a `RecyclerView.Adapter` subclass to bind the `RecyclerView`'s list items to data in a `List` (Section 8.6). Each `RecyclerView` item has a corresponding object of a subclass of class `RecyclerView.ViewHolder` (Section 8.6.2) that maintains references to the item's view(s) for reuse. The `RecyclerView` and its `RecyclerView.Adapter` work together to recycle the view(s) for items that scroll off the screen.

#### **8.3.5 RecyclerView.ItemDecoration**

Class `ListView` automatically displays a horizontal line between items, but `RecyclerView` does not provide any default decorations. To display horizontal lines between the items, you'll define a subclass of `RecyclerView.ItemDecoration` that draws divider lines onto the `RecyclerView` (Section 8.7).

#### **8.3.6 Displaying a List of Options in an AlertDialog**

This app enables the user to long touch a `RecyclerView` item to display an `AlertDialog` containing a list of options from which the user can select only one. You'll use an `AlertDialog.Builder`'s `setItems` method to specify a `String` array resource containing names of the option to display and to set the event handler that's called when the user touches one of the options.

## **8.4 Building the App's GUI and Resource Files**

In this section, you'll build the `Twitter Searches` app's GUI and resource files. Recall from Section 8.3.3 that `RecyclerView` does not define how to render its list items. So you'll also create a layout that defines a list item's GUI. The `RecyclerView` will inflate this layout as necessary when creating list items.

### 8.4.1 Creating the Project

Create a new project using the **Blank Activity** template. Fragments are not required for this app, so when you configure the **Blank Activity**, do not check the **Use a Fragment** checkbox. Specify the following values in the **Create New Project** dialog's **New Project** step:

- **Application name:** Twitter Searches
- **Company Domain:** deitel.com (or specify your own domain name)

Follow the steps you used in earlier apps to add an app icon to your project. Delete the **Hello world!** **TextView** from the `content_main.xml`, as it's not used. Also, follow the steps in Section 4.4.3 to configure Java SE 7 support for the project.

### 8.4.2 AndroidManifest.xml

Most users will launch this app so that they can perform an existing saved search. When the first focusable GUI component in an activity is an **EditText**, Android gives that component the focus when the activity is displayed. When an **EditText** receives the focus, its corresponding virtual keyboard is displayed unless a hardware keyboard is present. In this app, we want to prevent the soft keyboard from being displayed until the user touches one of the app's **EditTexts**. To do so, follow the steps in Section 3.7 for setting the `windowSoftInputMode` option, but set its value to `stateAlwaysHidden`.

### 8.4.3 Adding the RecyclerView Library

This app uses new material-design user-interface components from the Android Design Support Library, including the **TextInputLayout**, **FloatingActionButton**, and the **RecyclerView**. Android Studio's new app templates are already configured with Android Design Support Library support for **TextInputLayout** and **FloatingActionButton**. To use **RecyclerView**, however, you must update the app's dependencies to include the **RecyclerView** library:

1. Right click the project's app folder and select **Open Module Settings** to open the **Project Structure** window.
2. Open the **Dependencies** tab, then click the add icon (+) and select **Library Dependency** to open the **Choose Library Dependency** dialog.
3. Select the **recyclerview-v7** library in the list, then click **OK**. The library will appear in the **Dependencies** tab's list.
4. In the **Project Structure** window, click **OK**.

The IDE updates the project's `build.gradle` file—the one that appears in the project's **Gradle Scripts** node as `build.gradle (Module: app)`—to specify the new dependency. The Gradle build tool then makes the libraries available for use in your project.

### 8.4.4 colors.xml

For this app, we changed the app's default accent color (used for the **EditTexts**, **TextInputLayouts** and **FloatingActionButton**) and added a color resource for the background color in the **Tagged Searches** area of the screen. Open `colors.xml` and replace the hexa-

decimal value for the `colorAccent` resource with `#FF5722`, then add a new color resource named `colorTaggedSearches` with the value `#BBDEFB`.

### 8.4.5 strings.xml

Add the String resources in Fig. 8.11 to `strings.xml`.

| Key                                  | Default Value  |
|--------------------------------------|--|
| <code>query_prompt</code>            | Enter Twitter search query here                                      |
| <code>tag_prompt</code>              | Tag your query   |
| <code>save_description</code>        | Touch this button to save your tagged search                         |
| <code>tagged_searches</code>         | Tagged Searches  |
| <code>search_URL</code>              | <code>http://mobile.twitter.com/search?q=</code>                     |
| <code>share_edit_delete_title</code> | Share, Edit or Delete the search tagged as <code>\"&gt;%s\%"</code>  |
| <code>cancel</code>                  | Cancel   |
| <code>share_subject</code>           | Twitter search that might interest you                               |
| <code>share_message</code>           | Check out the results of this Twitter search: %s                     |
| <code>share_search</code>            | Share Search to:   |
| <code>confirm_message</code>         | Are you sure you want to delete the search <code>\"&gt;%s\%"?</code> |
| <code>delete</code>                  | Delete   |

**Fig. 8.11** | String resources used in the **Twitter Searches** app.

### 8.4.6 arrays.xml

Recall from Chapter 4 that array resources are normally defined in `arrays.xml`. Follow the steps in Section 4.4.6 to create an `arrays.xml` file, then add the resource in (Fig. 8.12) to the file.

| Array resource name       | Values              |
|---------------------------|---------------------|
| <code>dialog_items</code> | Share, Edit, Delete |

**Fig. 8.12** | String array resources defined in `arrays.xml`.

### 8.4.7 dimens.xml

Add the dimension resource shown in Fig. 8.13 to the `dimens.xml` file.

| Resource name               | Value             |
|-----------------------------|-------------------|
| <code>fab_margin_top</code> | <code>90dp</code> |

**Fig. 8.13** | Dimension resources in `dimens.xml`.

### 8.4.8 Adding the Save Button Icon

Use Android Studio’s **Vector Asset Studio** (Section 4.4.9) to add the material design save icon (✉; located in the **Content** group) to the project—this will be used as the **FloatingActionButton**’s icon. After adding the vector icon, go to the project’s `res/drawable` folder, open the icon’s XML file and change the `<path>` element’s `android:fillColor` value to

```
"@android:color/white"
```

This will make the icon more visible against the app’s accent color, which is applied to the **FloatingActionButton** by the app’s theme.

### 8.4.9 activity\_main.xml

In this section, you’ll customize the **FloatingActionButton** that’s built into Android Studio’s **Blank Activity** app template. By default, the button contains an email icon and is positioned the bottom-right of **MainActivity**’s layout. You’ll replace the email icon with the save icon ✉ that you added in Section 8.4.8 and reposition the button at the layout’s top right. Perform the following steps:

1. Open `activity_main.xml` and, in **Design** view, select the **FloatingActionButton** in the **Component Tree**.
2. Set the `contentDescription` property to the `save_description` String resource and set the `src` property to the `ic_save_24dp` Drawable resource.

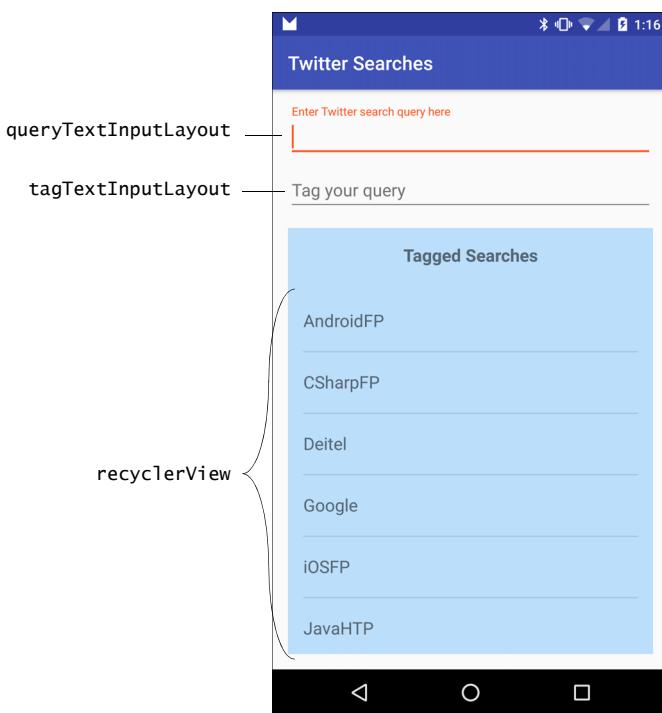
At the time of this writing, Android Studio does not display layout properties for components from the Android Design Support Library, so any changes to these properties must be implemented directly in the layout’s XML. Switch to **Text** view, then:

3. Change the `layout_gravity` property’s value from “`bottom|end`” to “`top|end`” so that the **FloatingActionButton**’s moves to the top of the layout.
4. Change the name of the `layout_margin` property to `layout_marginEnd` so it applies only to the **FloatingActionButton**’s right side (or left side for right-to-left languages).
5. Add the following line to the **FloatingActionButton**’s XML element to specify a new value for its top margin—this moves the button down from the top of the layout over the part of the GUI defined by `content_main.xml`:

```
    android:layout_marginTop="@dimen/fab_margin_top"
```

### 8.4.10 content\_main.xml

The `RelativeLayout` in this app’s `content_main.xml` contains two `TextInputLayouts` and a `LinearLayout` that, in turn, contains a `TextView` and a `RecyclerView`. Use the layout editor and the **Component Tree** window to form the layout structure shown in Fig. 8.14. As you create the GUI components, set their `ids` as specified in the figure. There are several components in this layout that do not require `ids`, as the app’s Java code does not reference them directly.



**Fig. 8.14** | Twitter Searches GUI's components labeled with their `id` property values.

#### *Step 1: Adding the `queryTextInputLayout` and Its Nested `EditText`*

Add the `queryTextInputLayout` and its nested `EditText` as follows:

1. Insert a `TextInputLayout`. In the layout editor's **Design** view, click **CustomView** in the **Palette**'s **Custom** section. In the dialog that appears, begin typing `TextInputLayout` to search the list of custom GUI components. Once the IDE highlights `TextInputLayout`, click **OK**, then in the **Component Tree**, click the `RelativeLayout` to insert the `TextInputLayout` as a nested layout. Select the `TextInputLayout` and set its `id` to `queryTextInputLayout`.
2. To add an `EditText` to the `TextInputLayout`, switch to the layout editor's **Text** view, then change the `TextInputLayout` element's closing `>/` to `>`, position the cursor to the right of the `>`, press *Enter* and type `</`. The IDE will auto-complete the closing tag. Between the `TextInputLayout`'s starting and ending tags, type `<EditText`. The IDE will show an auto-complete window with `EditText` selected. Press *Enter* to insert an `EditText`, then set its `layout_width` to `match_parent` and `layout_height` to `wrap_content`.
3. Switch back to **Design** view, then in the **Component Tree**, select the `EditText` and set its `imeOptions` to `actionNext` (the keyboard displays a button to jump to the next `EditText`), its `hint` to the `String` resource `query_prompt` and check its `singleLine` property's checkbox. To view the `imeOptions` property, you must first click the **Show expert properties** button () at the top of the **Properties** window.

***Step 2: Adding the tagTextInputLayout and Its Nested EditText***

Using the techniques from the previous step, add the tagTextInputLayout and its nested EditText, with the following changes:

1. After adding the TextInputLayout, set its id to tagTextInputLayout.
2. In Text view, add the following line to the tagTextInputLayout's XML element to indicate that this TextInputLayout should appear below the queryTextInputLayout:
 

**android:layout\_below="@+id/queryTextInputLayout"**
3. In Design view, set the String resource tag\_prompt as the tagTextInputLayout EditText's hint.
4. Set the EditText's imeOptions to actionDone—for this option, the keyboard displays a  button to dismiss the keyboard.

***Step 3: Adding the LinearLayout***

Next, add a LinearLayout below the tagTextInputLayout:

1. In Design view, drag a **LinearLayout (vertical)** onto the **RelativeLayout** node in the **Component Tree**.
2. In the **Properties** window, expand the **layout:alignComponent** property's node, then click the value field to the right of **top:bottom** and select **tagTextInputLayout**. This indicates that the top of the **LinearLayout** will be placed below the bottom of the **tagTextInputLayout**.

***Step 3: Adding the LinearLayout's Nested TextView and RecyclerView***

Finally, add the **LinearLayout**'s nested **TextView** and **RecyclerView**:

1. Drag a **Medium Text** onto the **LinearLayout (vertical)** node in the **Component Tree**, then set its **layout:width** to **match\_parent**, its **text** to the **String** resource named **tagged\_searches**, its **gravity** to **center\_horizontal** and its **textStyle** to **bold**. Also, expand its **padding** property and set **top** and **bottom** to the dimension resource named **activity\_vertical\_margin**.
2. Next, you'll insert a **RecyclerView**. In the layout editor's **Design** view, click **CustomView** in the **Palette**'s **Custom** section. In the dialog that appears, begin typing **RecyclerView** to search the list of custom GUI components. Once the IDE highlights **RecyclerView**, click **OK**, then in the **Component Tree**, click the **LinearLayout** to insert the **RecyclerView** as a nested view.
3. Select the **RecyclerView** in the **Component Tree**, then set its **id** to **recyclerView**, its **layout:width** to **match\_parent**, its **layout:height** to **0dp** and its **layout:weight** to **1**—the **RecyclerView** will fill all remaining vertical space in the **LinearLayout**. Also, expand the **RecyclerView**'s **padding** property and set **left** and **right** to the dimension resource named **activity\_horizontal\_margin**.

**8.4.11 RecyclerView Item's Layout: `List_item.xml`**

When populating a **RecyclerView** with data, you must specify each list item's layout. The list items in this app each display the tag name of one saved search. You'll now create a

new layout that contains only a `TextView` with the appropriate formatting. Perform the following steps:

1. In the **Project** window, expand the project's `res` folder, then right click the `layout` folder and select **New > Layout resource file** to display the **New Resource File** dialog.
2. In the **File name** field, specify `list_item.xml`.
3. In the **Root element** field, specify `TextView`.
4. Click **OK**. The new `list_item.xml` file will appear in the `res/layout` folder.

The IDE opens the new layout in the layout editor. Select the `TextView` in the **Component Tree** window, set its `id` to `textView`, then set the following properties:

- `layout:width`—`match_parent`
- `layout:height`—`?android:attr/listPreferredItemHeight`—This value is a pre-defined Android resource that represents a list item's preferred height for a touchable view.<sup>3</sup>



### Look-and-Feel Observation 8.1

*The Android design guidelines specify that the minimum recommended size for a touchable item on the screen is 48dp-by-48dp. For more information on GUI sizing and spacing, see <https://www.google.com/design/spec/layout/metrics-keylines.html>.*

- `gravity`—`center_vertical`
- `textAppearance`—`?android:attr/textAppearanceMedium`—This is the pre-defined theme resource that specifies the font size for medium-sized text.

### Other Predefined Android Resources

There are many predefined Android resources like the ones used to set the `height` and `textAppearance` for a list item. You can view the complete list at:

<http://developer.android.com/reference/android/R.attr.html>

To use a value in your layouts, specify it in the format

`?android:attr/resourceName`

## 8.5 MainActivity Class

This app consists of three classes:

- Class `MainActivity`—which we discuss in this section—configures the app's GUI and defines the app's logic.
  - Class `SearchesAdapter` (Section 8.6) is a subclass of `RecyclerView.Adapter` that defines how to bind the tag names for the user's searches to the `RecyclerView`'s items. Class `MainActivity`'s `onCreate` method creates an object of class `SearchesAdapter` as the `RecyclerView`'s adapter.
- 
3. At the time of this writing, you must set this directly in the XML due to an Android Studio bug that erroneously appends `dp` to the end of this property value when you set it via the **Properties** window.

- Class `ItemDivider` (Section 8.7) is a subclass of `RecyclerView.ItemDecoration` that the `RecyclerView` uses to draw a horizontal line between items.

Sections 8.5.1–8.5.10 discuss class `MainActivity` in detail. This app does not need a menu, so we removed the `MainActivity` methods `onCreateOptionsMenu` and `onOptionsItemSelected`, and the corresponding menu resource from the project's `res/menu` folder.

### 8.5.1 package and import Statements

Figure 8.15 shows `MainActivity`'s package and `import` statements. We discuss the imported types in Section 8.3 and as we encounter them in class `MainActivity`.

---

```

1 // MainActivity.java
2 // Manages your favorite Twitter searches for easy
3 // access and display in the device's web browser
4 package com.deitel.twittersearches;
5
6 import android.app.AlertDialog;
7 import android.content.Context;
8 import android.content.DialogInterface;
9 import android.content.Intent;
10 import android.content.SharedPreferences;
11 import android.net.Uri;
12 import android.os.Bundle;
13 import android.support.design.widget.FloatingActionButton;
14 import android.support.design.widget.TextInputLayout;
15 import android.support.v7.app.AppCompatActivity;
16 import android.support.v7.widget.LinearLayoutManager;
17 import android.support.v7.widget.RecyclerView;
18 import android.support.v7.widget.Toolbar;
19 import android.text.Editable;
20 import android.text.TextWatcher;
21 import android.view.View;
22 import android.view.View.OnClickListener;
23 import android.view.View.OnLongClickListener;
24 import android.view.inputmethod.InputMethodManager;
25 import android.widget.EditText;
26 import android.widget.TextView;
27
28 import java.util.ArrayList;
29 import java.util.Collections;
30 import java.util.List;
31

```

---

**Fig. 8.15** | `MainActivity`'s package and `import` statements.

### 8.5.2 MainActivity Fields

As in the `WeatherViewer` app, class `MainActivity` (Fig. 8.16) extends `AppCompatActivity` (line 32) so that it can display an app bar and use other `AppCompat` library features on devices running past or current Android versions. The static `String` constant `SEARCHES` (line 34) represents the name of a `SharedPreferences` file that will store tag–query pairs on the device.

---

```

32  public class MainActivity extends AppCompatActivity {
33      // name of SharedPreferences XML file that stores the saved searches
34      private static final String SEARCHES = "searches";
35
36      private EditText queryEditText; // where user enters a query
37      private EditText tagEditText; // where user enters a query's tag
38      private FloatingActionButton saveFloatingActionButton; // save search
39      private SharedPreferences savedSearches; // user's favorite searches
40      private List<String> tags; // list of tags for saved searches
41      private SearchesAdapter adapter; // for binding data to RecyclerView
42

```

---

**Fig. 8.16** | MainActivity fields.

Lines 36–41 define MainActivity’s instance variables:

- Lines 36–37 declare EditTexts that we’ll use to access the queries and tags that the user enters as input.
- Line 38 declares a FloatingActionButton that the user touches to save a search. In the **Blank Activity** app template, this was declared as a local variable in method `onCreate` (Section 8.5.3)—we renamed it and made it an instance variable, so we can hide the button when the EditTexts are empty and show it when the EditTexts both contain input.
- Line 39 declares the SharedPreferences instance variable `savedSearches`, which we’ll use to manipulate the tag–query pairs representing the user’s saved searches.
- Line 40 declares the List<String> `tags` that will store the sorted tag names for the user’s searches.
- Line 41 declares the SearchesAdapter instance variable `adapter`, which will refer to the RecyclerView.Adapter subclass object that provides data to the RecyclerView.

### 8.5.3 Overridden Activity Method `onCreate`

Overridden Activity method `onCreate` (Fig. 8.17) initializes the Activity’s instance variables and configures the GUI components. Lines 52–57 obtain references to the `queryEditText` and `tagEditText` and, for each, register a `TextWatcher` (Section 8.5.4) that’s notified when the user enters or removes characters in the EditTexts.

---

```

43      // configures the GUI and registers event listeners
44      @Override
45      protected void onCreate(Bundle savedInstanceState) {
46          super.onCreate(savedInstanceState);
47          setContentView(R.layout.activity_main);
48          Toolbar toolbar = (Toolbar) findViewById(R.id.toolbar);
49          setSupportActionBar(toolbar);

```

---

**Fig. 8.17** | Overridden Activity method `onCreate`. (Part I of 2.)

```
50 // get references to the EditTexts and add TextWatchers to them
51 queryEditText = ((TextInputLayout) findViewById(
52     R.id.queryTextInputLayout)).getEditText();
53 queryEditText.addTextChangedListener(textWatcher);
54 tagEditText = ((TextInputLayout) findViewById(
55     R.id.tagTextInputLayout)).getEditText();
56 tagEditText.addTextChangedListener(textWatcher);
57
58 // get the SharedPreferences containing the user's saved searches
59 savedSearches = getSharedPreferences(SEARCHES, MODE_PRIVATE);
60
61 // store the saved tags in an ArrayList then sort them
62 tags = new ArrayList<>(savedSearches.getAll().keySet());
63 Collections.sort(tags, String.CASE_INSENSITIVE_ORDER);
64
65 // get reference to the RecyclerView to configure it
66 RecyclerView recyclerView =
67     (RecyclerView) findViewById(R.id.recyclerView);
68
69 // use a LinearLayoutManager to display items in a vertical list
70 recyclerView.setLayoutManager(new LinearLayoutManager(this));
71
72 // create RecyclerView.Adapter to bind tags to the RecyclerView
73 adapter = new SearchesAdapter(
74     tags, itemClickListener, itemLongClickListener);
75 recyclerView.setAdapter(adapter);
76
77 // specify a custom ItemDecorator to draw lines between list items
78 recyclerView.addItemDecoration(new ItemDivider(this));
79
80 // register listener to save a new or edited search
81 saveFloatingActionButton =
82     (FloatingActionButton) findViewById(R.id.fab);
83 saveFloatingActionButton.setOnClickListener(saveButtonListener);
84 updateSaveFAB(); // hides button because EditTexts initially empty
85
86 }
87 }
```

---

**Fig. 8.17** | Overridden Activity method `onCreate`. (Part 2 of 2.)

### Getting a `SharedPreferences` Object

Line 60 uses the method `getSharedPreferences` (inherited indirectly from class `Context`) to get a `SharedPreferences` object that can read existing *tag-query pairs* (if any) from the `searches` file. The first argument indicates the name of the file that contains the data. The second argument specifies the file's access-level and can be set to:

- `MODE_PRIVATE`—Accessible *only* to this app. In most cases, you'll use this option.
- `MODE_WORLD_READABLE`—Any app on the device can *read* the file.
- `MODE_WORLD_WRITEABLE`—Any app on the device can *write* to the file.

These constants can be combined with the bitwise OR operator (`|`).

### **Getting the Keys Stored in the SharedPreferences Object**

We'd like to display the search tags alphabetically so the user can easily find a search to perform. First, line 63 gets the Strings representing the keys in the `SharedPreferences` object and stores them in `tags` (an `ArrayList<String>`). `SharedPreferences` method `getAll` returns all the saved searches as a `Map` (package `java.util`)—a collection of key–value pairs. We then call method `keySet` on the `Map` object to get all the keys as a `Set<String>` (package `java.util`)—a collection of unique values. The result is used to initialize `tags`.

### **Sorting the ArrayList of Tags**

Line 64 uses `Collections.sort` to sort `tags`. Since the user could enter tags using mixtures of uppercase and lowercase letters, we perform a *case-insensitive sort* by passing the predefined `Comparator<String>` object `String.CASE_INSENSITIVE_ORDER` as the second argument to `Collections.sort`.

### **Configuring the RecyclerView**

Lines 67–79 configure the `RecyclerView`:

- Lines 67–68 get a reference to the `RecyclerView`.
- A `RecyclerView` can arrange its items for display in difference ways. For this app, we use the `LinearLayoutManager` to display the items in a vertical list. The `LinearLayoutManager`'s constructor receives a `Context` object, which is the `MainActivity` in this case. Line 71 creates a `LinearLayoutManager` calls `RecyclerView` method `setLayoutManager` to set the new object as the `RecyclerView`'s layout manager.
- Lines 74–75 create a `SearchesAdapter` (Section 8.6)—a subclass of `RecyclerView.Adapter`—that will supply data for display in the `RecyclerView`. Line 76 calls `RecyclerView` method `setAdapter` to specify that the `SearchesAdapter` will supply the `RecyclerView`'s data.
- Line 79 creates a subclass of `RecyclerView.ItemDecoration` named `ItemDivider` (Section 8.7) and passes the object to `RecyclerView` method `addItemDecoration`. This enables the `RecyclerView` to draw a horizontal line decoration between list items.

### **Registering a Listener for the FloatingActionButton**

Lines 82–85 obtain a reference to the `saveFloatingActionButton` and register its `OnClickListener`. Instance variable `saveButtonListener` refers to an *anonymous-inner-class object* that implements interface `View.OnClickListener` (Section 8.5.5). Line 85 calls method `updateSaveFAB` (Section 8.5.4), which initially hides the `saveFloatingActionButton`, because the `EditTexts` are empty when `onCreate` is first called—the button displays only when both `EditTexts` contain input.

### **8.5.4 TextWatcher Event Handler and Method updateSaveFAB**

Figure 8.18 defines an anonymous inner class that implements interface `TextWatcher` (lines 89–103). The `TextWatcher`'s `onTextChanged` method calls `updateSaveFAB` when the contents change in either of the app's `EditTexts`. Lines 54 and 57 (Fig. 8.17) register the instance variable `textWatcher` as the listener for the `EditTexts` events.

```

88     // hide/show saveFloatingActionButton based on EditTexts' contents
89     private final TextWatcher textWatcher = new TextWatcher() {
90         @Override
91         public void beforeTextChanged(CharSequence s, int start, int count,
92             int after) { }
93
94         // hide/show the saveFloatingActionButton after user changes input
95         @Override
96         public void onTextChanged(CharSequence s, int start, int before,
97             int count) {
98             updateSaveFAB();
99         }
100
101        @Override
102        public void afterTextChanged(Editable s) { }
103    };
104
105    // shows or hides the saveFloatingActionButton
106    private void updateSaveFAB() {
107        // check if there is input in both EditTexts
108        if (queryEditText.getText().toString().isEmpty() ||
109            tagEditText.getText().toString().isEmpty())
110            saveFloatingActionButton.hide();
111        else
112            saveFloatingActionButton.show();
113    }
114

```

**Fig. 8.18** | TextWatcher event handler and method updateSaveFAB.

The updatedSaveFAB method (Fig. 8.18, lines 106–113) checks whether there's text in both EditTexts (lines 108–109). If either (or both) of the EditTexts is empty, line 110 calls the FloatingActionButton's **hide** method to hide the button, because both the query and tag are required before a tag–query pair can be saved. If both contain text, line 112 calls the FloatingActionButton's **show** method, to display the button so the user can touch it to store a tag–query pair.

### 8.5.5 saveButton's OnClickListener

Figure 8.19 defines instance variable saveButtonListener, which refers to an anonymous inner class object that implements the interface OnClickListener. Line 84 (Fig. 8.17) registered saveButtonListener as the saveFloatingActionButton's event handler. Lines 119–135 (Fig. 8.19) override interface OnClickListener's onClick method. Lines 121–122 get the Strings from the EditTexts. If the user entered a query and a tag (line 124):

- lines 126–128 hide the soft keyboard
- line 130 calls method addTaggedSearch (Section 8.5.6) to store the tag–query pair
- lines 131–132 clear the two EditTexts, and
- line 133 calls the queryEditText's requestFocus method to position the input cursor in the queryEditText.

---

```

115 // saveButtonListener save a tag-query pair into SharedPreferences
116 private final OnClickListener saveButtonListener =
117     new OnClickListener() {
118         // add/update search if neither query nor tag is empty
119         @Override
120         public void onClick(View view) {
121             String query = queryEditText.getText().toString();
122             String tag = tagEditText.getText().toString();
123
124             if (!query.isEmpty() && !tag.isEmpty()) {
125                 // hide the virtual keyboard
126                 ((InputMethodManager) getSystemService(
127                     Context.INPUT_METHOD_SERVICE)).hideSoftInputFromWindow(
128                         view.getWindowToken(), 0);
129
130                 addTaggedSearch(tag, query); // add/update the search
131                 queryEditText.setText(""); // clear queryEditText
132                 tagEditText.setText(""); // clear tagEditText
133                 queryEditText.requestFocus(); // queryEditText gets focus
134             }
135         }
136     };
137 
```

---

**Fig. 8.19** | Anonymous inner class that implements the saveButton's OnClickListener to save a new or updated search.

### 8.5.6 addTaggedSearch Method

The event handler in Fig. 8.19 calls method addTaggedSearch (Fig. 8.20) to add a new search to savedSearches or to modify an existing search.

---

```

138 // add new search to file, then refresh all buttons
139 private void addTaggedSearch(String tag, String query) {
140     // get a SharedPreferences.Editor to store new tag/query pair
141     SharedPreferences.Editor preferencesEditor = savedSearches.edit();
142     preferencesEditor.putString(tag, query); // store current search
143     preferencesEditor.apply(); // store the updated preferences
144
145     // if tag is new, add to and sort tags, then display updated list
146     if (!tags.contains(tag)) {
147         tags.add(tag); // add new tag
148         Collections.sort(tags, String.CASE_INSENSITIVE_ORDER);
149         adapter.notifyDataSetChanged(); // update tags in RecyclerView
150     }
151 }
152 
```

---

**Fig. 8.20** | MainActivity's addTaggedSearch method.

#### *Editing a SharedPreferences Object's Contents*

Recall from Section 4.6.7 that to change a SharedPreferences object's contents, you must first call its edit method to obtain a SharedPreferences.Editor object (Fig. 8.20,

line 141), which can add key–value pairs to, remove key–value pairs from, and modify the value associated with a particular key in a `SharedPreferences` file. Line 142 calls `SharedPreferences.Editor` method `putString` to save the search’s tag (the key) and query (the corresponding value)—if the tag already exists in the `SharedPreferences` this updates the value. Line 143 commits the changes by calling `SharedPreferences.Editor` method `apply` to make the changes to the file.

### *Notifying the RecyclerView.Adapter That Its Data Has Changed*

When the user adds a new search, the `RecyclerView` should be updated to display it. Line 146 determines whether a new tag was added. If so, lines 147–148 add the new search’s tag to `tags`, then sort `tags`. Line 149 calls the `RecyclerView.Adapter`’s `notifyDataSetChanged` method to indicate that the underlying data in `tags` has changed. As with a `ListView` adapter, the `RecyclerView.Adapter` then notifies the `RecyclerView` to update its list of displayed items.

### 8.5.7 Anonymous Inner Class That Implements `View.OnClickListener` to Display Search Results

Figure 8.21 defines instance variable `itemClickListener`, which refers to an anonymous inner-class object that implements interface `OnClickListener` (a nested interface of class `View`). Lines 156–168 override the interface’s `onClick` method. The method’s argument is the `View` that the user touched—in this case, the `TextView` that displays a search tag in the `RecyclerView`.

---

```

153 // itemClickListener launches web browser to display search results
154 private final OnClickListener itemClickListener =
155     new OnClickListener() {
156     @Override
157     public void onClick(View view) {
158         // get query string and create a URL representing the search
159         String tag = ((TextView) view).getText().toString();
160         String urlString = getString(R.string.search_URL) +
161             Uri.encode(savedSearches.getString(tag, ""), "UTF-8");
162
163         // create an Intent to launch a web browser
164         Intent webIntent = new Intent(Intent.ACTION_VIEW,
165             Uri.parse(urlString));
166
167         startActivity(webIntent); // show results in web browser
168     }
169 };
170

```

---

**Fig. 8.21** | Anonymous inner class that implements `View.OnClickListener` to display search results.

### *Getting String Resources*

Line 159 gets the text of the `View` that the user touched in the `RecyclerView`—this is the tag for a search. Lines 160–161 create a `String` containing the Twitter search URL and the que-

ry to perform. Line 160 calls `Activity`'s inherited method `getString` with one argument to get the `String` resource named `search_URL`, then we append the query `String` to it.

### ***Getting Strings from a SharedPreferences Object***

We append the result of line 161 to the search URL to complete the `urlString`. `SharedPreference`s method `getString` returns the query associated with the tag. If the tag does not already exist, the second argument ("`"` in this case) is returned. Line 161 passes the query to `Uri` method `encode`, which *escapes* any special URL characters (such as `?`, `/`, `:`, etc.) and returns a so-called *URL-encoded String*. Class `Uri` (uniform resource identifier) of package `android.net` enables us to convert a URL into the format required by an `Intent` that launches the device's web browser.<sup>4</sup> This is important to ensure that the Twitter web server that receives the request can parse the URL properly to obtain the search query.

### ***Creating an Intent to Launch the Device's Web Browser***

Lines 164–165 create a new `Intent`, which we'll use to launch the device's web browser and display the search results. In Chapter 4, you used an explicit `Intent` to launch another activity in the same app. Here you'll use an implicit `Intent` to launch another app. The first argument of `Intent`'s constructor is a constant describing the action to perform. `Intent.ACTION_VIEW` indicates that we'd like to display a representation of the `Intent`'s data. Many constants are defined in the `Intent` class describing actions such as *searching*, *choosing*, *sending* and *playing*:

```
http://developer.android.com/reference/android/content/Intent.html
```

The second argument (line 165) is a `Uri` representing the *data* for which to perform the action. Class `Uri`'s `parse` method converts a `String` representing a URL (uniform resource locator) to a `Uri`.

### ***Starting an Activity for an Intent***

Line 167 passes the `Intent` to the inherited `Activity` method `startActivity`, which starts an `Activity` that can perform the specified *action* for the given *data*. In this case, because we've specified to view a URI, the `Intent` launches the device's web browser to display the corresponding web page. This page shows the results of the supplied Twitter search.

## **8.5.8 Anonymous Inner Class That Implements `View.OnLongClickListener` to Share, Edit or Delete a Search**

Figure 8.22 defines instance variable `itemLongClickListener`, which refers to an anonymous inner-class object that implements interface `OnLongClickListener`. Lines 175–216 override interface `OnLongClickListener`'s `onLongClick` method.

---

4. A Uniform Resource Identifier (URI) uniquely identifies a resource on a network. One common type of URI is a Uniform Resource Locator (URL) that identifies items on the Web, such as web pages, image files, web service methods and more.

```
171 // itemLongClickListener displays a dialog allowing the user to share
172 // edit or delete a saved search
173 private final OnLongClickListener itemLongClickListener =
174     new OnLongClickListener() {
175         @Override
176         public boolean onLongClick(View view) {
177             // get the tag that the user long touched
178             final String tag = ((TextView) view).getText().toString();
179
180             // create a new AlertDialog
181             AlertDialog.Builder builder =
182                 new AlertDialog.Builder(MainActivity.this);
183
184             // set the AlertDialog's title
185             builder.setTitle(
186                 getString(R.string.share_edit_delete_title, tag));
187
188             // set list of items to display and create event handler
189             builder.setItems(R.array.dialog_items,
190                 new DialogInterface.OnClickListener() {
191                     @Override
192                     public void onClick(DialogInterface dialog, int which) {
193                         switch (which) {
194                             case 0: // share
195                             shareSearch(tag);
196                             break;
197                             case 1: // edit
198                             // set EditTexts to match chosen tag and query
199                             tagEditText.setText(tag);
200                             queryEditText.setText(
201                                 savedSearches.getString(tag, ""));
202                             break;
203                             case 2: // delete
204                             deleteSearch(tag);
205                             break;
206                         }
207                     }
208                 });
209
210             // set the AlertDialog's negative Button
211             builder.setNegativeButton(getString(R.string.cancel), null);
212
213             builder.create().show(); // display the AlertDialog
214             return true;
215         }
216     };
217 };
218
```

---

**Fig. 8.22** | Anonymous inner class that implements View.OnLongClickListener.

#### **Final Local Variables for Use in Anonymous Inner Classes**

Line 178 assigns to `final` local variable `tag` the text of the item the user *long pressed*—`final` is required for any local variable or method parameter used in an anonymous inner class.

### **AlertDialog That Displays a List of Items**

Lines 181–186 create an `AlertDialog.Builder` and set the dialog's title to a formatted `String` (`R.string.share_edit_delete_title`) in which `tag` replaces the format specifier. Line 186 calls `Activity`'s inherited method `getString` that receives multiple arguments—a `String` resource ID representing a format `String` and the values that should replace the format specifiers in the format `String`. In addition to buttons, an `AlertDialog` can display a list of items. Lines 189–209 use `AlertDialog.Builder` method `setItems` to specify that the dialog should display the array of `Strings` `R.array.dialog_items` and to define an anonymous inner class object that responds when the user touches any item in the list.

### **Event Handler for the Dialog's List of Items**

The anonymous inner class in lines 190–208 determines which item the user selected in the dialog's list and performs the appropriate action. If the user selects `Share`, `shareSearch` is called (line 195). If the user selects `Edit`, lines 199–201 display the search's query and tag in the `EditTexts`. If the user selects `Delete`, `deleteSearch` is called (line 204).

### **Configuring the Negative Button and Displaying the Dialog**

Line 212 configures the dialog's negative button. When the negative button's event handler is `null`, touching the negative button simply dismisses the dialog. Line 214 creates and shows the dialog.

## **8.5.9 shareSearch Method**

Method `shareSearch` (Fig. 8.23) is called when the user selects to share a search (Fig. 8.22). Lines 222–223 create a `String` representing the search to share. Lines 226–232 create and configure an `Intent` that allows the user to send the search URL using an `Activity` that can handle the `Intent.ACTION_SEND`.

---

```

219    // allow user to choose an app for sharing URL of a saved search
220    private void shareSearch(String tag) {
221        // create the URL representing the search
222        String urlString = getString(R.string.search_URL) +
223            Uri.encode(savedSearches.getString(tag, ""), "UTF-8");
224
225        // create Intent to share urlString
226        Intent shareIntent = new Intent();
227        shareIntent.setAction(Intent.ACTION_SEND);
228        shareIntent.putExtra(Intent.EXTRA_SUBJECT,
229            getString(R.string.share_subject));
230        shareIntent.putExtra(Intent.EXTRA_TEXT,
231            getString(R.string.share_message, urlString));
232        shareIntent.setType("text/plain");
233
234        // display apps that can share plain text
235        startActivity(Intent.createChooser(shareIntent,
236            getString(R.string.share_search)));
237    }
238

```

---

**Fig. 8.23** | `MainActivity`'s `shareSearch` method.

### *Adding Extras to an Intent*

An Intent includes a Bundle of *extras*—additional information that's passed to the Activity that handles the Intent. For example, an e-mail Activity can receive *extras* representing the e-mail's subject, CC and BCC addresses, and the body text. Lines 228–231 use Intent method `putExtra` to add to the Intent's Bundle key-value pairs representing the extras. The method's first argument is a String key representing the purpose of the extra and the second argument is the corresponding extra data. Extras may be primitive type values, primitive type arrays, entire Bundle objects and more—see class Intent's documentation for a complete list of the `putExtra` overloads.

The extra at lines 228–229 specifies an e-mail's subject with the String resource `R.string.share_subject`. For an Activity that does *not* use a subject (such as sharing on a social network), this extra is ignored. The extra at lines 230–231 represents the text to share—a formatted String in which the `urlString` is substituted into the String resource `R.string.share_message`. Line 232 sets the Intent's MIME type to `text/plain`—such data can be handled by any Activity capable of sending plain text messages.

### *Displaying an Intent Chooser*

To display the *intent chooser* shown in Fig. 8.8(a), we pass the Intent and a String title to Intent's static `createChooser` method (lines 235–236). The intent chooser's title is specified by the second argument (`R.string.share_search`). It's important to set this title to remind the user to select an appropriate Activity. You cannot control the apps installed on a user's phone or the Intent filters that can launch those apps, so it's possible that incompatible activities could appear in the chooser. Method `createChooser` returns an Intent that we pass to `startActivity` to display the intent chooser.

## 8.5.10 deleteSearch Method

The `deleteSearch` method (Fig. 8.24) is called when the user long presses a search tag and selects **Delete** from the dialog displayed by the code in Fig. 8.22. Before deleting the search, the app displays an `AlertDialog` to confirm the delete operation. Line 243 (Fig. 8.24) sets the dialog's title to a formatted String in which `tag` replaces the format specifier in the String resource `R.string.confirm_message`. Line 246 configures the dialog's negative button to dismiss the dialog. Lines 249–264 configure the dialog's positive button to remove the search. Line 252 removes the tag from the tags collection, and lines 255–258 use a `SharedPreferences.Editor` to remove the search from the app's Shared Preferences. Line 261 then notifies the `RecyclerView.Adapter` that the underlying data has changed so that the `RecyclerView` can update its displayed list of items.

---

```

239 // deletes a search after the user confirms the delete operation
240 private void deleteSearch(final String tag) {
241     // create a new AlertDialog and set its message
242     AlertDialog.Builder confirmBuilder = new AlertDialog.Builder(this);
243     confirmBuilder.setMessage(getString(R.string.confirm_message, tag));
244
245     // configure the negative (CANCEL) Button
246     confirmBuilder.setNegativeButton(getString(R.string.cancel), null);

```

Fig. 8.24 | `MainActivity`'s `deleteSearch` method. (Part I of 2.)

---

```

247
248     // configure the positive (DELETE) Button
249     confirmBuilder.setPositiveButton(getString(R.string.delete),
250         new DialogInterface.OnClickListener() {
251             public void onClick(DialogInterface dialog, int id) {
252                 tags.remove(tag); // remove tag from tags
253
254                 // get SharedPreferences.Editor to remove saved search
255                 SharedPreferences.Editor preferencesEditor =
256                     savedSearches.edit();
257                 preferencesEditor.remove(tag); // remove search
258                 preferencesEditor.apply(); // save the changes
259
260                 // rebind tags to RecyclerView to show updated list
261                 adapter.notifyDataSetChanged();
262             }
263         });
264     );
265
266     confirmBuilder.create().show(); // display AlertDialog
267 }
268 }
```

**Fig. 8.24** | MainActivity's deleteSearch method. (Part 2 of 2.)

## 8.6 SearchesAdapter Subclass of RecyclerView.Adapter

This section presents the RecyclerView.Adapter that binds the items in MainActivity's List<String> named tags to the app's RecyclerView.

### 8.6.1 package Statement, import statements, Instance Variables and Constructor

Figure 8.25 shows the beginning of class SearchesAdapter's definition. The class extends generic class RecyclerView.Adapter, using as its type argument the nested class SearchesAdapter.ViewHolder (defined in Section 8.6.2). The instance variables in lines 17–18 maintain references to the event listeners (defined in class MainActivity) that are registered for each RecyclerView item. The instance variable in line 21 maintains a reference to MainActivity's List<String> that contains the tag names to display.

---

```

1 // SearchesAdapter.java
2 // Subclass of RecyclerView.Adapter for binding data to RecyclerView items
3 package com.deitel.twittersearches;
4
5 import android.support.v7.widget.RecyclerView;
6 import android.view.LayoutInflater;
7 import android.view.View;
```

**Fig. 8.25** | SearchesAdapter package statement, import statements, instance variables and constructor. (Part 1 of 2.)

```
8 import android.view.ViewGroup;
9 import android.widget.TextView;
10
11 import java.util.List;
12
13 public class SearchesAdapter
14     extends RecyclerView.Adapter<SearchesAdapter.ViewHolder> {
15
16     // listeners from MainActivity that are registered for each list item
17     private final View.OnClickListener clickListener;
18     private final View.OnLongClickListener longClickListener;
19
20     // List<String> used to obtain RecyclerView items' data
21     private final List<String> tags; // search tags
22
23     // constructor
24     public SearchesAdapter(List<String> tags,
25         View.OnClickListener clickListener,
26         View.OnLongClickListener longClickListener) {
27         this.tags = tags;
28         this.clickListener = clickListener;
29         this.longClickListener = longClickListener;
30     }
31 }
```

**Fig. 8.25** | SearchesAdapter package statement, import statements, instance variables and constructor. (Part 2 of 2.)

## 8.6.2 Nested ViewHolder Subclass of RecyclerView.ViewHolder

Every item in a RecyclerView must be wrapped in its own RecyclerView.ViewHolder. For this app, we defined a RecyclerView.ViewHolder called ViewHolder (Fig. 8.26). The ViewHolder constructor (line 39–48) receives a View object and listeners for that View's OnClick and OnLongClick events. The View represents an item in the RecyclerView, which is passed to the superclass's constructor (line 42). Line 43 stores a reference to the TextView for the item. Line 46 registers the TextView's OnClickListener, which displays the search results for that TextView's tag. Line 47 registers the TextView's OnLongClickListener, which opens the Share, Edit or Delete dialog for that TextView's tag. The constructor is called when the RecyclerView.Adapter creates a new list item method onCreateViewHolder (Section 8.6.3).

```
32     // nested subclass of RecyclerView.ViewHolder used to implement
33     // the view-holder pattern in the context of a RecyclerView--the logic
34     // of recycling views that have scrolled offscreen is handled for you
35     public static class ViewHolder extends RecyclerView.ViewHolder {
36         public final TextView textView;
37     }
```

**Fig. 8.26** | SearchesAdapter nested ViewHolder subclass of RecyclerView.ViewHolder. (Part 1 of 2.)

---

```

38     // configures a RecyclerView item's ViewHolder
39     public ViewHolder(View itemView,
40         View.OnClickListener clickListener,
41         View.OnLongClickListener longClickListener) {
42         super(itemView);
43         textView = (TextView) itemView.findViewById(R.id.textView);
44
45         // attach listeners to itemView
46         itemView.setOnClickListener(clickListener);
47         itemView.setOnLongClickListener(longClickListener);
48     }
49 }
50

```

**Fig. 8.26** | SearchesAdapter nested ViewHolder subclass of RecyclerView.ViewHolder.  
(Part 2 of 2.)

### 8.6.3 Overridden RecyclerView.Adapter Methods

Figure 8.27 defines the overridden RecyclerView.Adapter methods onCreateViewHolder (lines 52–61), onBindViewHolder (lines 64–67) and getItemCount (lines 70–73).

---

```

51     // sets up new list item and its ViewHolder
52     @Override
53     public ViewHolder onCreateViewHolder(ViewGroup parent,
54         int viewType) {
55         // inflate the list_item layout
56         View view = LayoutInflater.from(parent.getContext()).inflate(
57             R.layout.list_item, parent, false);
58
59         // create a ViewHolder for current item
60         return (new ViewHolder(view, clickListener, longClickListener));
61     }
62
63     // sets the text of the list item to display the search tag
64     @Override
65     public void onBindViewHolder(ViewHolder holder, int position) {
66         holder.textView.setText(tags.get(position));
67     }
68
69     // returns the number of items that adapter binds
70     @Override
71     public int getItemCount() {
72         return tags.size();
73     }
74 }

```

**Fig. 8.27** | SearchesAdapter overridden RecyclerView.Adapter methods onCreateViewHolder, onBindViewHolder and getItemCount.

### **Overriding the `onCreateViewHolder` Method**

The RecyclerView calls its RecyclerView.Adapter's `onCreateViewHolder` method (lines 52–61) to inflate the layout for each RecyclerView item (lines 56–57) and wrap it in an object of the RecyclerView.ViewHolder subclass named ViewHolder (line 60). This new ViewHolder object is then returned to the RecyclerView for display.

### **Overriding the `onBindViewHolder` Method**

The RecyclerView calls its RecyclerView.Adapter's `onBindViewHolder` method (lines 64–67) to set the data that's displayed for a particular RecyclerView item. The method receives:

- an object of our custom subclass of `RecyclerView.ViewHolder` containing the Views in which data will be displayed—in this case, one `TextView`—and
- an `int` representing the item's position in the `RecyclerView`.

Line 66 sets the `TextView`'s text to the `String` in `tags` at the given position.

### **Overriding the `getItemCount` Method**

The RecyclerView calls its RecyclerView.Adapter's `getItemCount` method (lines 70–73) to obtain the total number of items that the RecyclerView needs to display—in this case, the number of items in `tags` (line 72).

## 8.7 ItemDivider Subclass of `RecyclerView.ItemDecoration`

A `RecyclerView.ItemDecoration` object draws *decorations*—such as separators between items—on a RecyclerView. The `RecyclerView.ItemDecoration` subclass `ItemDivider` (Fig. 8.28) draws divider lines between list items. Lines 17–18 in the constructor obtain the predefined Android Drawable resource `android.R.attr.listDivider`, which is the standard Android list-item divider used by default in `ListsViews`.

---

```

1 // ItemDivider.java
2 // Class that defines dividers displayed between the RecyclerView items;
3 // based on Google's sample implementation at bit.ly/DividerItemDecoration
4 package com.deitel.twittersearches;
5
6 import android.content.Context;
7 import android.graphics.Canvas;
8 import android.graphics.drawable.Drawable;
9 import android.support.v7.widget.RecyclerView;
10 import android.view.View;
11
12 class ItemDivider extends RecyclerView.ItemDecoration {
13     private final Drawable divider;
14

```

---

**Fig. 8.28** | `ItemDivider` subclass of `RecyclerView.ItemDecoration` for displaying a horizontal line between items in the `RecyclerView`. (Part I of 2.)

```
15 // constructor loads built-in Android list item divider
16 public ItemDivider(Context context) {
17     int[] attrs = {android.R.attr.listDivider};
18     divider = context.obtainStyledAttributes(attrs).getDrawable(0);
19 }
20
21 // draws the list item dividers onto the RecyclerView
22 @Override
23 public void onDrawOver(Canvas c, RecyclerView parent,
24     RecyclerView.State state) {
25     super.onDrawOver(c, parent, state);
26
27     // calculate left/right x-coordinates for all dividers
28     int left = parent.getPaddingLeft();
29     int right = parent.getWidth() - parent.getPaddingRight();
30
31     // for every item but the last, draw a line below it
32     for (int i = 0; i < parent.getChildCount() - 1; ++i) {
33         View item = parent.getChildAt(i); // get ith list item
34
35         // calculate top/bottom y-coordinates for current divider
36         int top = item.getBottom() + ((RecyclerView.LayoutParams)
37             item.getLayoutParams()).bottomMargin;
38         int bottom = top + divider.getIntrinsicHeight();
39
40         // draw the divider with the calculated bounds
41         divider.setBounds(left, top, right, bottom);
42         divider.draw(c);
43     }
44 }
45 }
```

**Fig. 8.28** | ItemDivider subclass of RecyclerView.ItemDecoration for displaying a horizontal line between items in the RecyclerView. (Part 2 of 2.)

### Overriding the `onDrawOver` Method

As the user scrolls through the RecyclerView's items, the RecyclerView's contents are repeatedly redrawn to display the items in their new positions on the screen. As part of this process, the RecyclerView calls its RecyclerView.ItemDecoration's `onDrawOver` method (lines 22–44) to draw the decorations on the RecyclerView. The method receives:

- a Canvas for drawing the decorations on the RecyclerView.
- the RecyclerView object on which the Canvas draws
- the RecyclerView.State—an object that stores information passed between various RecyclerView components. In this app, we simply pass this value to the superclass's `onDrawOver` method (line 25).

Lines 28–29 calculate the left and right *x*-coordinates that are used to specify the bound's of the Drawable that will be displayed. The left *x*-coordinate is determined by calling the RecyclerView's `getPaddingLeft` method, which returns the amount of padding between the RecyclerView's left edge and its content. The right *x*-coordinate is determined

by calling the RecyclerView's `getWidth` method and subtracting the result of calling the RecyclerView's `getPaddingRight` method, which returns the amount of padding between the RecyclerView's right edge and its content.

Lines 32–43 draw the dividers on the RecyclerView's Canvas by iterating through all but the last item and drawing the dividers below each item. Line 33 gets and stores the current RecyclerView item. Lines 36–37 calculate one divider's top *y*-coordinate, using the item's bottom *y*-coordinate plus the item's margin. Line 38 calculates the divider's bottom *y*-coordinate, using the top *y*-coordinate plus the divider's height—returned by Drawable method `getIntrinsicHeight`. Line 41 sets the divider's bounds and line 42 draws it to the Canvas.

## 8.8 A Note on Fabric: Twitter's New Mobile Development Platform

In Chapter 7, you used REST web services to obtain a weather forecast. Twitter provides extensive REST web services that enable you to integrate Twitter functionality into your apps. Using these web services requires a Twitter developer account and special authentication. The focus of this chapter is not on how to use Twitter's web services. For this reason, the app performs searches as if you enter them directly on the Twitter website in the web browser. The Twitter website then returns the results directly to the device's web browser for display.

Working with the Twitter web services directly using Chapter 7's techniques can be challenging. Twitter recognized this and now offers Fabric—a robust mobile development platform for Android and iOS. Fabric encapsulates the Twitter web services's details in libraries that you incorporate into your projects, making it easier for developers to add Twitter capabilities to their apps. In addition, you can add mobile identity management (called Digits; for user sign-in to websites and apps), advertising-based monetization capabilities (called MoPub) and app crash reporting (called Crashlytics).

To use Fabric, sign up at

<https://get.fabric.io/>

and install the Android Studio plug-in. Once installed, you simply click the plug-in's icon on the Android Studio toolbar and it walks you through the steps that add the Fabric libraries to your project. The preceding website also provides extensive Fabric documentation and tutorials.

## 8.9 Wrap-Up

In this chapter, you created the **Twitter Searches** app. You used a `SharedPreferences` file to store and manipulate key–value pairs representing the user's saved Twitter searches.

We introduced the RecyclerView (from package `android.support.v7.widget`)—a flexible, customizable view that enables you to control how an app displays a scrolling list of data. You learned that RecyclerViews support different layout managers and arranged this app's RecyclerView items vertically using a LinearLayoutManager—a subclass of `RecyclerView.LayoutManager`.

We once again used the view-holder pattern for reusing views that scroll off-screen. You learned that `RecyclerView` formalizes the view-holder pattern, making it required. You created a subclass of `RecyclerView.Adapter` to bind the `RecyclerView`'s list items to data. You also created a subclass of `RecyclerView.ViewHolder` to maintains references to each list item's view for reuse. To display decorations between a `RecyclerView`'s items, you defined a subclass of `RecyclerView.ItemDecoration` to draw divider lines onto the `RecyclerView`.

You used two implicit `Intents` for which you did not specify the precise component that should handle each `Intent`. You used one to launch the device's default web browser to display Twitter search results, based on a search query embedded in a URL, and that displayed an `Intent` chooser, enabling the user to select from a variety of apps that could share text.

Finally, you displayed an `AlertDialog` containing a list of options from which the user could select only one. You used an `AlertDialog.Builder`'s `setItems` method to specify a `String` array resource containing names of the option to display and to set the event handler that was called when the user touched one of the options.

In Chapter 9, we build the database-driven `Address Book` app, which provides quick and easy access to stored contact information and the ability to add contacts, delete contacts and edit existing contacts. You'll learn how to dynamically swap `Fragments` in a GUI and provide layouts that optimize screen real estate on phones and tablets.

# 9

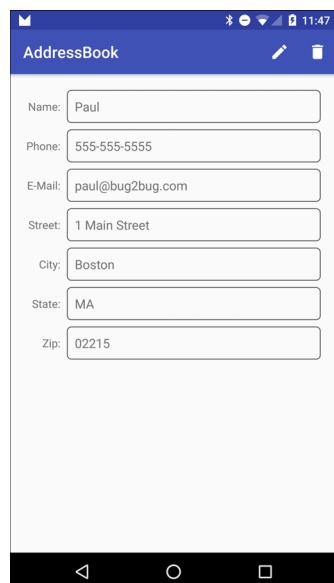
# Address Book App

FragmentTransactions and the Fragment Back Stack,  
SQLite, SQLiteDatabase, SQLiteOpenHelper,  
ContentProvider, ContentResolver, Loader,  
LoaderManager, Cursor and GUI Styles

## Objectives

In this chapter you'll:

- Use **FragmentTransactions** and the back stack to dynamically attach **Fragments** to and detach **Fragments** from the GUI.
- Use a **RecyclerView** to display data from a database.
- Create and open databases with **SQLiteOpenHelper**.
- Use a **ContentProvider** and a **SQLiteDatabase** object to interact with data in a SQLite database.
- Use a **ContentResolver** to invoke methods of a **ContentProvider** to perform tasks with a database.
- Use a **LoaderManager** and **Loaders** to perform database access asynchronously outside the GUI thread.
- Use **Cursors** to manipulate database query results.
- Define styles containing common GUI attributes and values, then apply them to multiple GUI components.



## Outline

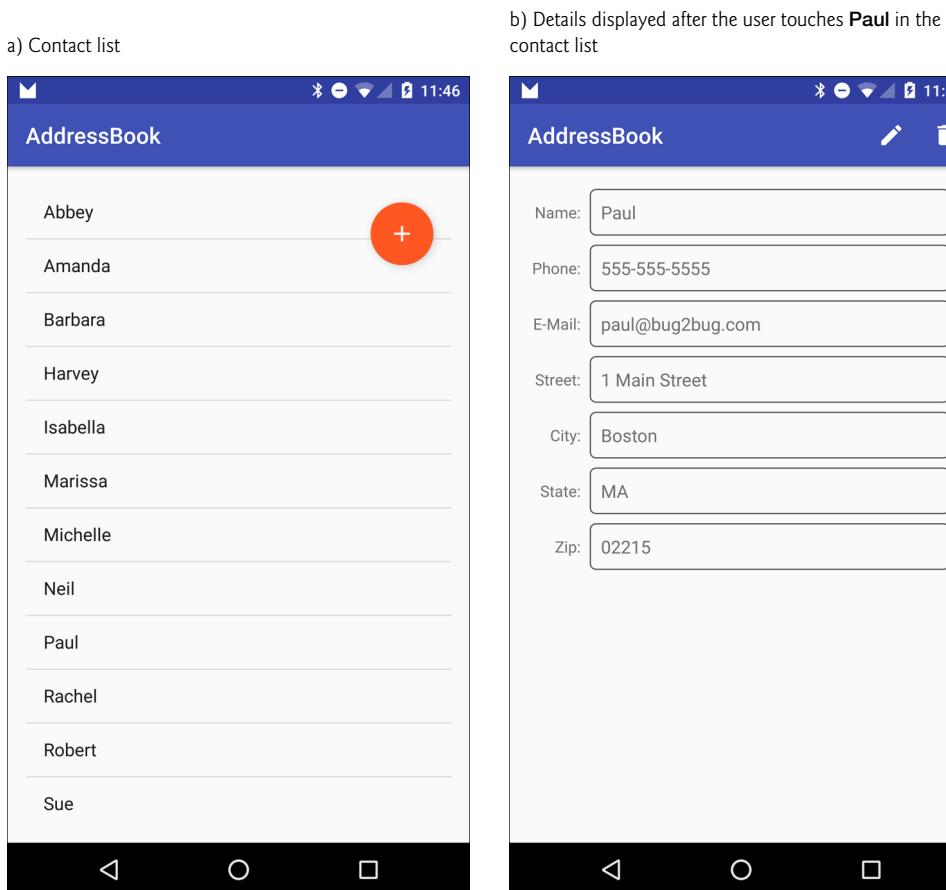
- 9.1 Introduction**
- 9.2 Test-Driving the Address Book App**
  - 9.2.1 Adding a Contact
  - 9.2.2 Viewing a Contact
  - 9.2.3 Editing a Contact
  - 9.2.4 Deleting a Contact
- 9.3 Technologies Overview**
  - 9.3.1 Displaying Fragments with FragmentTransactions
  - 9.3.2 Communicating Data Between a Fragment and a Host Activity
  - 9.3.3 Manipulating a SQLite Database
  - 9.3.4 ContentProviders and ContentResolvers
  - 9.3.5 Loader and LoaderManager—Asynchronous Database Access
  - 9.3.6 Defining Styles and Applying Them to GUI Components
  - 9.3.7 Specifying a TextView Background
- 9.4 Building the GUI and Resource Files**
  - 9.4.1 Creating the Project
  - 9.4.2 Creating the App's Classes
  - 9.4.3 Add the App's Icons
  - 9.4.4 strings.xml
  - 9.4.5 styles.xml
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  - 9.4.7 MainActivity's Layout
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  - 9.4.9 DetailFragment's Layout
  - 9.4.10 AddEditFragment's Layout
  - 9.4.11 DetailFragment's Menu
- 9.5 Overview of This Chapter's Classes**
- 9.6 DatabaseDescription Class**
  - 9.6.1 static Fields
  - 9.6.2 Nested Class Contact
- 9.7 AddressBookDatabaseHelper Class**
- 9.8 AddressBookContentProvider Class**
  - 9.8.1 AddressBookContentProvider Fields
  - 9.8.2 Overridden Methods onCreate and getType
  - 9.8.3 Overridden Method query
  - 9.8.4 Overridden Method insert
  - 9.8.5 Overridden Method update
  - 9.8.6 Overridden Method delete
- 9.9 MainActivity Class**
  - 9.9.1 Superclass, Implemented Interfaces and Fields
- 9.9.2 Overridden Method onCreate
- 9.9.3 ContactsFragment.ContactsFragmentListener Methods
- 9.9.4 Method displayContact
- 9.9.5 Method displayAddEditFragment
- 9.9.6 DetailFragment.DetailFragmentListener Methods
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- 9.10 ContactsFragment Class**
  - 9.10.1 Superclass and Implemented Interface
  - 9.10.2 ContactsFragmentListener
  - 9.10.3 Fields
  - 9.10.4 Overridden Fragment Method onCreateView
  - 9.10.5 Overridden Fragment Methods onAttach and onDetach
  - 9.10.6 Overridden Fragment Method onActivityCreated
  - 9.10.7 Method updateContactList
  - 9.10.8 LoaderManager.LoaderCallbacks<Cursor> Methods
- 9.11 ContactsAdapter Class**
- 9.12 AddEditFragment Class**
  - 9.12.1 Superclass and Implemented Interface
  - 9.12.2 AddEditFragmentListener
  - 9.12.3 Fields
  - 9.12.4 Overridden Fragment Methods onAttach, onDetach and onCreateView
  - 9.12.5 TextWatcher nameChangedListener and Method updateSaveButtonFAB
  - 9.12.6 View.OnClickListener saveContactButtonClicked and Method saveContact
  - 9.12.7 LoaderManager.LoaderCallbacks<Cursor> Methods
- 9.13 DetailFragment Class**
  - 9.13.1 Superclass and Implemented Interface
  - 9.13.2 DetailFragmentListener
  - 9.13.3 Fields
  - 9.13.4 Overridden Methods onAttach, onDetach and onCreateView
  - 9.13.5 Overridden Methods onCreateOptionsMenu and onOptionsItemSelectedSelected
  - 9.13.6 Method deleteContact and DialogFragment confirmDelete
  - 9.13.7 LoaderManager.LoaderCallback<Cursor> Methods
- 9.14 Wrap-Up**

## 9.1 Introduction

The **Address Book** app (Fig. 9.1) provides convenient access to contact information that's stored in a SQLite database on the device. You can:

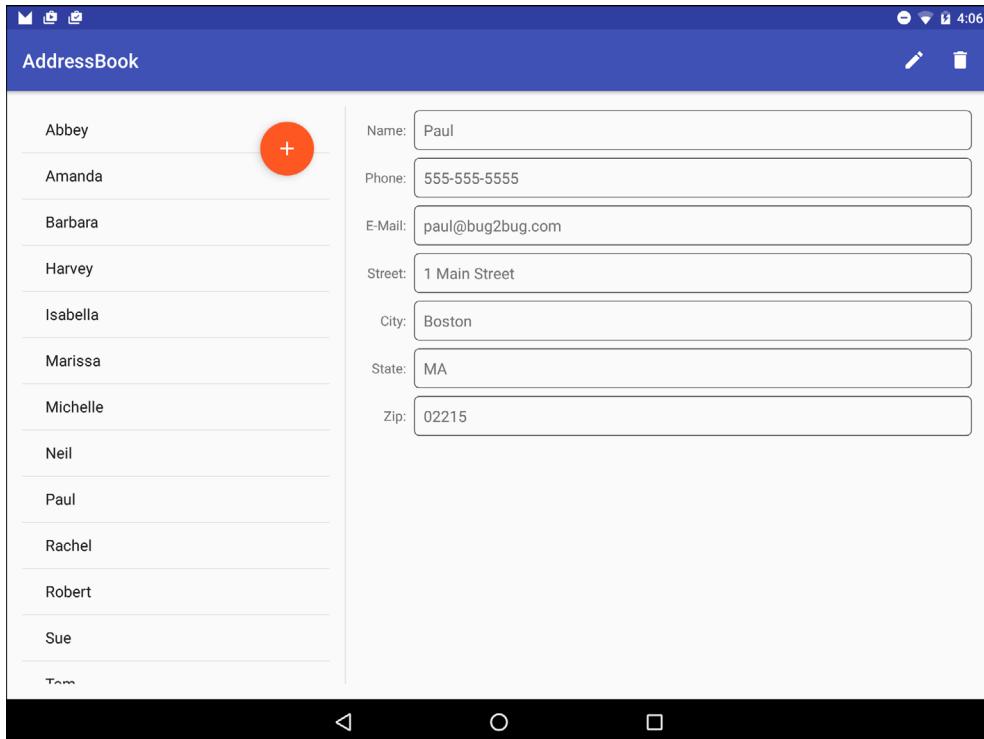
- scroll through an alphabetical contact list
- view a contact's details by touching a contact's name in the contact list
- add new contacts
- edit or delete existing contacts.

The app provides a separate tablet layout (Fig. 9.2) that always displays the contact list in one third of the screen and uses the screen's remaining two thirds to display either the selected contact's data or the screen for adding and editing a contact.



**Fig. 9.1** | Contact list and a selected contact's details.

- a) In landscape orientation on a phone or tablet, the app bar icons are displayed with their text



**Fig. 9.2 | Address Book** running in landscape on a tablet.

This app presents several new technologies:

- You'll dynamically add Fragments to and remove Fragments from an Activity's GUI using FragmentTransactions. You'll also take advantage of the **Fragment back stack** to enable back-button support, so the user can navigate backward through the Fragments that have been displayed.
- You'll display database data in a RecyclerView.
- You'll create and open a database with a subclass of SQLiteOpenHelper.
- You'll use a ContentProvider, a ContentResolver and a SQLiteDatabase object to perform database insert, update, delete and query operations.
- You'll use a LoaderManager and Loaders to perform database access asynchronously outside the GUI thread and to receive those results in the GUI thread.
- Finally, you'll define styles containing common GUI attributes and values, then apply them to multiple GUI components.

First, you'll test-drive the app. Then we'll overview the technologies we used to build it. Next, you'll create the app's GUI and resource files. Finally, we'll present and walk through the app's complete source code, discussing the app's new features in more detail.

## 9.2 Test-Driving the Address Book App

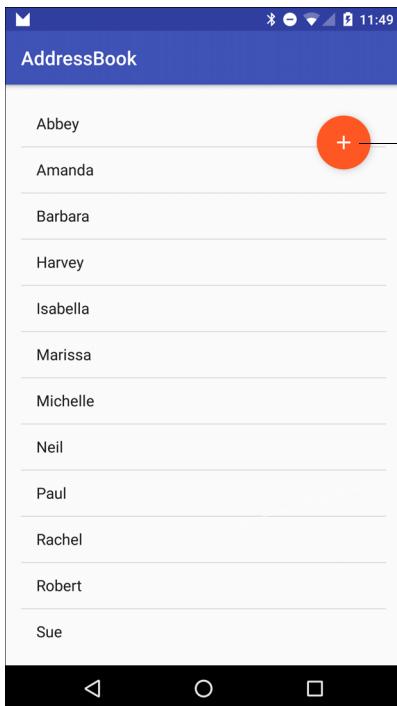
### *Opening and Running the App*

Open Android Studio and open the **Address Book** app from the **AddressBook** folder in the book's examples folder, then execute the app in the AVD or on a device. This builds the project and runs the app.

#### 9.2.1 Adding a Contact

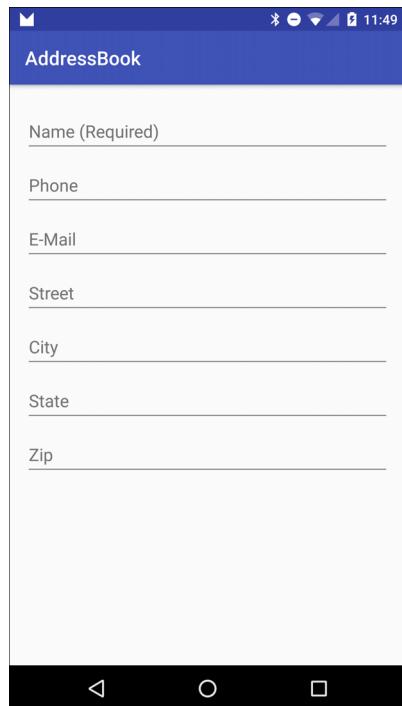
The first time you run the app, the contact list will be empty. Touch the **+** FloatingActionButton to display the screen for adding a new entry (Fig. 9.3). The app requires each contact to have a name, so the save (**□**) FloatingActionButton appears only when the Name EditText is not empty. After adding the contact's information, touch **□** to store the contact in the database and return to the app's main screen. If you choose not to add the contact, you can simply touch the device's back button to return to the main screen. Add more contacts if you wish. On a tablet, after adding a contact, the new contact's details are displayed next to the contact list (Fig. 9.2). Notice that on tablets, the contact list is always displayed.

a) Touch the FloatingActionButton to add a new contact



Touching this button displays a Fragment for entering a new contact

b) Fragment for adding the contact



**Fig. 9.3** | Adding a contact to the database.

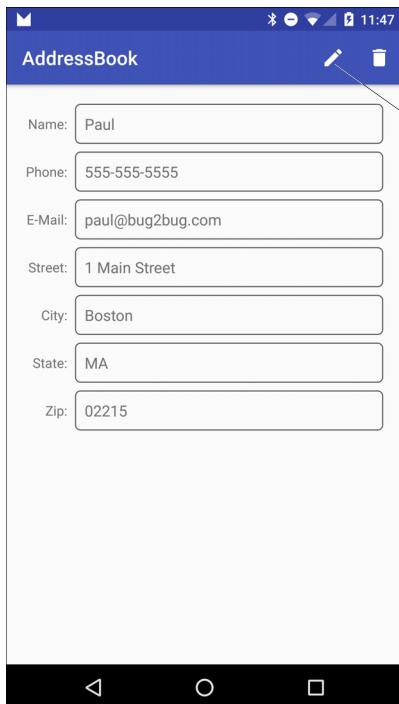
### 9.2.2 Viewing a Contact

On a phone or phone AVD, touch the name of the contact you just added to view that contact's details (as you saw in Fig. 9.1). Again, on a tablet, the details are displayed automatically to the right of the contact list (Fig. 9.2).

### 9.2.3 Editing a Contact

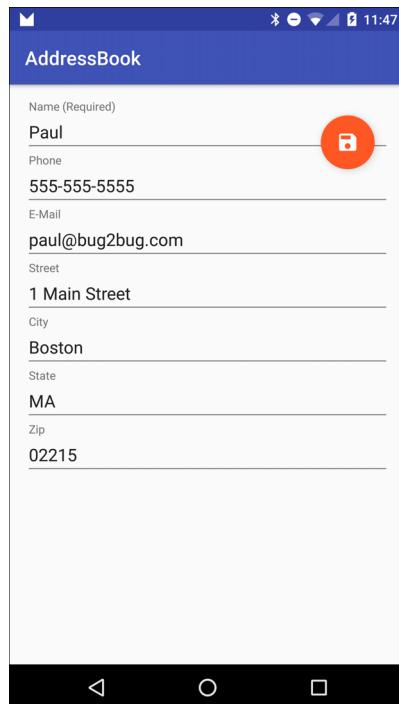
While viewing the contact's details, touch  on the app bar to display a screen of Edit-Texts that are prepopulated with the contact's data (Fig. 9.4). Edit the data as necessary, then touch the **FloatingActionButton**  to store the updated contact in the database and return to the app's main screen. If you choose not to edit the contact, you can simply touch the device's back button () to return to the prior screen. On a tablet, after editing a contact, the updated contact details are displayed to the right of the contact list.

a) Details for a contact



Touch this icon on the app bar to display a Fragment for editing the current contact's data

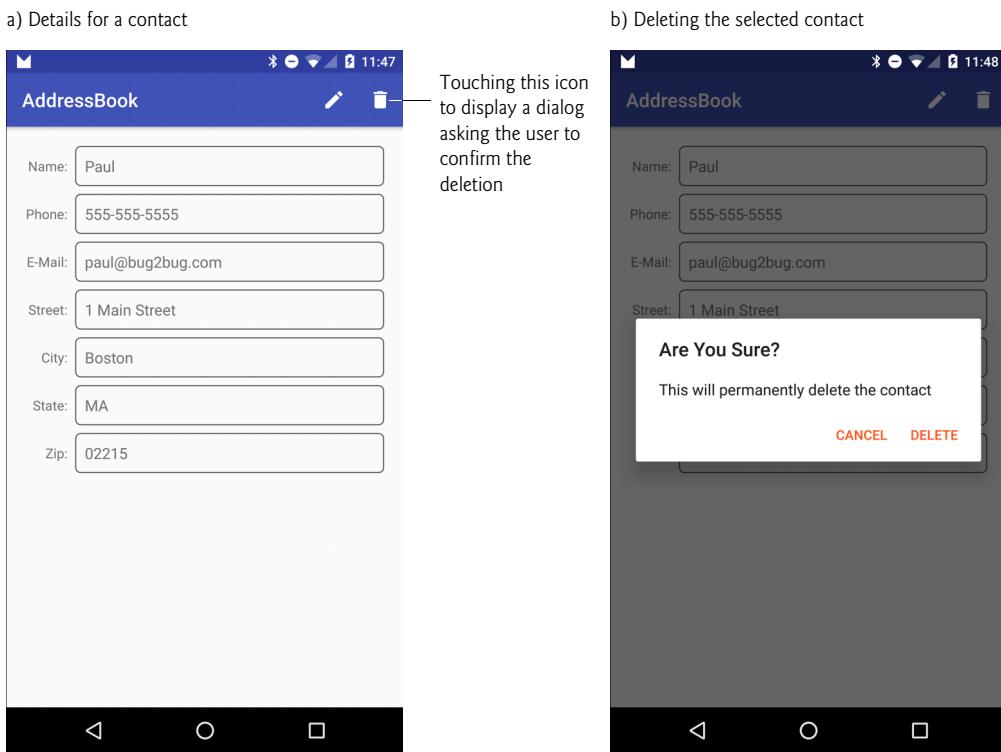
b) Fragment for editing the contact



**Fig. 9.4** | Editing a contact's data.

### 9.2.4 Deleting a Contact

While viewing the contact's details, touch  on the app bar to delete the contact. A dialog will ask you to confirm this action (Fig. 9.5). Touching **DELETE** removes the contact from the database and the app will display the updated contact list. Touching **CANCEL** retains the contact.



**Fig. 9.5** | Deleting a contact from the database.

## 9.3 Technologies Overview

This section introduces the features you'll use to build the **Address Book** app.

### 9.3.1 Displaying Fragments with FragmentTransactions

In earlier apps that used **Fragments**, you declared each **Fragment** in an **Activity**'s layout or, for a **DialogFragment**, called its `show` method to create it. The **Flag Quiz** app demonstrated how to use multiple activities to host each of the app's **Fragments** on a phone device, and a single **Activity** to host multiple **Fragments** on a tablet device.

In this app, you'll use only one **Activity** to host all of the app's **Fragments**. On a phone-sized device, you'll display one **Fragment** at a time. On a tablet, you'll always display the **Fragment** containing the contact list and display the **Fragments** for viewing, adding and editing contacts as they're needed. To do this, you'll use the **FragmentManager** and **FragmentTransactions** to dynamically display **Fragments**. In addition, you'll use Android's **Fragment back stack**—a data structure that stores **Fragments** in last-in-first-out (LIFO) order—to provide automatic support for Android's back button (◀). This enables users to go back to prior **Fragments** via the back button. For more information on **Fragments** and **FragmentTransactions**, visit:

<http://developer.android.com/guide/components/fragments.html>

### 9.3.2 Communicating Data Between a Fragment and a Host Activity

To communicate data between Fragments and a host Activity or the Activity's other Fragments, it's considered best practice to do so through the host Activity—this makes the Fragments more reusable, because they do not refer to one another directly. Typically, each Fragment defines an *interface* of *callback methods* that are implemented in the host Activity. We'll use this technique to enable this app's MainActivity to be notified when the user:

- selects a contact to display,
- touches the contact-list Fragment's add (+) FloatingActionButton,
- touches the contact details Fragment's ✎ or ✖ actions,
- or touches ✕ to finish editing an existing contact or adding a new one.

### 9.3.3 Manipulating a SQLite Database

The contact information is stored in a SQLite database. According to [www.sqlite.org](http://www.sqlite.org), SQLite is one of the world's most widely deployed database engines. You'll use a subclass of **SQLiteOpenHelper** (package `android.database.sqlite`) to simplify creating the database and to obtain a **SQLiteDatabase** object (package `android.database.sqlite`) for manipulating the database's contents. Database queries are performed with Structured Query Language (SQL). Query results are managed via a **Cursor** (package `android.database`). For more information on SQLite in Android, visit:

<http://developer.android.com/guide/topics/data/data-storage.html#db>

### 9.3.4 ContentProviders and ContentResolvers

A **ContentProvider** (package `android.provider`) exposes an app's data for use in that app or in other apps. Android provides various built-in ContentProviders. For example, your apps can interact with data from the Android **Contacts** and **Calendar** apps. There are also ContentProviders for various telephony features, the media store (e.g., for images/video) and the user dictionary (used with Android's predictive text-input capabilities).

In addition to exposing data to other apps, ContentProviders also enable your app to provide custom search suggestions when a user performs searches on a device and are used to support copy-and-paste operations between apps.

In this app, we use a ContentProvider to help access the database asynchronously outside the GUI thread—this is required when working with Loaders and the LoaderManager (introduced in Section 9.3.5). You'll define a subclass of ContentProvider that specifies how to:

- query the database to locate a specific contact or all the contacts
- insert a new contact into the database
- update an existing contact in the database, and
- delete an existing contact from the database.

The ContentProvider will use a subclass of **SQLiteOpenHelper** to create the database and to obtain **SQLiteDatabase** objects to perform the preceding tasks. When changes are made to the database, the ContentProvider will notify listeners of those changes so data can be updated in the GUI.

***Uris***

The `ContentProvider` will define `Uris` that help determine the tasks to perform. For example, in this app the `ContentProvider`'s `query` method is used for two different queries—one that returns a `Cursor` for a single contact and one that returns a `Cursor` for the names of all contacts in the database.

***ContentResolver***

To invoke the `ContentProvider`'s `query`, `insert`, `update` and `delete` capabilities, we'll use the corresponding methods of the `Activity`'s built-in `ContentResolver` (package `android.content`). The `ContentProvider` and `ContentResolver` handle communication for you—including between apps if your `ContentProvider` exposes its data to other apps. As you'll see, the `ContentResolver`'s methods receive as their first argument a `Uri` that specifies the `ContentProvider` to access. Each `ContentResolver` method invokes the corresponding method of the `ContentProvider`, which uses the `Uri` to help determine the task to perform. For more information on `ContentProviders` and `ContentResolvers`, see:

<http://developer.android.com/guide/topics/providers/content-providers.html>

### 9.3.5 Loader and LoaderManager—Asynchronous Database Access

As we've stated previously, long-running operations or operations that block execution until they complete (e.g., file and database access) should be performed outside the GUI thread. This helps maintain application responsiveness and avoid Activity Not Responding (ANR) dialogs that appear when Android determines that the GUI is not responsive. Loaders and the `LoaderManager` help you perform asynchronous data access from any `Activity` or `Fragment`.

***Loaders***

A `Loader` (package `android.content`) performs asynchronous data access. When interacting with a `ContentProvider` to load and manipulate data, you'll typically use a `CursorLoader`—a subclass of `AsyncTaskLoader` that uses an `AsyncTask` to perform the data access in a separate thread. Loaders also:

- Watch for changes to the corresponding data source and make the updated data available to the corresponding `Activity` or `Fragment`.
- Reconnect to the last Loader's `Cursor`, rather than perform a new query, when a configuration change occurs.

***LoaderManager and LoaderManager.LoaderCallbacks***

An `Activity`'s or `Fragment`'s Loaders are created and managed by its `LoaderManager` (package `android.app`), which ties each Loader's lifecycle to its `Activity`'s or `Fragment`'s lifecycle. In addition, a `LoaderManager` invokes methods of the `LoaderManager.LoaderCallbacks` interface to notify an `Activity` or `Fragment` when a Loader

- should be created,
- finishes loading its data, or
- is reset and the data is no longer available.

You'll use Loaders and LoaderManagers in several of this app's Fragment subclasses. For more information about Loaders and LoaderManagers, see:

<http://developer.android.com/guide/components/loaders.html>

### 9.3.6 Defining Styles and Applying Them to GUI Components

You can define common GUI component attribute–value pairs as **style resources** (Section 9.4.5). You can then apply the styles to all components that share those values (Section 9.4.9) by using the **style attribute**. Any subsequent changes you make to a style are automatically applied to all GUI components that use it. We use this to style the TextViews that display a contact's information. For more information on styles, visit:

<http://developer.android.com/guide/topics/ui/themes.html>

### 9.3.7 Specifying a TextView Background

By default TextViews do not have a border. To define one, you can specify a Drawable as the value for the TextView's android:background attribute. The Drawable could be an image, but in this app you'll define a Drawable as a shape in a resource file (Section 9.4.6). Like an image, the resource file for such a Drawable is defined in one (or more) of the app's drawable folders. For more information on drawable resources, visit:

<http://developer.android.com/guide/topics/resources/drawable-resource.html>

## 9.4 Building the GUI and Resource Files

In this section, you'll create the **Address Book** app's additional Java source-code files, resource files and GUI layout files.

### 9.4.1 Creating the Project

Create a new project using the **Blank Activity** template. When configuring the project, check the **Use a Fragment** checkbox. Specify the following values in the **Create New Project** dialog's **New Project** step:

- **Application name:** Address Book
- **Company Domain:** deitel.com (or specify your own domain name)

Follow the steps you used in earlier apps to add an app icon to your project. Follow the steps in Section 4.4.3 to configure Java SE 7 support for the project. Follow the steps in Section 8.4.3 to add the RecyclerView library to this project. In `colors.xml`, change the `colorAccent` color's value to `#FF4081`.

### 9.4.2 Creating the App's Classes

When you create this project, Android Studio defines the classes `MainActivity` and `MainActivityFragment` for you. In this app, we renamed `MainActivityFragment` as `ContactsFragment`. To do so:

1. Open class `MainActivityFragment` in the editor.

2. Right click the class name and select **Refactor > Rename...**. The IDE highlights the class name for editing.
3. Type **ContactsFragment** and press *Enter*. The IDE renames the class and its constructor, and changes class's file name.

### **Package com.deitel.addressbook**

This app consists of seven additional classes that you must add to the project (**File > New > Java Class**). The additional classes in package **com.deitel.addressbook** are:

- Class **ContactsAdapter** is a subclass of **RecyclerView.Adapter** that supplies data to the **ContactsFragment**'s **RecyclerView**.
- Class **AddEditFragment** is a subclass of **Fragment** that provides a GUI for adding a new contact or editing an existing one.
- Class **DetailFragment** is a subclass of **Fragment** that displays one contact's data and provides menu items for editing and deleting that contact.
- Class **ItemDivider** is a subclass of **RecyclerView.ItemDecoration** that the **ContactsFragment**'s **RecyclerView** uses to draw a horizontal line between items. This class is identical to the one in Section 8.7, so you can simply copy this class from the **Twitter Searches** app's project and paste it into the **app > java > com.deitel.addressbook** node in the **Project** window.

### **Package com.deitel.addressbook.data**

This class also defines a nested package named **com.deitel.addressbook.data** that contains the classes used to manipulate this app's database. To create the package:

1. In the **Project** window, right click the package **com.deitel.addressbook** and select **New > Package**.
2. Type **data** as the new package name to create the **com.deitel.addressbook.data** package.

Next add the following classes to the **com.deitel.addressbook.data** package:

- Class **DatabaseDescription** describes the database's contacts table.
- Class **AddressBookDatabaseHelper** is a subclass of **SQLiteOpenHelper** that creates the database and is used to access the database.
- Class **AddressBookContentProvider** is a subclass of **ContentProvider** that defines how to manipulate the database. To create this class, use **New > Other > Content Provider**. For **URI authorities** specify **com.deitel.addressbook.data** and uncheck the **Exported** checkbox, then click **Finish**. Unchecking **Exported** indicates that this **ContentProvider** is for use only in this app. The IDE defines a subclass of **ContentProvider** and overrides its required methods. In addition, the IDE declares the **ContentProvider** **AndroidManifest.xml** as a **<provider>** element nested in the **<application>** element. This is *required* to register the **ContentProvider** with the Android operating system—not only for use in this app, but for use in other apps (when the **ContentProvider** is exported).

We overview all of the classes in Section 9.5 and discuss their details in Sections 9.6–9.13.

### 9.4.3 Add the App's Icons

Use Android Studio's **Vector Asset Studio** (Section 4.4.9) to add the material design save (💾), add (+), edit (✍) and delete (trash) icons to the project—this will be used as the `FloatingActionButton`'s icon. After adding the vector icons, go to the project's `res/drawable` folder, open each icon's XML file and change the `<path>` element's `android:fillColor` to

```
"@android:color/white"
```

### 9.4.4 strings.xml

Figure 9.6 shows this app's `String` resource names and corresponding values. Double click `strings.xml` in the `res/values` folder to display the resource editor for creating these `String` resources.

| Resource name                    | Value                                    |
|----------------------------------|--|
| <code>menuitem_edit</code>       | Edit                                     |
| <code>menuitem_delete</code>     | Delete                                   |
| <code>hint_name_required</code>  | Name (Required)                          |
| <code>hint_email</code>          | E-Mail                                   |
| <code>hint_phone</code>          | Phone                                    |
| <code>hint_street</code>         | Street                                   |
| <code>hint_city</code>           | City                                     |
| <code>hint_state</code>          | State                                    |
| <code>hint_zip</code>            | Zip                                      |
| <code>label_name</code>          | Name:                                    |
| <code>label_email</code>         | E-Mail:                                  |
| <code>label_phone</code>         | Phone:                                   |
| <code>label_street</code>        | Street:                                  |
| <code>label_city</code>          | City:                                    |
| <code>label_state</code>         | State:                                   |
| <code>label_zip</code>           | Zip:                                     |
| <code>confirm_title</code>       | Are You Sure?                            |
| <code>confirm_message</code>     | This will permanently delete the contact |
| <code>button_cancel</code>       | Cancel                                   |
| <code>button_delete</code>       | Delete                                   |
| <code>contact_added</code>       | Contact added successfully               |
| <code>contact_not_added</code>   | Contact was not added due to an error    |
| <code>contact_updated</code>     | Contact updated                          |
| <code>contact_not_updated</code> | Contact was not updated due to an error  |

**Fig. 9.6** | String resources used in the **Address Book** app. (Part I of 2.)

| Resource name      | Value               |
|--------------------|---------------------|
| invalid_query_uri  | Invalid query Uri:  |
| invalid_insert_uri | Invalid insert Uri: |
| invalid_update_uri | Invalid update Uri: |
| invalid_delete_uri | Invalid delete Uri: |
| insert_failed      | Insert failed: s    |

**Fig. 9.6** | String resources used in the **Address Book** app. (Part 2 of 2.)

#### 9.4.5 styles.xml

In this section, you'll define the styles for the `DetailFragment`'s `TextViews` that display a contact's information (Section 9.4.9). Like other resources, style resources are placed in the app's `res/values` folder. When you create a project, the IDE creates a `styles.xml` file containing predefined styles. Each new style you create specifies a name that's used to apply that style to GUI components and one or more items specifying property values to apply. To create the new styles, in the app's `res/values` folder, open the `styles.xml` file then add the code in Fig. 9.7 before the file's closing `</resources>` tag. When you're done, save and close `styles.xml`.

---

```

1 <style name="ContactLabelTextview">
2   <item name="android:layout_width">wrap_content</item>
3   <item name="android:layout_height">wrap_content</item>
4   <item name="android:layout_gravity">right|center_vertical</item>
5 </style>
6
7 <style name="ContactTextview">
8   <item name="android:layout_width">wrap_content</item>
9   <item name="android:layout_height">wrap_content</item>
10  <item name="android:layout_gravity">fill_horizontal</item>
11  <item name="android:textSize">16sp</item>
12  <item name="android:background">@drawable/textview_border</item>
13 </style>

```

---

**Fig. 9.7** | New styles for formatting the `DetailFragment`'s `TextViews`.

Lines 1–5 define a new style named `ContactLabelTextview` that defines values for the layout properties `layout_width`, `layout_height` and `layout_gravity`. You'll apply this style to the `DetailFragment`'s `TextViews` displayed to the left of each piece of a contact's information. Each new style consists of a `style` element containing `item` elements. The `style`'s `name` is used to apply it. An `item` element's `name` specifies the property to set and its value is assigned to that property when the style is applied to a view. Lines 7–13 define another new style named `ContactTextview` that will be applied to the `DetailFragment`'s `TextViews` that display the contact's information. Line 12 sets the property `android:background` to the `drawable` resource defined in Section 9.4.6.

### 9.4.6 `textview_border.xml`

The style `ContactTextView` that you created in the preceding section defines the appearance of the `TextViews` that are used to display a contact's details. You specified a `Drawable` (i.e., an image or graphic) named `@drawable/textview_border` as the value for the `TextViews`'s `android:background` attribute. In this section, you'll define that `Drawable` in the app's `res/drawable` folder. To define that `Drawable`:

1. Right click the `res/drawable` folder and select **New > Drawable resource file**.
2. Specify `textview_border.xml` as the **File name** and click **OK**.
3. Replace the file's contents with the XML code in Fig. 9.8.

---

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <shape xmlns:android="http://schemas.android.com/apk/res/android"
3     android:shape="rectangle">
4     <corners android:radius="5dp"/>
5     <stroke android:width="1dp" android:color="#555"/>
6     <padding android:top="10dp" android:left="10dp" android:bottom="10dp"
7         android:right="10dp"/>
8 </shape>
```

---

**Fig. 9.8** | XML representation of a `Drawable` that's used to place a border on a `TextView`.

The **shape** element's `android:shape` attribute (line 3) can have the value "rectangle" (used in this example), "oval", "line" or "ring". The **corners** element (line 4) specifies the rectangle's corner radius, which rounds the corners. The **stroke** element (line 5) defines the rectangle's line width and line color. The **padding** element (lines 6–7) specifies the spacing around the content in the element to which this `Drawable` is applied. You must specify the top, left, bottom and right padding amounts separately. The complete details of defining shapes can be viewed at:

<http://developer.android.com/guide/topics/resources/drawable-resource.html#Shape>

### 9.4.7 `MainActivity`'s Layout

By default, `MainActivity`'s layout contains a `FloatingActionButton` and includes the layout file `content_main.xml`. In this app, we provide `FloatingActionButtons` as needed in the app's `Fragments`. For this reason, open `activity_main.xml` in the `res/layout` folder and remove the predefined `FloatingActionButton`. Also, set the `CoordinatorLayout`'s `id` to `coordinatorLayout`—we use this when displaying `SnackBars`. Remove the code that configures the `FloatingActionButton` from `MainActivity`'s `onCreate` method.

#### *Phone Layout: `content_main.xml`*

In this app, you'll provide two `content_main.xml` layouts to be included into `MainActivity`—one for phone-sized devices and one for tablet-sized devices. For the phone layout, open `content_main.xml` in the `res/layout` folder and replace its contents with the XML in Fig. 9.9. `MainActivity` dynamically displays the app's `Fragments` in the `FrameLayout` named `fragmentContainer`. This layout fills the available space in `MainActivity`'s layout with `16dp` padding on all sides. The `app:layout_behavior` property (line 20) is used by

`activity_main.xml`'s CoordinatorLayout to manage interactions between its views. Setting this property ensures that the contents of the FrameLayout scroll below the Toolbar defined in `activity_main.xml`.

---

```

9 <FrameLayout
10     android:id="@+id/fragmentContainer"
11     xmlns:android="http://schemas.android.com/apk/res/android"
12     xmlns:app="http://schemas.android.com/apk/res-auto"
13     xmlns:tools="http://schemas.android.com/tools"
14     android:layout_width="match_parent"
15     android:layout_height="match_parent"
16     android:paddingBottom="@dimen/activity_vertical_margin"
17     android:paddingLeft="@dimen/activity_horizontal_margin"
18     android:paddingRight="@dimen/activity_horizontal_margin"
19     android:paddingTop="@dimen/activity_vertical_margin"
20     app:layout_behavior="@string/appbar_scrolling_view_behavior"
21     tools:context=".MainActivity"/>

```

---

**Fig. 9.9** | `content_main.xml` used on a phone device.

#### *Tablet Layout: `content_main.xml` for Large Devices*

Create the new tablet layout `content_main.xml` (as in Section 4.5.4). This layout should use a horizontal LinearLayout containing a ContactsFragment and an empty FrameLayout as shown in Fig. 9.10. Create the `divider_margin` resource (16dp) used in lines 24 and 32. This LinearLayout uses several properties that we have not discussed previously:

- `divider` (line 9)—This property specifies a `drawable` resource that's used to separate items in the LinearLayout. In this case, we use the predefined Android `drawable` theme resource `?android:listDivider`. The `?android:` indicates that the LinearLayout should use the list divider defined in the current theme.
- `showDividers` (line 15)—This property is used with the `divider` property to specify where the dividers appear—in this case, `middle` indicates that the dividers should appear only between the LinearLayout's elements. You can also display a divider before the first item in the layout (`beginning`) and after the last item (`end`), and you can combine these values using `|`.
- `weightSum` (line 16)—This helps allocate the horizontal space between the ContactsFragment and FrameLayout. Setting `weightSum` to 3, then setting the ContactsFragment's and FrameLayout's `layout_weights` to 1 and 2, respectively, indicates that the ContactsFragment should occupy one-third of the LinearLayout's width and the FrameLayout should occupy the remaining two-thirds.

---

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <LinearLayout
3     xmlns:android="http://schemas.android.com/apk/res/android"
4     xmlns:app="http://schemas.android.com/apk/res-auto"
5     xmlns:tools="http://schemas.android.com/tools"
6     android:layout_width="match_parent"

```

---

**Fig. 9.10** | `content_main.xml` used on a tablet device. (Part 1 of 2.)

```

7   android:layout_height="match_parent"
8   android:baselineAligned="false"
9   android:divider="?android:listDivider"
10  android:orientation="horizontal"
11  android:paddingBottom="@dimen/activity_vertical_margin"
12  android:paddingLeft="@dimen/activity_horizontal_margin"
13  android:paddingRight="@dimen/activity_horizontal_margin"
14  android:paddingTop="@dimen/activity_vertical_margin"
15  android:showDividers="middle"
16  android:weightSum="3"
17  app:layout_behavior="@string/appbar_scrolling_view_behavior">
18
19 <fragment
20   android:id="@+id/contactsFragment"
21   android:name="com.deitel.addressbook.ContactsFragment"
22   android:layout_width="0dp"
23   android:layout_height="match_parent"
24   android:layout_marginEnd="@dimen/divider_margin"
25   android:layout_weight="1"
26   tools:layout="@layout/fragment_contacts"/>
27
28 <FrameLayout
29   android:id="@+id/rightPaneContainer"
30   android:layout_width="0dp"
31   android:layout_height="match_parent"
32   android:layout_marginStart="@dimen/divider_margin"
33   android:layout_weight="2"/>
34 </LinearLayout>

```

**Fig. 9.10** | content\_main.xml used on a tablet device. (Part 2 of 2.)

#### 9.4.8 ContactsFragment's Layout

In addition to renaming class `MainActivityFragment` as `ContactsFragment`, we renamed the corresponding layout file as `fragment_contacts.xml`. We then removed the default `TextView`, changed the default layout from a `RelativeLayout` to a `FrameLayout` and removed the layout's padding properties. Next, we added a `RecyclerView` named `recyclerView` and a `FloatingActionButton` named `addButton`. The layout's final XML is shown in Fig. 9.11. Ensure that you set the `RecyclerView` and a `FloatingActionButton` properties as shown.

```

1 <FrameLayout
2   xmlns:android="http://schemas.android.com/apk/res/android"
3   android:layout_width="match_parent"
4   android:layout_height="match_parent">
5
6   <android.support.v7.widget.RecyclerView
7     android:id="@+id/recyclerView"
8     android:layout_width="match_parent"
9     android:layout_height="match_parent"/>
10

```

**Fig. 9.11** | fragment\_contacts.xml layout. (Part 1 of 2.)

```

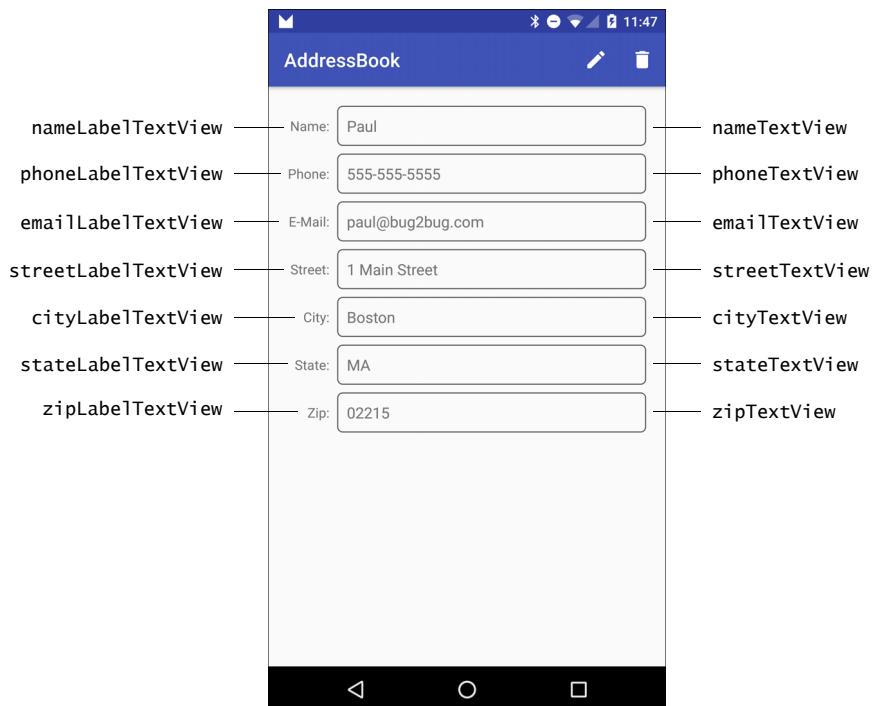
11 <android.support.design.widget.FloatingActionButton
12     android:id="@+id/addButton"
13     android:layout_width="wrap_content"
14     android:layout_height="wrap_content"
15     android:layout_gravity="top|end"
16     android:layout_margin="@dimen/fab_margin"
17     android:src="@drawable/ic_add_24dp"/>
18 </FrameLayout>

```

**Fig. 9.11** | fragment\_contacts.xml layout. (Part 2 of 2.)

#### 9.4.9 DetailFragment's Layout

When the user touches a contact in the `MainActivity`, the app displays the `DetailFragment` (Fig. 9.12). This Fragment's layout (`fragment_details.xml`) consists of a `ScrollView` containing a vertical `GridLayout` with two columns of `TextViews`. A `ScrollView` is a **ViewGroup** that provides scrolling functionality for a view with content too large to display on the screen. We use a `ScrollView` here to ensure that the user can scroll through a contact's details if a device does not have enough vertical space to show all the `TextViews` in Fig. 9.12. For this fragment, create a new `fragment_details.xml` layout resource file and specify a `ScrollView` as the **Root Element**. After creating the file add a `GridLayout` to the `ScrollView`.



**Fig. 9.12** | DetailFragment's GUI components labeled with their `id` property values.

### **GridLayout Settings**

For the GridLayout, we set the `layout:width` to `match_parent`, `layout:height` to `wrap_content`, `columnCount` to 2 and `useDefaultMargins` to true. The `layout:height` value enables the parent ScrollView to determine the GridLayout's actual height and decide whether to provide scrolling. Add TextViews to the GridLayout as shown in Fig. 9.12.

### **Left Column TextView Settings**

For each TextView in the left column set the TextView's `id` property as specified in Fig. 9.12 and set:

- `layout:row` to a value from 0–6 depending on the row.
- `layout:column` to 0.
- `text` to the appropriate String resource from `strings.xml`.
- `style` to `@style/ContactLabelTextView`—style resources are specified using the syntax `@style/styleName`.

### **Right Column TextView Settings**

For each TextView in the right column set the TextView's `id` property as specified in Fig. 9.12 and set:

- `layout:row` to a value from 0–6 depending on the row.
- `layout:column` to 1.
- `style` to `@style/ContactTextView`.

## **9.4.10 AddEditFragment's Layout**

When the user touches the FloatingActionButton in the ContactsFragment or the edit () app bar item in the DetailFragment, the MainActivity displays the AddEditFragment (Fig. 9.13) with the layout `fragment_add_edit.xml` with a root FrameLayout that contains a ScrollView and a FloatingActionButton. The ScrollView contains a vertical LinearLayout with seven TextInputLayouts.

### **ScrollView Settings**

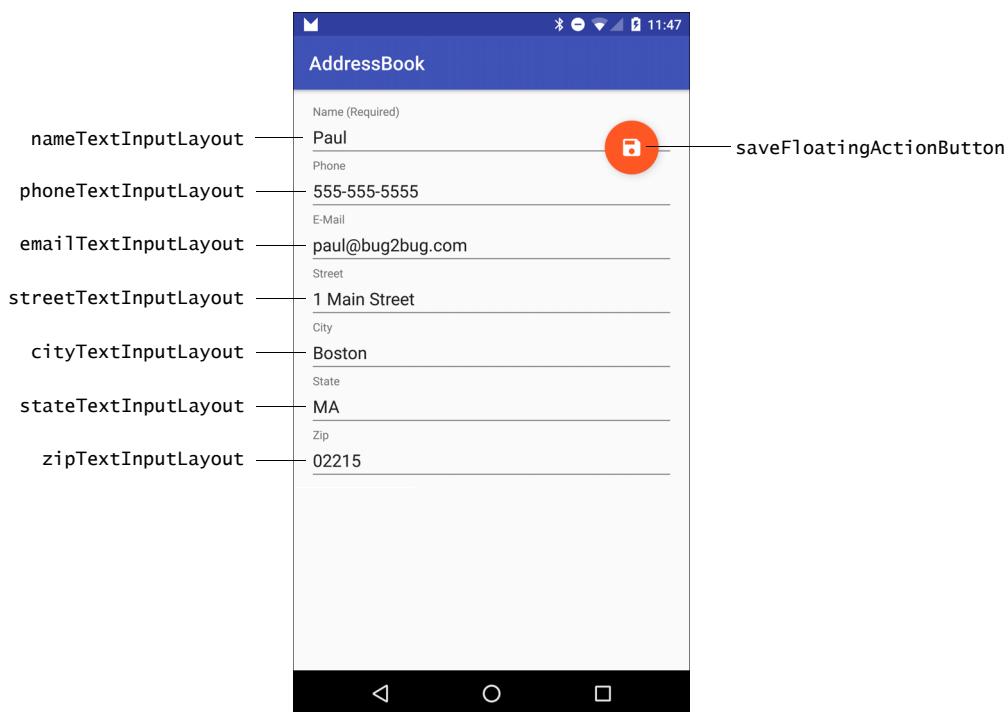
For the ScrollView, we set the `layout:width` and `layout:height` to `match_parent`.

### **LinearLayout Settings**

For the LinearLayout, we set the `layout:width` to `match_parent`, the `layout:height` to `wrap_content` and the `orientation` to `vertical`. We then added the seven TextInputLayouts with the ids in Fig. 9.13, each with its `layout:width` set to `match_parent` and `layout:height` to `wrap_content`.

### **EditText Settings**

We placed an EditText in each TextInputLayout, then set its `hint` property to the appropriate String resource in `strings.xml`. We also set each EditText's `inputType` and `imeOptions` properties. For devices that display a soft keyboard, the `inputType` specifies which keyboard to display for the corresponding EditText. This enables us to *customize the keyboard* to the specific type of data the user must enter in a given EditText. To display a next button () on the soft keyboards for the EditTexts in the nameTextInputLayout,



**Fig. 9.13** | AddEditFragment's GUI components labeled with their `id` property values. This GUI's root component is a `ScrollView` that contains a vertical `GridLayout`.

For `phoneTextInputLayout`, `emailTextInputLayout`, `streetTextInputLayout`, `cityTextInputLayout` and `stateTextInputLayout`, we set the `imeOptions` property to `actionNext`. When one of these `EditTexts` has the focus, touching transfers the focus to the next `EditText` in the layout. If the `EditText` in the `zipTextInputLayout` has the focus, you can hide the soft keyboard by touching the keyboard's button—for this `EditText`, set the `imeOptions` property to `actionDone`.

Set the `EditTexts`' `inputType` properties to display appropriate keyboards as follows:

- `nameTextInputLayout`'s `EditText`: check `textPersonName` and `textCapWords`—for entering names and starts each word with a capital letter.
- `phoneTextInputLayout`'s `EditText`: check `phone`—for entering phone numbers.
- `emailTextInputLayout`'s `EditText`: check `textEmailAddress`—for entering an e-mail address.
- `streetTextInputLayout`'s `EditText`: check `textPostalAddress` and `textCapWords`—for entering an address and starts each word with a capital letter.
- `cityTextInputLayout`'s `EditText`: check `textPostalAddress` and `textCapWords`.
- `stateTextInputLayout`'s `EditText`: check `textPostalAddress` and `textCapCharacters`—ensures that state abbreviations are displayed in capital letters.
- `zipTextInputLayout`'s `EditText`: check `number`—for entering numbers.

#### 9.4.11 DetailFragment's Menu

When you created the project, the IDE defined the menu resource `menu_main.xml`. The `MainActivity` in this app does not need a menu, so you can remove `MainActivity`'s `onCreateOptionsMenu` and `onOptionsItemSelected` methods, and rename this menu resource for use in the `DetailFragment`, which displays menu items on the app bar for editing an existing contact and deleting a contact. Rename the file `menu_main.xml` as `fragment_details_menu.xml`, then replace the `Settings` menu item with the menu items in Fig. 9.14. For each menu item's `android:icon` value, we specified a drawable resource that you added in Section 9.4.3.

---

```
1  <?xml version="1.0" encoding="utf-8"?>
2  <menu xmlns:android="http://schemas.android.com/apk/res/android"
3      xmlns:app="http://schemas.android.com/apk/res-auto">
4
5      <item
6          android:id="@+id/action_edit"
7          android:icon="@drawable/ic_mode_edit_24dp"
8          android:orderInCategory="1"
9          android:title="@string/menuitem_edit"
10         app:showAsAction="always"/>
11
12      <item
13          android:id="@+id/action_delete"
14          android:icon="@drawable/ic_delete_24dp"
15          android:orderInCategory="2"
16          android:title="@string/menuitem_delete"
17         app:showAsAction="always"/>
18  </menu>
```

**Fig. 9.14** | Menu resource file `fragment_details_menu.xml`.

## 9.5 Overview of This Chapter's Classes

This app consists of nine classes in two packages. Due to the size of this app we overview the classes and their purposes here.

### *com.deitel.addressbook.data Package*

This package contains the three classes that define this app's SQLite database access:

- `DatabaseDescription` (Section 9.6)—This class contains `public static` fields that are used with the app's `ContentProvider` and `ContentResolver`. The nested `Contact` class defines `static` fields for the name of a database table, the `Uri` used to access that table via the `ContentProvider` and the names of the database table's columns, and a `static` method for creating a `Uri` that references a specific contact in the database.
- `AddressBookDatabaseHelper` (Section 9.7)—A subclass of `SQLiteOpenHelper` that creates the database and enables `AddressBookContentProvider` to access it.
- `AddressBookContentProvider` (Section 9.8)—A `ContentProvider` subclass that defines `query`, `insert`, `update` and `delete` operations on the database.

***com.deitel.addressbook Package***

This package contains the classes that define this app’s `MainActivity`, `Fragments` and the adapter that’s used to display database contents in a `RecyclerView`:

- `MainActivity` (Section 9.9)—This class manages the app’s `Fragments` and implements their callback interface methods to respond when a contact is selected, a new contact is added, or an existing contact is updated or deleted.
- `ContactsFragment` (Section 9.10)—This class manages the contact-list `RecyclerView` and the `FloatingActionButton` for adding contacts. On a phone, this is the first `Fragment` presented by `MainActivity`. On a tablet, `MainActivity` always displays this `Fragment`. `ContactsFragment`’s nested interface defines callback methods implemented by `MainActivity` so that it can respond when a contact is selected or added.
- `ContactsAdapter` (Section 9.11)—This subclass of `RecyclerView.Adapter` is used by `ContactsFragment`’s `RecyclerView` to bind the sorted list of contact names to the `RecyclerView`. `RecyclerView.Adapter` was introduced in Sections 8.3.4 and 8.6, so we discuss only the database-specific operations in this class.
- `AddEditFragment` (Section 9.12)—This class manages the `TextInputLayouts` and a `FloatingActionButton` for adding a new contact or editing an existing one. `AddEditFragment`’s nested interface defines a callback method implemented by `MainActivity` so that it can respond when a new or updated contact is saved.
- `DetailFragment` (Section 9.13)—This class manages the styled `TextViews` that display a selected contact’s details and the app bar items that enable the user to edit or delete the currently displayed contact. `DetailFragment`’s nested interface defines callback methods implemented by `MainActivity` so that it can respond when a contact is deleted or when the user touches the app bar item to edit a contact.
- `ItemDivider`—This class defines the divider that’s displayed between items in the `ContactsFragment`’s `RecyclerView`. We do not present the class in the chapter, because it’s identical to the one presented in Section 8.7.

## 9.6 DatabaseDescription Class

Class `DatabaseDescription` contains `static` fields that are used with the app’s `ContentProvider` and `ContentResolver`, and a nested `Contact` class that describes the database’s only table and its columns.

### 9.6.1 static Fields

Class `DatabaseDescription` defines two `static` fields (Fig. 9.15; lines 12–17) that together are used to define the `ContentProvider`’s `authority`—the name that’s supplied to a `ContentResolver` to locate a `ContentProvider`. The authority is typically the package name of the `ContentProvider` subclass. Each `Uri` that’s used to access a specific `ContentProvider` begins with “`content://`” followed by the authority—this is the `ContentProvider`’s base `Uri`. Line 17 uses `Uri` method `parse` to create the base `Uri`.

---

```

1 // DatabaseDescription.java
2 // Describes the table name and column names for this app's database,
3 // and other information required by the ContentProvider
4 package com.deitel.addressbook.data;
5
6 import android.content.ContentUris;
7 import android.net.Uri;
8 import android.provider.BaseColumns;
9
10 public class DatabaseDescription {
11     // ContentProvider's name: typically the package name
12     public static final String AUTHORITY =
13         "com.deitel.addressbook.data";
14
15     // base URI used to interact with the ContentProvider
16     private static final Uri BASE_CONTENT_URI =
17         Uri.parse("content://" + AUTHORITY);
18

```

---

**Fig. 9.15** | DatabaseDescription class declaration and static fields.

### 9.6.2 Nested Class Contact

The nested class `Contact` (Fig. 9.16) defines the database's table name (line 21), the table's `Uri` for accessing the table via the `ContentProvider` (lines 24–25) and the table's column names (lines 28–34). The table name and column names will be used by the `AddressBookDatabaseHelper` class (Section 9.7) to create the database. Method `buildContactUri` creates a `Uri` for a specific contact in the database table (lines 37–39). Class `ContentUris` (package `android.content`) contains static utility methods for manipulating "content://" `Urises`. Method `withAppendedId` appends a forward slash (/) and a record ID to the end of the `Uri` in its first argument. For every database table, you'd typically have a class similar to class `Contact`.

---

```

19 // nested class defines contents of the contacts table
20 public static final class Contact implements BaseColumns {
21     public static final String TABLE_NAME = "contacts"; // table's name
22
23     // Uri for the contacts table
24     public static final Uri CONTENT_URI =
25         BASE_CONTENT_URI.buildUpon().appendPath(TABLE_NAME).build();
26
27     // column names for contacts table's columns
28     public static final String COLUMN_NAME = "name";
29     public static final String COLUMN_PHONE = "phone";
30     public static final String COLUMN_EMAIL = "email";
31     public static final String COLUMN_STREET = "street";
32     public static final String COLUMN_CITY = "city";
33     public static final String COLUMN_STATE = "state";
34     public static final String COLUMN_ZIP = "zip";
35

```

---

**Fig. 9.16** | DatabaseDescription nested class Contact. (Part 1 of 2.)

---

```

36     // creates a Uri for a specific contact
37     public static Uri buildContactUri(long id) {
38         return ContentUris.withAppendedId(CONTENT_URI, id);
39     }
40 }
41 }
```

---

**Fig. 9.16** | DatabaseDescription nested class Contact. (Part 2 of 2.)

In a database table, each row typically has a primary key that uniquely identifies the row. When working with `ListView`s and `Cursors`, this column's name must be `"_id"`—Android also uses this for the ID column in SQLite database tables. This name is not required for `RecyclerView`s, but we use it here due to the similarities between `ListView`s and `RecyclerView`s, and because we're using `Cursors` and a SQLite database. Rather than defining this constant directly in class `Contact`, we implement interface `BaseColumns` (package `android.provider`; line 20), which defines the constant `_ID` with the value `"_id"`.

## 9.7 AddressBookDatabaseHelper Class

The `AddressBookDatabaseHelper` class (Fig. 9.17) extends abstract class `SQLiteOpenHelper`, which helps apps create databases and manage database version changes.

---

```

1 // AddressBookDatabaseHelper.java
2 // SQLiteOpenHelper subclass that defines the app's database
3 package com.deitel.addressbook.data;
4
5 import android.content.Context;
6 import android.database.sqlite.SQLiteDatabase;
7 import android.database.sqlite.SQLiteOpenHelper;
8
9 import com.deitel.addressbook.data.DatabaseDescription.Contact;
10
11 class AddressBookDatabaseHelper extends SQLiteOpenHelper {
12     private static final String DATABASE_NAME = "AddressBook.db";
13     private static final int DATABASE_VERSION = 1;
14
15     // constructor
16     public AddressBookDatabaseHelper(Context context) {
17         super(context, DATABASE_NAME, null, DATABASE_VERSION);
18     }
19
20     // creates the contacts table when the database is created
21     @Override
22     public void onCreate(SQLiteDatabase db) {
23         // SQL for creating the contacts table
24         final String CREATE_CONTACTS_TABLE =
25             "CREATE TABLE " + Contact.TABLE_NAME + "(" +
```

---

**Fig. 9.17** | `AddressBookDatabaseHelper` subclass of `SQLiteOpenHelper` defines the app's database. (Part 1 of 2.)

```

26      Contact._ID + " integer primary key, " +
27      Contact.COLUMN_NAME + " TEXT, " +
28      Contact.COLUMN_PHONE + " TEXT, " +
29      Contact.COLUMN_EMAIL + " TEXT, " +
30      Contact.COLUMN_STREET + " TEXT, " +
31      Contact.COLUMN_CITY + " TEXT, " +
32      Contact.COLUMN_STATE + " TEXT, " +
33      Contact.COLUMN_ZIP + " TEXT);";
34  db.execSQL(CREATE_CONTACTS_TABLE); // create the contacts table
35 }
36
37 // normally defines how to upgrade the database when the schema changes
38 @Override
39 public void onUpgrade(SQLiteDatabase db, int oldVersion,
40     int newVersion) { }
41 }
```

**Fig. 9.17** | AddressBookDatabaseHelper subclass of SQLiteOpenHelper defines the app's database. (Part 2 of 2.)

### Constructor

The constructor (lines 16–18) simply calls the superclass constructor, which requires four arguments:

- the Context in which the database is being created or opened,
- the database name—this can be null if you wish to use an in-memory database,
- the CursorFactory to use—null indicates that you wish to use the default SQLite CursorFactory (typically for most apps) and
- the database version number (starting from 1).

### Overridden Methods

You must override this class's abstract methods onCreate and onUpgrade. If the database does not yet exist, the DatabaseOpenHelper's **onCreate** method will be called to create it. If you supply a newer version number than the database version currently stored on the device, the DatabaseOpenHelper's **onUpgrade** method will be called to upgrade the database to the new version (perhaps to add tables or to add columns to an existing table).

The onCreate method (lines 22–35) specifies the table to create with the SQL CREATE TABLE command, which is defined as a String (lines 24–33) that's constructed using constants from class Contact (Section 9.6.2). In this case, the contacts table contains an integer primary key field (Contact.\_ID), and text fields for all the other columns. Line 34 uses SQLiteDatabase's execSQL method to execute the CREATE TABLE command.

Since we don't need to upgrade the database, we simply override method onUpgrade with an empty body. Class SQLiteOpenHelper also provides the **onDowngrade** method that can be used to downgrade a database when the currently stored version has a higher version number than the one requested in the call to class SQLiteOpenHelper's constructor. Downgrading might be used to revert the database back to a prior version with fewer columns in a table or fewer tables in the database—perhaps to fix a bug in the app.

## 9.8 AddressBookContentProvider Class

The AddressBookContentProvider subclass of ContentProvider defines how to perform query, insert, update and delete operations on this app's database.



### Error-Prevention Tip 9.1

*ContentProviders can be invoked from multiple threads in one process and multiple processes, so it's important to note that ContentProviders do not provide any synchronization by default. However, SQLite does synchronize access to the database, so in this app it's unnecessary to provide your own synchronization mechanisms.*

### 9.8.1 AddressBookContentProvider Fields

Class AddressBookContentProvider (Fig. 9.18) defines several fields:

- Instance variable dbHelper (line 17) is a reference to an AddressBookDatabaseHelper object that creates the database and enables this ContentProvider to get readable and writable access to the database.
- Class variable uriMatcher (lines 20–21) is an object of class UriMatcher (package android.content). A ContentProvider uses a UriMatcher to help determine which operation to perform in its query, insert, update and delete methods.
- The UriMatcher returns the integer constants ONE\_CONTACT and CONTACTS (lines 24–25)—the ContentProvider uses these constants in switch statements in its query, insert, update and delete methods.

---

```

1 // AddressBookContentProvider.java
2 // ContentProvider subclass for manipulating the app's database
3 package com.deitel.addressbook.data;
4
5 import android.content.ContentProvider;
6 import android.content.ContentValues;
7 import android.content.UriMatcher;
8 import android.database.Cursor;
9 import android.database.SQLException;
10 import android.database.sqlite.SQLiteQueryBuilder;
11 import android.net.Uri;
12
13 import com.deitel.addressbook.data.DatabaseDescription.Contact;
14
15 public class AddressBookContentProvider extends ContentProvider {
16     // used to access the database
17     private AddressBookDatabaseHelper dbHelper;
18
19     // UriMatcher helps ContentProvider determine operation to perform
20     private static final UriMatcher uriMatcher =
21         new UriMatcher(UriMatcher.NO_MATCH);
22
23     // constants used with UriMatcher to determine operation to perform
24     private static final int ONE_CONTACT = 1; // manipulate one contact
25     private static final int CONTACTS = 2; // manipulate contacts table

```

---

Fig. 9.18 | AddressBookContentProvider fields. (Part 1 of 2.)

```

26
27     // static block to configure this ContentProvider's UriMatcher
28     static {
29         // Uri for Contact with the specified id (#)
30         uriMatcher.addURI(DatabaseDescription.AUTHORITY,
31             Contact.TABLE_NAME + "/#", ONE_CONTACT);
32
33         // Uri for Contacts table
34         uriMatcher.addURI(DatabaseDescription.AUTHORITY,
35             Contact.TABLE_NAME, CONTACTS);
36     }
37

```

**Fig. 9.18** | AddressBookContentProvider fields. (Part 2 of 2.)

Lines 28–36 define a `static` block that adds `Uri`s to the `static UriMatcher`—this block executes once when class `AddressBookContentProvider` is loaded into memory. `UriMatcher` method `addUri` takes three arguments:

- a `String` representing the `ContentProvider`'s authority (`DatabaseDescription.AUTHORITY` in this app)
- a `String` representing a path—each `Uri` used to invoke the `ContentProvider` contains "content://" followed by the authority and a path that the `ContentProvider` uses to determine the task to perform
- an `int` code that the `UriMatcher` returns when a `Uri` supplied to the `ContentProvider` matches a `Uri` stored in the `UriMatcher`.

Lines 30–31 add a `Uri` of the form:

```
content://com.deitel.addressbook.data/contacts/#
```

where `#` is a **wildcard** that matches a string of numeric characters—in this case, the unique primary-key value for one contact in the `contacts` table. There is also a `*` wildcard that matches any number of characters. When a `Uri` matches this format, the `UriMatcher` returns the constant `ONE_CONTACT`.

Lines 34–35 add a `Uri` of the form:

```
content://com.deitel.addressbook.data/contacts
```

which represents the entire `contacts` table. When a `Uri` matches this format, the `UriMatcher` returns the constant `CONTACTS`. As we discuss the rest of class `AddressBookContentProvider`, you'll see how the `UriMatcher` and the constants `ONE_CONTACT` and `CONTACTS` are used.

## 9.8.2 Overridden Methods onCreate and getType

As you'll see, you use a `ContentResolver` to invoke a `ContentProvider`'s methods. When Android receives a request from a `ContentResolver`, it automatically creates the corresponding `ContentProvider` object—or uses an existing one, if it was created previously. When a `ContentProvider` is created, Android calls its `onCreate` method to configure the `ContentProvider` (Fig. 9.19, lines 39–44). Line 42 creates the `AddressBookDatabase`

Helper object that enables the provider to access the database. The first time the provider is invoked to write to the database, the `AddressBookDatabaseHelper` object's `onCreate` method will be called to create the database (Fig. 9.17, lines 22–35).

---

```

38     // called when the AddressBookContentProvider is created
39     @Override
40     public boolean onCreate() {
41         // create the AddressBookDatabaseHelper
42         dbHelper = new AddressBookDatabaseHelper(getContext());
43         return true; // ContentProvider successfully created
44     }
45
46     // required method: Not used in this app, so we return null
47     @Override
48     public String getType(Uri uri) {
49         return null;
50     }
51

```

---

**Fig. 9.19** | Overridden ContentProvider methods `onCreate` and `getType`.

Method `getType` (Fig. 9.19, lines 47–50) is a required `ContentProvider` method that simply returns `null` in this app. This method typically is used when creating and starting `Intents` for `Uri`s with specific MIME types. Android can use MIME types to determine appropriate activities to handle the `Intents`.

### 9.8.3 Overridden Method `query`

The overridden `ContentProvider` method `query` (Fig. 9.20) retrieves data from the provider's data source—in this case, the database. The method returns a `Cursor` that's used to interact with the results. Method `query` receives five arguments:

- `uri`—A `Uri` representing the data to retrieve.
- `projection`—A `String` array representing the specific columns to retrieve. If this argument is `null`, all columns will be included in the result.
- `selection`—A `String` containing the selection criteria. This is the SQL `WHERE` clause, specified *without* the `WHERE` keyword. If this argument is `null`, all rows will be included in the result.
- `selectionArgs`—A `String` array containing the arguments used to replace any argument placeholders (?) in the `selection String`.
- `sortOrder`—A `String` representing the sort order. This is the SQL `ORDER BY` clause, specified *without* the `ORDER BY` keywords. If this argument is `null`, the provider determines this sort order—the order in which results are returned to the app is not guaranteed unless you provide an appropriate sort order.

#### `SQLiteQueryBuilder`

Line 58 creates a `SQLiteQueryBuilder` (package `android.database.sqlite`) for building SQL queries that are submitted to a SQLite database. Line 59 uses method `setTables` to specify that the query will select data from the database's `contacts` table. This method's

```

52    // query the database
53    @Override
54    public Cursor query(Uri uri, String[] projection,
55        String selection, String[] selectionArgs, String sortOrder) {
56
57        // create SQLiteQueryBuilder for querying contacts table
58        SQLiteQueryBuilder queryBuilder = new SQLiteQueryBuilder();
59        queryBuilder.setTables(Contact.TABLE_NAME);
60
61        switch (uriMatcher.match(uri)) {
62            case ONE_CONTACT: // contact with specified id will be selected
63                queryBuilder.appendWhere(
64                    Contact._ID + "=" + uri.getLastPathSegment());
65                break;
66            case CONTACTS: // all contacts will be selected
67                break;
68            default:
69                throw new UnsupportedOperationException(
70                    getContext().getString(R.string.invalid_query_uri) + uri);
71        }
72
73        // execute the query to select one or all contacts
74        Cursor cursor = queryBuilder.query(dbHelper.getReadableDatabase(),
75            projection, selection, selectionArgs, null, null, sortOrder);
76
77        // configure to watch for content changes
78        cursor.setNotificationUri(getContext().getContentResolver(), uri);
79        return cursor;
80    }
81

```

**Fig. 9.20** | Overridden ContentProvider method query.

String argument can be used to perform table join operations by specifying multiple tables in a comma separated list or as an appropriate SQL JOIN clause.

### *Using the UriMatcher to Determine the Operation to Perform*

In this app, there are two queries:

- select a specific contact from the database to display or edit its details, and
- select all contacts in the database to display their names in the `ContactsFragment`'s `RecyclerView`.

Lines 61–71 use `UriMatcher` method `match` to determine which query operation to perform. This method returns one of the constants that was registered with the `UriMatcher` (Section 9.8.1). If the constant returned is `ONE_CONTACT`, only the contact with the ID specified in the `Uri` should be selected. In this case, lines 63–64 use the `SQLiteQueryBuilder`'s `appendWhere` method to add a `WHERE` clause containing the contact's ID to the query. `Uri` method `getLastPathSegment` returns the last segment in the `Uri`—for example, the contact ID 5 in the following `Uri`

content://com.deitel.addressbook.data/contacts/5

If the constant returned is CONTACTS, the switch terminates without adding anything to the query—in this case, all contacts will be selected because there is no WHERE clause. For any Uri that is not a match, lines 69–70 throw an `UnsupportedOperationException` indicating that the Uri was invalid.

### *Querying the Database*

Lines 74–75 use the `SQLiteQueryBuilder`'s `query` method to perform the database query and get a `Cursor` representing the results. The method's arguments are similar to those received by the `ContentProvider`'s `query` method:

- A `SQLiteDatabase` to query—the `AddressBookDatabaseHelper`'s `getReadableDatabase` method returns a read-only `SQLiteDatabase` object.
- `projection`—A `String` array representing the specific columns to retrieve. If this argument is `null`, all columns will be included in the result.
- `selection`—A `String` containing the selection criteria. This is the SQL WHERE clause, specified *without* the WHERE keyword. If this argument is `null`, all rows will be included in the result.
- `selectionArgs`—A `String` array containing the arguments used to replace any argument placeholders (?) in the `selection String`.
- `groupBy`—A `String` containing the grouping criteria. This is the SQL GROUP BY clause, specified *without* the GROUP BY keywords. If this argument is `null`, no grouping is performed.
- `having`—When using `groupBy`, this argument is a `String` indicating which groups to include in the results. This is the SQL HAVING clause, specified *without* the HAVING keyword. If this argument is `null`, all groups specified by the `groupBy` argument will be included in the results.
- `sortOrder`—A `String` representing the sort order. This is the SQL ORDER BY clause, specified *without* the ORDER BY keywords. If this argument is `null`, the provider determines this sort order.

### *Registering the Cursor to Watch for Content Changes*

Line 78 calls the `Cursor`'s `setNotificationUri` method to indicate that the `Cursor` should be updated if the data it refers to changes. This first argument is the `ContentResolver` that invoked the `ContentProvider` and the second is the `Uri` used to invoke the `ContentProvider`. Line 79 returns the `Cursor` containing the query results.

#### 9.8.4 Overridden Method `insert`

The overridden `ContentProvider` method `insert` (Fig. 9.21) adds a new record to the `contacts` table. Method `insert` receives two arguments:

- `uri`—A `Uri` representing the table in which the data will be inserted.
- `values`—A `ContentValues` object containing key-value pairs in which the column names are the keys and each key's value is the data to insert in that column.

Lines 87–108 check whether the `Uri` is for the `contacts` table—if not, the `Uri` is invalid for the `insert` operation and lines 106–107 throw an `UnsupportedOperationException`.

---

```

82     // insert a new contact in the database
83     @Override
84     public Uri insert(Uri uri, ContentValues values) {
85         Uri newContactUri = null;
86
87         switch (uriMatcher.match(uri)) {
88             case CONTACTS:
89                 // insert the new contact--success yields new contact's row id
90                 long rowId = dbHelper.getWritableDatabase().insert(
91                     Contact.TABLE_NAME, null, values);
92
93                 // if the contact was inserted, create an appropriate Uri;
94                 // otherwise, throw an exception
95                 if (rowId > 0) { // SQLite row IDs start at 1
96                     newContactUri = Contact.buildContactUri(rowId);
97
98                     // notify observers that the database changed
99                     getContext().getContentResolver().notifyChange(uri, null);
100                }
101                else
102                    throw new SQLException(
103                        getContext().getString(R.string.insert_failed) + uri);
104                break;
105            default:
106                throw new UnsupportedOperationException(
107                    getContext().getString(R.string.invalid_insert_uri) + uri);
108            }
109
110            return newContactUri;
111        }
112    }

```

---

**Fig. 9.21** | Overridden ContentProvider method insert.

Exception. If the Uri is a match, lines 90–91 insert the new contact in the database. First, we use the AddressBookDatabaseHelper’s **getWritableDatabase** method to get a SQLiteDatabaseObject for modifying data in the database.

SQLiteDatabase’s **insert** method (lines 90–91) inserts the values from the third argument’s ContentValues object into the table specified as the first argument—the contacts table in this case. The second parameter of this method, which is not used in this app, is named **nullColumnHack** and is needed because *SQLite does not support inserting a completely empty row into a table*—this would be the equivalent of passing an empty ContentValues object to **insert**. Instead of making it illegal to pass an empty ContentValues to the method, the **nullColumnHack** parameter is used to identify a column that accepts NULL values.

Method **insert** returns the new contact’s unique ID if the insert operation is successful or -1 otherwise. Line 95 checks whether the **rowID** is greater than 0 (rows are indexed from 1 in SQLite). If so, line 96 creates a Uri representing the new contact and line 99 notifies the ContentResolver that the database changed, so the ContentResolver’s client code can respond to the database changes. If the **rowID** is not greater than 0, the database operation failed and lines 102–103 throws a SQLException.

### 9.8.5 Overridden Method update

The overridden ContentProvider method **update** (Fig. 9.22) updates an existing record. Method **update** receives four arguments:

- **uri**—A Uri representing the rows to update.
- **values**—A ContentValues object containing the columns to update and their corresponding values.
- **selection**—A String containing the selection criteria. This is the SQL WHERE clause, specified *without* the WHERE keyword. If this argument is null, all rows will be included in the result.
- **selectionArgs**—A String array containing the arguments used to replace any argument placeholders (?) in the selection String.

---

```

113 // update an existing contact in the database
114 @Override
115 public int update(Uri uri, ContentValues values,
116     String selection, String[] selectionArgs) {
117     int numberOfRowsUpdated; // 1 if update successful; 0 otherwise
118
119     switch (uriMatcher.match(uri)) {
120         case ONE_CONTACT:
121             // get from the uri the id of contact to update
122             String id = uri.getLastPathSegment();
123
124             // update the contact
125             numberOfRowsUpdated = dbHelper.getWritableDatabase().update(
126                 Contact.TABLE_NAME, values, Contact._ID + "=" + id,
127                 selectionArgs);
128             break;
129         default:
130             throw new UnsupportedOperationException(
131                 getContext().getString(R.string.invalid_update_uri) + uri);
132     }
133
134     // if changes were made, notify observers that the database changed
135     if (numberOfRowsUpdated != 0) {
136         getContext().getContentResolver().notifyChange(uri, null);
137     }
138
139     return numberOfRowsUpdated;
140 }
141

```

---

**Fig. 9.22** | Overridden ContentProvider method update.

Updates in this app are performed only on a specific contact, so lines 119–132 check only for a ONE\_CONTACT Uri. Line 122 gets the Uri argument's last path segment, which is the contact's unique ID. Lines 125–127 get a writeable SQLiteDatabase object then call its **update** method to update the specified contact with the values from the ContentValues argument. The update method's arguments are:

- the `String` name of the table to update
- the `ContentValues` object containing the columns to update and their new values
- the `String` representing the SQL `WHERE` clause that specifies the rows to update
- a `String` array containing any arguments that should replace `?` placeholders in the `WHERE` clause.

If the operation is successful, method `update` returns an integer indicating the number of modified rows; otherwise, `update` returns 0. Line 136 notifies the `ContentResolver` that the database changed, so the `ContentResolver`'s client code can respond to the changes. Line 139 returns the number of modified rows.

### 9.8.6 Overridden Method `delete`

The overridden `ContentProvider` method `delete` (Fig. 9.23) removes an existing record. Method `delete` receives three arguments:

- `uri`—A `Uri` representing the row(s) to delete.
- `selection`—A `String` containing the `WHERE` clause specifying the rows to delete.
- `selectionArgs`—A `String` array containing the arguments used to replace any argument placeholders (?) in the `selection` `String`.

---

```

142     // delete an existing contact from the database
143     @Override
144     public int delete(Uri uri, String selection, String[] selectionArgs) {
145         int numberOfRowsDeleted;
146
147         switch (UriMatcher.match(uri)) {
148             case ONE_CONTACT:
149                 // get from the uri the id of contact to update
150                 String id = uri.getLastPathSegment();
151
152                 // delete the contact
153                 numberOfRowsDeleted = dbHelper.getWritableDatabase().delete(
154                     Contact.TABLE_NAME, Contact._ID + "=" + id, selectionArgs);
155                 break;
156             default:
157                 throw new UnsupportedOperationException(
158                     getContext().getString(R.string.invalid_delete_uri) + uri);
159         }
160
161         // notify observers that the database changed
162         if (numberOfRowsDeleted != 0) {
163             getContext().getContentResolver().notifyChange(uri, null);
164         }
165
166         return numberOfRowsDeleted;
167     }
168 }
```

---

**Fig. 9.23** | Overridden `ContentProvider` method `delete`.

Deletions in this app are performed only on a specific contact, so lines 147–159 check for a `ONE_CONTACT Uri`—any other `Uri` represents an unsupported operation. Line 150 gets the `Uri` argument’s last path segment, which is the contact’s unique ID. Lines 153–154 get a writeable `SQLiteDatabase` object then call its `delete method` to remove the specified contact. The three arguments are the database table from which to delete the record, the `WHERE` clause and, if the `WHERE` clause has arguments, a `String` array of values to substitute into the `WHERE` clause. The method returns the number of rows deleted. Line 163 notifies the `ContentResolver` that the database changed, so the `ContentResolver`’s client code can respond to the changes. Line 166 returns the number of deleted rows.

## 9.9 MainActivity Class

Class `MainActivity` manages the app’s fragments and coordinates the interactions between them. On phones, `MainActivity` displays one `Fragment` at a time, starting with the `ContactsFragment`. On tablets, `MainActivity` always displays the `ContactsFragment` at the left of the layout and, depending on the context, displays either the `DetailFragment` or the `AddEditFragment` in the right two-thirds of the layout.

### 9.9.1 Superclass, Implemented Interfaces and Fields

Class `MainActivity` (Fig. 9.24) uses class `FragmentTransaction` from the v4 support library to add and remove the app’s `Fragments`. `MainActivity` implements three interfaces:

- `ContactsFragment.ContactsFragmentListener` (Section 9.10.2) contains callback methods that the `ContactsFragment` uses to tell the `MainActivity` when the user selects a contact in the contact list or adds a new contact.
- `DetailFragment.DetailFragmentListener` (Section 9.13.2) contains callback methods that the `DetailFragment` uses to tell the `MainActivity` when the user deletes a contact or wishes to edit an existing contact.
- `AddEditFragment.AddEditFragmentListener` (Section 9.12.2) contains a callback method that the `AddEditFragment` uses to tell the `MainActivity` when the user saves a new contact or saves changes to an existing contact.

The constant `CONTACT_URI` (line 17) is used as a key in a key–value pair that’s passed between the `MainActivity` and its `Fragments`. The instance variable `ContactsFragment` (line 19) is used to tell the `ContactsFragment` to update the displayed list of contacts after a contact is added or deleted.

---

```

1 // MainActivity.java
2 // Hosts the app's fragments and handles communication between them
3 package com.deitel.addressbook;
4
5 import android.net.Uri;
6 import android.os.Bundle;
7 import android.support.v4.app.FragmentTransaction;
8 import android.support.v7.app.AppCompatActivity;
9 import android.support.v7.widget.Toolbar;
```

---

**Fig. 9.24** | `MainActivity`’s superclass, implemented interfaces and fields, (Part 1 of 2.)

---

```

10  public class MainActivity extends AppCompatActivity
11      implements ContactsFragment.ContactsFragmentListener,
12      DetailFragment.DetailFragmentListener,
13      AddEditFragment.AddEditFragmentListener {
14
15      // key for storing a contact's Uri in a Bundle passed to a fragment
16      public static final String CONTACT_URI = "contact_uri";
17
18      private ContactsFragment contactsFragment; // displays contact list
19
20

```

**Fig. 9.24** | MainActivity's superclass, implemented interfaces and fields, (Part 2 of 2.)

### 9.9.2 Overridden Method onCreate

Overridden Activity method `onCreate` (Fig. 9.25) inflates MainActivity's GUI and, if the app is running on a phone-sized device, creates and displays a `ContactsFragment`. If the Activity is being restored after being shut down or recreated from a configuration change, `savedInstanceState` will not be `null`. In this case, lines 43–45 simply get a reference to the existing `ContactsFragment`—on a phone, it would have been saved by Android and on a tablet, it's part of the MainActivity's layout that was inflated in line 25.

---

```

21      // display ContactsFragment when MainActivity first loads
22      @Override
23      protected void onCreate(Bundle savedInstanceState) {
24          super.onCreate(savedInstanceState);
25          setContentView(R.layout.activity_main);
26          Toolbar toolbar = (Toolbar) findViewById(R.id.toolbar);
27          setSupportActionBar(toolbar);
28
29          // if layout contains fragmentContainer, the phone layout is in use;
30          // create and display a ContactsFragment
31          if (savedInstanceState != null &&
32              findViewById(R.id.fragmentContainer) != null) {
33              // create ContactsFragment
34              contactsFragment = new ContactsFragment();
35
36              // add the fragment to the FrameLayout
37              FragmentTransaction transaction =
38                  getSupportFragmentManager().beginTransaction();
39              transaction.add(R.id.fragmentContainer, contactsFragment);
40              transaction.commit(); // display ContactsFragment
41          }
42          else {
43              contactsFragment =
44                  (ContactsFragment) getSupportFragmentManager().
45                  findFragmentById(R.id.contactsFragment);
46          }
47      }
48

```

**Fig. 9.25** | Overridden Activity method `onCreate`.

If the `R.id.fragmentContainer` exists in `MainActivity`'s layout (line 32), then the app is running on a phone. In this case, line 34 creates the `ContactsFragment`, then lines 37–40 use a `FragmentTransaction` to add the `ContactsFragment` to the user interface. Lines 37–38 call `FragmentManager`'s `beginTransaction` method to obtain a `FragmentTransaction`. Next, line 39 calls `FragmentTransaction` method `add` to specify that, when the `FragmentTransaction` completes, the `ContactsFragment` should be attached to the View with the ID specified as the first argument. Finally, line 40 uses `FragmentTransaction` method `commit` to finalize the transaction and display the `ContactsFragment`.

### 9.9.3 ContactsFragment.ContactsFragmentListener Methods

Figure 9.26 contains `MainActivity`'s implementations of the callback methods in the interface `ContactsFragment.ContactsFragmentListener`. Method `onContactSelected` (lines 50–60) is called by the `ContactsFragment` to notify the `MainActivity` when the user selects a contact to display. If the app is running on a phone (line 52), line 53 calls method `displayContact` (Section 9.9.4), which replaces the `ContactsFragment` in the `fragmentContainer` (defined in Section 9.4.7) with the `DetailFragment` that shows the contact's information. On a tablet, line 56 calls the `FragmentManager`'s `popBackStack` method to *pop* (remove) the top `Fragment` on the back stack (if there is one), then line 58 calls `displayContact`, which replaces the contents of the `rightPaneContainer` (defined in Section 9.4.7) with the `DetailFragment` that shows the contact's information.

---

```

49     // display DetailFragment for selected contact
50     @Override
51     public void onContactSelected(Uri contactUri) {
52         if (findViewById(R.id.fragmentContainer) != null) // phone
53             displayContact(contactUri, R.id.fragmentContainer);
54         else { // tablet
55             // removes top of back stack
56             getSupportFragmentManager().popBackStack();
57
58             displayContact(contactUri, R.id.rightPaneContainer);
59         }
60     }
61
62     // display AddEditFragment to add a new contact
63     @Override
64     public void onAddContact() {
65         if (findViewById(R.id.fragmentContainer) != null) // phone
66             displayAddEditFragment(R.id.fragmentContainer, null);
67         else // tablet
68             displayAddEditFragment(R.id.rightPaneContainer, null);
69     }
70

```

---

**Fig. 9.26** | `ContactsFragment.ContactsFragmentListener` methods.

Method `onAddContact` (lines 63–69) is called by the `ContactsFragment` to notify the `MainActivity` when the user chooses to add a new contact. If the layout contains the `fragmentContainer`, line 66 calls `displayAddEditFragment` (Section 9.9.5) to display the Add-

`EditFragment` in the `fragmentContainer`; otherwise, line 68 displays the `Fragment` in the `rightPaneContainer`. The second argument to `displayAddEditFragment` is a `Bundle` that the `AddEditFragment` uses to determine whether a new contact is being added or an existing contact is being edited—`null` indicates that a new contact is being added; otherwise, the bundle includes the existing contact's `Uri`.

#### 9.9.4 Method `displayContact`

Method `displayContact` (Fig. 9.27) creates the `DetailFragment` that displays the selected contact. You can pass arguments to a `Fragment` by placing them in a `Bundle` of key-value pairs—we do this to pass the selected contact's `Uri` so that the `DetailFragment` knows which contact to get from the `ContentProvider`. Line 76 creates the `Bundle`. Line 77 calls its `putParcelable` method to store a key–value pair containing the `CONTACT_URI` (a `String`) as the key and the `contactUri` (a `Uri`) as the value. Class `Uri` implements the `Parcelable` interface, so a `Uri` can be stored in a `Bundle` as a `Parcel` object. Line 78 passes the `Bundle` to the `Fragment`'s `setArguments` method—the `Fragment` can then extract the information from the `Bundle` (as you'll see in Section 9.13).

---

```

71 // display a contact
72 private void displayContact(Uri contactUri, int viewID) {
73     DetailFragment detailFragment = new DetailFragment();
74
75     // specify contact's Uri as an argument to the DetailFragment
76     Bundle arguments = new Bundle();
77     arguments.putParcelable(CONTACT_URI, contactUri);
78     detailFragment.setArguments(arguments);
79
80     // use a FragmentTransaction to display the DetailFragment
81     FragmentTransaction transaction =
82         getSupportFragmentManager().beginTransaction();
83     transaction.replace(viewID, detailFragment);
84     transaction.addToBackStack(null);
85     transaction.commit(); // causes DetailFragment to display
86 }
87

```

---

Fig. 9.27 | Method `displayContact`.

Lines 81–82 get a `FragmentTransaction`, then line 83 calls `FragmentTransaction` method `replace` to specify that, when the `FragmentTransaction` completes, the `DetailFragment` should replace the contents of the `View` with the `ID` specified as the first argument. Line 84 calls `FragmentTransaction` method `addToBackStack` to *push* (add) the `DetailFragment` onto the back stack. This allows the user to touch the back button to pop the `Fragment` from the back stack and allows `MainActivity` to programmatically pop the `Fragment` from the back stack. Method `addToBackStack`'s argument is an optional name for a *back state*. This can be used to pop multiple `Fragment`s from the back stack to return to a prior state after multiple `Fragment`s have been added to the back stack. By default, only the topmost `Fragment` is popped.

### 9.9.5 Method `displayAddEditFragment`

Method `displayAddEditFragment` (Fig. 9.28) receives a View's resource ID specifying where to attach the `AddEditFragment` and a `Uri` representing a contact to edit. If the second argument is `null`, a new contact is being added. Line 90 creates the `AddEditFragment`. If the `contactUri` argument is not `null`, line 95 puts it into the `Bundle` that's used to supply the Fragment's arguments. Lines 100–104 then create the `FragmentTransaction`, replace the contents of the View with the specified resource ID, add the Fragment to the back stack and commit the transaction.

---

```

88     // display fragment for adding a new or editing an existing contact
89     private void displayAddEditFragment(int viewID, Uri contactUri) {
90         AddEditFragment addEditFragment = new AddEditFragment();
91
92         // if editing existing contact, provide contactUri as an argument
93         if (contactUri != null) {
94             Bundle arguments = new Bundle();
95             arguments.putParcelable(CONTACT_URI, contactUri);
96             addEditFragment.setArguments(arguments);
97         }
98
99         // use a FragmentTransaction to display the AddEditFragment
100        FragmentTransaction transaction =
101            getSupportFragmentManager().beginTransaction();
102        transaction.replace(viewID, addEditFragment);
103        transaction.addToBackStack(null);
104        transaction.commit(); // causes AddEditFragment to display
105    }
106

```

---

**Fig. 9.28** | Method `displayAddEditFragment`.

### 9.9.6 `DetailFragment.DetailFragmentListener` Methods

Figure 9.29 contains `MainActivity`'s implementations of the callback methods in the interface `DetailFragment.DetailFragmentListener`. Method `onContactDeleted` (lines 108–113) is called by the `DetailFragment` to notify the `MainActivity` when the user deletes a contact. In this case, line 111 pops the `DetailFragment` from the back stack so that the now deleted contact's information is no longer displayed. Line 112 calls the `ContactsFragment`'s `updateContactList` method to refresh the contacts list.

---

```

107     // return to contact list when displayed contact deleted
108     @Override
109     public void onContactDeleted() {
110         // removes top of back stack
111         getSupportFragmentManager().popBackStack();
112         contactsFragment.updateContactList(); // refresh contacts
113     }
114

```

---

**Fig. 9.29** | `DetailFragment.DetailFragmentListener` methods. (Part 1 of 2.)

---

```

115 // display the AddEditFragment to edit an existing contact
116 @Override
117 public void onEditContact(Uri contactUri) {
118     if (findViewById(R.id.fragmentContainer) != null) // phone
119         displayAddEditFragment(R.id.fragmentContainer, contactUri);
120     else // tablet
121         displayAddEditFragment(R.id.rightPaneContainer, contactUri);
122 }
123

```

---

**Fig. 9.29** | DetailFragment.DetailFragmentListener methods. (Part 2 of 2.)

Method `onEditContact` (lines 116–122) is called by the `DetailFragment` to notify the `MainActivity` when the user touches the app bar item to edit a contact. The `DetailFragment` passes a `Uri` representing the contact to edit so that it can be displayed in the `AddEditFragment`'s `EditTexts` for editing. If the layout contains the `fragmentContainer`, line 119 calls `displayAddEditFragment` (Section 9.9.5) to display the `AddEditFragment` in the `fragmentContainer`; otherwise, line 121 displays the `AddEditFragment` in the `rightPaneContainer`.

### 9.9.7 AddEditFragment.AddEditFragmentListener Method

Method `onAddEditCompleted` (Fig. 9.30) from the `AddEditFragment.AddEditFragmentListener` interface is called by the `AddEditFragment` to notify the `MainActivity` when the user saves a new contact or saves changes to an existing one. Line 128 pops the `AddEditFragment` from the back stack and line 129 updates the `ContactsFragment`'s contact list. If the app is running on a tablet (line 131), line 133 pops the back stack again to remove the `DetailFragment` (if there is one). Then line 136 displays the new or updated contact's details in the `rightPaneContainer`.

---

```

124 // update GUI after new contact or updated contact saved
125 @Override
126 public void onAddEditCompleted(Uri contactUri) {
127     // removes top of back stack
128     getSupportFragmentManager().popBackStack();
129     contactsFragment.updateContactList(); // refresh contacts
130
131     if (findViewById(R.id.fragmentContainer) == null) { // tablet
132         // removes top of back stack
133         getSupportFragmentManager().popBackStack();
134
135         // on tablet, display contact that was just added or edited
136         displayContact(contactUri, R.id.rightPaneContainer);
137     }
138 }
139

```

---

**Fig. 9.30** | AddEditFragment.AddEditFragmentListener method.

## 9.10 ContactsFragment Class

Class `ContactsFragment` displays the contact list in a `RecyclerView` and provides a `FloatingActionButton` that the user can touch to add a new contact.

### 9.10.1 Superclass and Implemented Interface

Figure 9.31 lists `ContactsFragment`'s package statement and `import` statements and the beginning of its class definition. The `ContactsFragment` uses a `LoaderManager` and a `Loader` to query the `AddressBookContentProvider` and receive a `Cursor` that the `ContactsAdapter` (Section 9.11) uses to supply data to the `RecyclerView`. `ContactsFragment` implements interface `LoaderManager.LoaderCallbacks<Cursor>` (line 23) so that it can respond to method calls from the `LoaderManager` to create the `Loader` and process the results returned by the `AddressBookContentProvider`.

---

```

1 // ContactsFragment.java
2 // Fragment subclass that displays the alphabetical list of contact names
3 package com.deitel.addressbook;
4
5 import android.content.Context;
6 import android.database.Cursor;
7 import android.net.Uri;
8 import android.os.Bundle;
9 import android.support.design.widget.FloatingActionButton;
10 import android.support.v4.app.Fragment;
11 import android.support.v4.app.LoaderManager;
12 import android.support.v4.content.CursorLoader;
13 import android.support.v4.content.Loader;
14 import android.support.v7.widget.LinearLayoutManager;
15 import android.support.v7.widget.RecyclerView;
16 import android.view.LayoutInflater;
17 import android.view.View;
18 import android.view.ViewGroup;
19
20 import com.deitel.addressbook.data.DatabaseDescription.Contact;
21
22 public class ContactsFragment extends Fragment
23     implements LoaderManager.LoaderCallbacks<Cursor> {
24

```

---

**Fig. 9.31** | `ContactsFragment` superclass and implemented interface.

### 9.10.2 ContactsFragmentListener

Figure 9.32 defines the nested interface `ContactsFragmentListener`, which contains the callback methods that `MainActivity` implements to be notified when the user selects a contact (line 28) and when the user touches the `FloatingActionButton` to add a new contact (line 31).

---

```

25  // callback method implemented by MainActivity
26  public interface ContactsFragmentListener {
27      // called when contact selected
28      void onContactSelected(Uri contactUri);
29
30      // called when add button is pressed
31      void onAddContact();
32  }
33

```

---

**Fig. 9.32** | Nested interface ContactsFragmentListener.

### 9.10.3 Fields

Figure 9.33 shows class `ContactsFragment`'s fields. Line 34 declares a constant that's used to identify the Loader when processing the results returned from the `AddressBookContentProvider`. In this case, we have only one Loader—if a class uses more than one Loader, each should have a constant with a unique integer value so that you can identify which Loader to manipulate in the `LoaderManager.LoaderCallbacks<Cursor>` callback methods. The instance variable `listener` (line 37) will refer to the object that implements the interface (`MainActivity`). Instance variable `contactsAdapter` (line 39) will refer to the `ContactsAdapter` that binds data to the `RecyclerView`.

---

```

34  private static final int CONTACTS_LOADER = 0; // identifies Loader
35
36  // used to inform the MainActivity when a contact is selected
37  private ContactsFragmentListener listener;
38
39  private ContactsAdapter contactsAdapter; // adapter for recyclerView
40

```

---

**Fig. 9.33** | `ContactsFragment` fields.

### 9.10.4 Overridden Fragment Method onCreateView

Overridden Fragment method `onCreateView` (Fig. 9.34) inflates and configures the Fragment's GUI. Most of this method's code has been presented in prior chapters, so we focus only on the new features here. Line 47 indicates that the `ContactsFragment` has menu items that should be displayed on the Activity's app bar (or in its options menu). Lines 56–74 configure the `RecyclerView`. Lines 60–67 create the `ContactsAdapter` that populates the `RecyclerView`. The argument to the constructor is an implementation of the `ContactsAdapter.ContactClickListener` interface (Section 9.11) specifying that when the user touches a contact, the `ContactsFragmentListener`'s `onContactSelected` should be called with the `Uri` of the contact to display in a `DetailFragment`.

```
41 // configures this fragment's GUI
42 @Override
43 public View onCreateView(
44     LayoutInflater inflater, ViewGroup container,
45     Bundle savedInstanceState) {
46     super.onCreateView(inflater, container, savedInstanceState);
47     setHasOptionsMenu(true); // fragment has menu items to display
48
49     // inflate GUI and get reference to the RecyclerView
50     View view = inflater.inflate(
51         R.layout.fragment_contacts, container, false);
52     RecyclerView recyclerView =
53         (RecyclerView) view.findViewById(R.id.recyclerView);
54
55     // recyclerView should display items in a vertical list
56     recyclerView.setLayoutManager(
57         new LinearLayoutManager(getActivity().getBaseContext()));
58
59     // create recyclerView's adapter and item click listener
60     contactsAdapter = new ContactsAdapter(
61         new ContactsAdapter.ContactClickListener() {
62             @Override
63             public void onClick(Uri contactUri) {
64                 listener.onContactSelected(contactUri);
65             }
66         });
67     recyclerView.setAdapter(contactsAdapter); // set the adapter
68
69     // attach a custom ItemDecorator to draw dividers between list items
70     recyclerView.addItemDecoration(new ItemDivider(getContext()));
71
72     // improves performance if RecyclerView's layout size never changes
73     recyclerView.setHasFixedSize(true);
74
75     // get the FloatingActionButton and configure its listener
76     FloatingActionButton addButton =
77         (FloatingActionButton) view.findViewById(R.id.addButton);
78     addButton.setOnClickListener(
79         new View.OnClickListener() {
80             // displays the AddEditFragment when FAB is touched
81             @Override
82             public void onClick(View view) {
83                 listener.onAddContact();
84             }
85         });
86     );
87
88     return view;
89 }
90
91 }
```

Fig. 9.34 | Overridden Fragment method onCreateView.

### 9.10.5 Overridden Fragment Methods `onAttach` and `onDetach`

Class `ContactsFragment` overrides Fragment lifecycle methods `onAttach` and `onDetach` (Fig. 9.35) to set instance variable `listener`. In this app, `listener` refers to the host Activity (line 96) when the `ContactsFragment` is attached and is set to `null` (line 103) when the `ContactsFragment` is detached.

---

```

92     // set ContactsFragmentListener when fragment attached
93     @Override
94     public void onAttach(Context context) {
95         super.onAttach(context);
96         listener = (ContactsFragmentListener) context;
97     }
98
99     // remove ContactsFragmentListener when Fragment detached
100    @Override
101    public void onDetach() {
102        super.onDetach();
103        listener = null;
104    }
105

```

---

**Fig. 9.35** | Overridden Fragment methods `onAttach` and `onDetach`.

### 9.10.6 Overridden Fragment Method `onActivityCreated`

Fragment lifecycle method `onActivityCreated` (Fig. 9.36) is called after a Fragment's host Activity has been created and the Fragment's `onCreateView` method completes execution—at this point, the Fragment's GUI is part of the Activity's view hierarchy. We use this method to tell the `LoaderManager` to initialize a Loader—doing this after the view hierarchy exists is important because the `RecyclerView` must exist before we can display the loaded data. Line 110 uses Fragment method `getLoaderManager` to obtain the Fragment's `LoaderManager` object. Next we call `LoaderManager`'s `initLoader` method, which receives three arguments:

- the integer ID used to identify the Loader
- a `Bundle` containing arguments for the Loader's constructor, or `null` if there are no arguments
- a reference to the implementation of the interface `LoaderManager.LoaderCallbacks<Cursor>` (this represents the `ContactsAdapter`)—you'll see the implementations of this interface's methods `onCreateLoader`, `onLoadFinished` and `onLoaderReset` in Section 9.10.8.

If there is not already an active Loader with the specified ID, the `initLoader` method asynchronously calls the `onCreateLoader` method to create and start a Loader for that ID. If there is an active Loader, the `initLoader` method immediately calls the `onLoadFinished` method.

---

```

106    // initialize a Loader when this fragment's activity is created
107    @Override
108    public void onActivityCreated(Bundle savedInstanceState) {
109        super.onActivityCreated(savedInstanceState);
110        getLoaderManager().initLoader(CONTACTS_LOADER, null, this);
111    }
112

```

---

**Fig. 9.36** | Overridden Fragment method `onActivityCreated`.

### 9.10.7 Method `updateContactList`

`ContactsFragment` method `updateContactList` (Fig. 9.37) simply notifies the `ContactsAdapter` when the data changes. This method is called when new contacts are added and when existing contacts are updated or deleted.

---

```

113    // called from MainActivity when other Fragment's update database
114    public void updateContactList() {
115        contactsAdapter.notifyDataSetChanged();
116    }
117

```

---

**Fig. 9.37** | `ContactsFragment` method `updateContactList`.

### 9.10.8 `LoaderManager.LoaderCallbacks<Cursor>` Methods

Figure 9.38 presents class `ContactsFragment`'s implementations of the callback methods in interface `LoaderManager.LoaderCallbacks<Cursor>`.

---

```

118    // called by LoaderManager to create a Loader
119    @Override
120    public Loader<Cursor> onCreateLoader(int id, Bundle args) {
121        // create an appropriate CursorLoader based on the id argument;
122        // only one Loader in this fragment, so the switch is unnecessary
123        switch (id) {
124            case CONTACTS_LOADER:
125                return new CursorLoader(getActivity(),
126                    Contact.CONTENT_URI, // Uri of contacts table
127                    null, // null projection returns all columns
128                    null, // null selection returns all rows
129                    null, // no selection arguments
130                    Contact.COLUMN_NAME + " COLLATE NOCASE ASC"); // sort order
131            default:
132                return null;
133        }
134    }
135

```

---

**Fig. 9.38** | `LoaderManager.LoaderCallbacks<Cursor>` methods. (Part 1 of 2.)

---

```

136     // called by LoaderManager when loading completes
137     @Override
138     public void onLoadFinished(Loader<Cursor> loader, Cursor data) {
139         contactsAdapter.swapCursor(data);
140     }
141
142     // called by LoaderManager when the Loader is being reset
143     @Override
144     public void onLoaderReset(Loader<Cursor> loader) {
145         contactsAdapter.swapCursor(null);
146     }
147 }
```

---

**Fig. 9.38** | LoaderManager.LoaderCallbacks<Cursor> methods. (Part 2 of 2.)

#### *Method **onCreateLoader***

The LoaderManager calls method **onCreateLoader** (lines 119–134) to create and return a new Loader for the specified ID, which the LoaderManager manages in the context of the Fragment's or Activity's lifecycle. Lines 123–133 determine the Loader to create, based on the ID received as **onCreateLoader**'s first argument.



#### Good Programming Practice 9.1

*For the ContactsFragment, we need only one Loader, so the switch statement is unnecessary, but we included it here as a good practice.*

Lines 125–130 create and return a CursorLoader that queries the AddressBookContentProvider to get the list of contacts, then makes the results available as a Cursor. The CursorLoader constructor receives the Context in which the Loader's lifecycle is managed and `uri`, `projection`, `selection`, `selectionArgs` and `sortOrder` arguments that have the same meaning as those in the ContentProvider's query method (Section 9.8.3). In this case, we specified `null` for the `projection`, `selection` and `selectionArgs` arguments and indicated that the contacts should be sorted by name in a case insensitive manner.

#### *Method **onLoadFinished***

Method **onLoadFinished** (lines 137–140) is called by the LoaderManager after a Loader finishes loading its data, so you can process the results in the `Cursor` argument. In this case, we call the `ContactsAdapter`'s `swapCursor` method with the `Cursor` as an argument, so the `ContactsAdapter` can refresh the `RecyclerView` based on the new `Cursor` contents.

#### *Method **onLoaderReset***

Method **onLoaderReset** (lines 143–146) is called by the LoaderManager when a Loader is reset and its data is no longer available. At this point, the app should immediately disconnect from the data. In this case, we call the `ContactsAdapter`'s `swapCursor` method with the argument `null` to indicate that there is no data to bind to the `RecyclerView`.

## 9.11 ContactsAdapter Class

In Section 8.6, we discussed how to create a `RecyclerView.Adapter` that's used to bind data to a `RecyclerView`. Here we highlight only the new code that helps the `ContactsAdapter` (Fig. 9.39) to populate the `RecyclerView` with contact names from a `Cursor`.

```
1 // ContactsAdapter.java
2 // Subclass of RecyclerView.Adapter that binds contacts to RecyclerView
3 package com.deitel.addressbook;
4
5 import android.database.Cursor;
6 import android.net.Uri;
7 import android.support.v7.widget.RecyclerView;
8 import android.view.LayoutInflater;
9 import android.view.View;
10 import android.view.ViewGroup;
11 import android.widget.TextView;
12
13 import com.deitel.addressbook.data.DatabaseDescription.Contact;
14
15 public class ContactsAdapter
16     extends RecyclerView.Adapter<ContactsAdapter.ViewHolder> {
17
18     // interface implemented by ContactsFragment to respond
19     // when the user touches an item in the RecyclerView
20     public interface ContactClickListener {
21         void onClick(Uri contactUri);
22     }
23
24     // nested subclass of RecyclerView.ViewHolder used to implement
25     // the view-holder pattern in the context of a RecyclerView
26     public class ViewHolder extends RecyclerView.ViewHolder {
27         public final TextView textView;
28         private long rowID;
29
30         // configures a RecyclerView item's ViewHolder
31         public ViewHolder(View itemView) {
32             super(itemView);
33             textView = (TextView) itemView.findViewById(android.R.id.text1);
34
35             // attach listener to itemView
36             itemView.setOnClickListener(
37                 new View.OnClickListener() {
38                     // executes when the contact in this ViewHolder is clicked
39                     @Override
40                     public void onClick(View view) {
41                         clickListener.onClick(Contact.buildContactUri(rowID));
42                     }
43                 });
44         }
45     }
46
47     // set the database row ID for the contact in this ViewHolder
48     public void setRowID(long rowID) {
49         this.rowID = rowID;
50     }
51 }
```

---

**Fig. 9.39** | Subclass of RecyclerView.Adapter that binds contacts to RecyclerView. (Part 1 of 2.)

```

52     // ContactsAdapter instance variables
53     private Cursor cursor = null;
54     private final ContactClickListener clickListener;
55
56
57     // constructor
58     public ContactsAdapter(ContactClickListener clickListener) {
59         this.clickListener = clickListener;
60     }
61
62     // sets up new list item and its ViewHolder
63     @Override
64     public ViewHolder onCreateViewHolder(ViewGroup parent, int viewType) {
65         // inflate the android.R.layout.simple_list_item_1 layout
66         View view = LayoutInflater.from(parent.getContext()).inflate(
67             android.R.layout.simple_list_item_1, parent, false);
68         return new ViewHolder(view); // return current item's ViewHolder
69     }
70
71     // sets the text of the list item to display the search tag
72     @Override
73     public void onBindViewHolder(ViewHolder holder, int position) {
74         cursor.moveToPosition(position);
75         holder.rowID(cursor.getLong(cursor.getColumnIndex(Contact._ID)));
76         holder.textView.setText(cursor.getString(cursor.getColumnIndex(
77             Contact.COLUMN_NAME)));
78     }
79
80     // returns the number of items that adapter binds
81     @Override
82     public int getItemCount() {
83         return (cursor != null) ? cursor.getCount() : 0;
84     }
85
86     // swap this adapter's current Cursor for a new one
87     public void swapCursor(Cursor cursor) {
88         this.cursor = cursor;
89         notifyDataSetChanged();
90     }
91 }
```

**Fig. 9.39** | Subclass of RecyclerView.Adapter that binds contacts to RecyclerView. (Part 2 of 2.)

### *Nested Interface ContactClickListener*

Lines 20–22 define the nested interface ContactClickListener that class ContactsFragment implements to be notified when the user touches a contact in the RecyclerView. Each item in the RecyclerView has a click listener that calls the ContactClickListener’s onClick method and passes the selected contact’s Uri. The ContactsFragment then notifies the MainActivity that a contact was selected, so the MainActivity can display the contact in a DetailFragment.

***Nested Class ViewHolder***

Class `ViewHolder` (lines 26–51) maintains a reference to a `RecyclerView` item's `TextView` and the database's `rowID` for the corresponding contact. The `rowID` is necessary because we sort the contacts before displaying them, so each contact's position number in the `RecyclerView` most likely does not match the contact's row ID in the database. `ViewHolder`'s constructor stores a reference to the `RecyclerView` item's `TextView` and sets its `View.OnClickListener`, which passes the contact's URI to the adapter's `ContactClickListener`.

***Overridden RecyclerView.Adapter Method onCreateViewHolder***

Method `onCreateViewHolder` (lines 63–69) inflates the GUI for a `ViewHolder` object. In this case we used the predefined layout `android.R.layout.simple_list_item_1`, which defines a layout containing one `TextView` named `text1`.

***Overridden RecyclerView.Adapter Method onBindViewHolder***

Method `onBindViewHolder` (lines 72–78) uses `Cursor` method `moveToPosition` to move to the contact that corresponds to the current `RecyclerView` item's position. Line 75 sets the `ViewHolder`'s `rowID`. To get this value, we use `Cursor` method `getRowIndex` to look up the column number of the `Contact._ID` column. We then pass that number to `Cursor` method `getLong` to get the contact's row ID. Lines 76–77 set the text for the `ViewHolder`'s `textView`, using a similar process—in this case, look up the column number for the `Contact.COLUMN_NAME` column, then call `Cursor` method `getString` to get the contact's name.

***Overridden RecyclerView.Adapter Method getItemCount***

Method `getItemCount` (lines 81–84) returns the total number of rows in the `Cursor` or 0 if `Cursor` is `null`.

***Method swapCursor***

Method `swapCursor` (lines 87–90) replaces the adapter's current `Cursor` and notifies the adapter that its data changed. This method is called from the `ContactsFragment`'s `onLoadFinished` and `onLoaderReset` methods.

## 9.12 AddEditFragment Class

The `AddEditFragment` class provides a GUI for adding new contacts or editing existing ones. Many of the programming concepts used in this class have been presented earlier in this chapter or in prior chapters, so we focus here only on the new features.

### 9.12.1 Superclass and Implemented Interface

Figure 9.40 lists the package statement, `import` statements and the beginning of the `AddEditFragment` class definition. The class extends `Fragment` and implements the `LoaderManager.LoaderCallbacks<Cursor>` interface to respond to `LoaderManager` events.

---

```

1 // AddEditFragment.java
2 // Fragment for adding a new contact or editing an existing one
3 package com.deitel.addressbook;

```

---

**Fig. 9.40** | `AddEditFragment` package statement and `import` statements. (Part I of 2.)

---

```

4 import android.content.ContentValues;
5 import android.content.Context;
6 import android.database.Cursor;
7 import android.net.Uri;
8 import android.os.Bundle;
9 import android.support.design.widget.CoordinatorLayout;
10 import android.support.design.widget.FloatingActionButton;
11 import android.support.design.widget.Snackbar;
12 import android.support.design.widget.TextInputLayout;
13 import android.support.v4.app.Fragment;
14 import android.support.v4.app.LoaderManager;
15 import android.support.v4.content.CursorLoader;
16 import android.support.v4.content.Loader;
17 import android.text.Editable;
18 import android.text.TextWatcher;
19 import android.view.LayoutInflater;
20 import android.view.View;
21 import android.view.ViewGroup;
22 import android.view.inputmethod.InputMethodManager;
23
24 import com.deitel.addressbook.data.DatabaseDescription.Contact;
25
26 public class AddEditFragment extends Fragment
27     implements LoaderManager.LoaderCallbacks<Cursor> {
28
29

```

**Fig. 9.40** | AddEditFragment package statement and import statements. (Part 2 of 2.)

### 9.12.2 AddEditFragmentListener

Figure 9.41 declares the nested interface AddEditFragmentListener containing the callback method onAddEditCompleted. MainActivity implements this interface to be notified when the user saves a new contact or saves changes to an existing one.

---

```

30 // defines callback method implemented by MainActivity
31 public interface AddEditFragmentListener {
32     // called when contact is saved
33     void onAddEditCompleted(Uri contactUri);
34 }
35

```

**Fig. 9.41** | Nested interface AddEditFragmentListener.

### 9.12.3 Fields

Figure 9.42 lists the class's fields:

- The constant CONTACT\_LOADER (line 37) identifies the Loader that queries the AddressBookContentProvider to retrieve one contact for editing.
- The instance variable listener (line 39) refers to the AddEditFragmentListener (MainActivity) that's notified when the user saves a new or updated contact.

- The instance variable `contactUri` (line 40) represents the contact to edit.
- The instance variable `addingNewContact` (line 41) specifies whether a new contact is being added (`true`) or an existing contact is being edited (`false`).
- The instance variables at lines 44–53 refer to the Fragment’s `TextInputLayouts`, `FloatingActionButton` and `CoordinatorLayout`.

---

```

36    // constant used to identify the Loader
37    private static final int CONTACT_LOADER = 0;
38
39    private AddEditFragmentListener listener; // MainActivity
40    private Uri contactUri; // Uri of selected contact
41    private boolean addingNewContact = true; // adding (true) or editing
42
43    // EditTexts for contact information
44    private TextInputLayout nameTextInputLayout;
45    private TextInputLayout phoneTextInputLayout;
46    private TextInputLayout emailTextInputLayout;
47    private TextInputLayout streetTextInputLayout;
48    private TextInputLayout cityTextInputLayout;
49    private TextInputLayout stateTextInputLayout;
50    private TextInputLayout zipTextInputLayout;
51    private FloatingActionButton saveContactFAB;
52
53    private CoordinatorLayout coordinatorLayout; // used with SnackBars
54

```

---

**Fig. 9.42** | AddEditFragment fields.

#### 9.12.4 Overridden Fragment Methods `onAttach`, `onDetach` and `onCreateView`

Figure 9.43 contains the overridden Fragment methods `onAttach`, `onDetach` and `onCreateView`. Methods `onAttach` and `onDetach` set instance variable `listener` to refer to the host Activity when the `AddEditFragment` is attached and to set `listener` to `null` when the `AddEditFragment` is detached.

---

```

55    // set AddEditFragmentListener when Fragment attached
56    @Override
57    public void onAttach(Context context) {
58        super.onAttach(context);
59        listener = (AddEditFragmentListener) context;
60    }
61
62    // remove AddEditFragmentListener when Fragment detached
63    @Override
64    public void onDetach() {
65        super.onDetach();
66        listener = null;
67    }

```

---

**Fig. 9.43** | Overridden Fragment Methods `onAttach`, `onDetach` and `onCreateView`. (Part I of 2.)

```

68
69 // called when Fragment's view needs to be created
70 @Override
71 public View onCreateView(
72     LayoutInflater inflater, ViewGroup container,
73     Bundle savedInstanceState) {
74     super.onCreateView(inflater, container, savedInstanceState);
75     setHasOptionsMenu(true); // fragment has menu items to display
76
77     // inflate GUI and get references to EditTexts
78     View view =
79         inflater.inflate(R.layout.fragment_add_edit, container, false);
80     nameTextInputLayout =
81         (TextInputLayout) view.findViewById(R.id.nameTextInputLayout);
82     nameTextInputLayout.getEditText().addTextChangedListener(
83         nameChangedListener);
84     phoneTextInputLayout =
85         (TextInputLayout) view.findViewById(R.id.phoneTextInputLayout);
86     emailTextInputLayout =
87         (TextInputLayout) view.findViewById(R.id.emailTextInputLayout);
88     streetTextInputLayout =
89         (TextInputLayout) view.findViewById(R.id.streetTextInputLayout);
90     cityTextInputLayout =
91         (TextInputLayout) view.findViewById(R.id.cityTextInputLayout);
92     stateTextInputLayout =
93         (TextInputLayout) view.findViewById(R.id.stateTextInputLayout);
94     zipTextInputLayout =
95         (TextInputLayout) view.findViewById(R.id.zipTextInputLayout);
96
97     // set FloatingActionButton's event listener
98     saveContactFAB = (FloatingActionButton) view.findViewById(
99         R.id.saveFloatingActionButton);
100    saveContactFAB.setOnClickListener(saveContactButtonClicked);
101    updateSaveButtonFAB();
102
103    // used to display SnackBars with brief messages
104    coordinatorLayout = (CoordinatorLayout) getActivity().findViewById(
105        R.id.coordinatorLayout);
106
107    Bundle arguments = getArguments(); // null if creating new contact
108
109    if (arguments != null) {
110        addingNewContact = false;
111        contactUri = arguments.getParcelable(MainActivity.CONTACT_URI);
112    }
113
114    // if editing an existing contact, create Loader to get the contact
115    if (contactUri != null)
116        getLoaderManager().initLoader(CONTACT_LOADER, null, this);
117
118    return view;
119}
120

```

**Fig. 9.43** | Overridden Fragment Methods onAttach, onDetach and onCreateView. (Part 2 of 2.)

Method `onCreateView` inflates the GUI and gets references to the Fragment's `TextInputLayouts` and configures the `FloatingActionButton`. Next, we use Fragment method `getArguments` to get the `Bundle` of arguments (line 107). When we launch the `AddEditFragment` from the `MainActivity`, we pass `null` for the `Bundle` argument, because the user is adding a new contact's information. In this case, `getArguments` returns `null`. If `getArguments` returns a `Bundle` (line 109), then the user is editing an existing contact. Line 111 reads the contact's `Uri` from the `Bundle` by calling method `getParcelable`. If `contactUri` is not `null`, line 116 uses the Fragment's `LoaderManager` to initialize a `Loader` that the `AddEditFragment` will use to get the data for the contact being edited.

### 9.12.5 TextWatcher nameChangedListener and Method updateSaveButtonFAB

Figure 9.44 shows the `TextWatcher` `nameChangedListener` and method `updatedSaveButtonFAB`. The listener calls method `updatedSaveButtonFAB` when the user edits the text in the `nameTextInputLayout`'s `EditText`. The name must be non-empty in this app, so method `updatedSaveButtonFAB` displays the `FloatingActionButton` only when the `nameTextInputLayout`'s `EditText` is not empty.

---

```

I21  // detects when the text in the nameTextInputLayout's EditText changes
I22  // to hide or show saveButtonFAB
I23  private final TextWatcher nameChangedListener = new TextWatcher() {
I24      @Override
I25      public void beforeTextChanged(CharSequence s, int start, int count,
I26          int after) {}
I27
I28      // called when the text in nameTextInputLayout changes
I29      @Override
I30      public void onTextChanged(CharSequence s, int start, int before,
I31          int count) {
I32          updateSaveButtonFAB();
I33      }
I34
I35      @Override
I36      public void afterTextChanged(Editable s) {}
I37  };
I38
I39  // shows saveButtonFAB only if the name is not empty
I40  private void updateSaveButtonFAB() {
I41      String input =
I42          nameTextInputLayout.getEditText().getText().toString();
I43
I44      // if there is a name for the contact, show the FloatingActionButton
I45      if (input.trim().length() != 0)
I46          saveContactFAB.show();
I47      else
I48          saveContactFAB.hide();
I49  }
I50

```

---

**Fig. 9.44** | `TextWatcher` `nameChangedListener` and method `updateSaveButtonFAB`.

### 9.12.6 View.OnClickListener saveContactButtonClicked and Method saveContact

When the user touches this Fragment's FloatingActionButton, the `saveContactButtonClicked` listener (Fig. 9.45, lines 152–162) executes. Method `onClick` hides the keyboard (lines 157–159), then calls method `saveContact`.

```

151 // responds to event generated when user saves a contact
152 private final View.OnClickListener saveContactButtonClicked =
153     new View.OnClickListener() {
154         @Override
155         public void onClick(View v) {
156             // hide the virtual keyboard
157             ((InputMethodManager) getActivity().getSystemService(
158                 Context.INPUT_METHOD_SERVICE)).hideSoftInputFromWindow(
159                 getView().getWindowToken(), 0);
160             saveContact(); // save contact to the database
161         }
162     };
163
164 // saves contact information to the database
165 private void saveContact() {
166     // create ContentValues object containing contact's key-value pairs
167     ContentValues contentValues = new ContentValues();
168     contentValues.put(Contact.COLUMN_NAME,
169         nameTextInputLayout.getEditText().getText().toString());
170     contentValues.put(Contact.COLUMN_PHONE,
171         phoneTextInputLayout.getEditText().getText().toString());
172     contentValues.put(Contact.COLUMN_EMAIL,
173         emailTextInputLayout.getEditText().getText().toString());
174     contentValues.put(Contact.COLUMN_STREET,
175         streetTextInputLayout.getEditText().getText().toString());
176     contentValues.put(Contact.COLUMN_CITY,
177         cityTextInputLayout.getEditText().getText().toString());
178     contentValues.put(Contact.COLUMN_STATE,
179         stateTextInputLayout.getEditText().getText().toString());
180     contentValues.put(Contact.COLUMN_ZIP,
181         zipTextInputLayout.getEditText().getText().toString());
182
183     if (addingNewContact) {
184         // use Activity's ContentResolver to invoke
185         // insert on the AddressBookContentProvider
186         Uri newContactUri = getActivity().getContentResolver().insert(
187             Contact.CONTENT_URI, contentValues);
188
189         if (newContactUri != null) {
190             Snackbar.make(coordinatorLayout,
191                 R.string.contact_added, Snackbar.LENGTH_LONG).show();
192             listener.onAddEditCompleted(newContactUri);
193         }

```

**Fig. 9.45** | View.OnClickListener `saveContactButtonClicked` and method `saveContact`. (Part 1 of 2.)

```

194        else {
195            Snackbar.make(coordinatorLayout,
196                R.string.contact_not_added, Snackbar.LENGTH_LONG).show();
197        }
198    } else {
199        // use Activity's ContentResolver to invoke
200        // insert on the AddressBookContentProvider
201        int updatedRows = getActivity().getContentResolver().update(
202            contactUri, contentValues, null, null);
203
204        if (updatedRows > 0) {
205            listener.onAddEditCompleted(contactUri);
206            Snackbar.make(coordinatorLayout,
207                R.string.contact_updated, Snackbar.LENGTH_LONG).show();
208        } else {
209            Snackbar.make(coordinatorLayout,
210                R.string.contact_not_updated, Snackbar.LENGTH_LONG).show();
211        }
212    }
213}
214}
215}
216}

```

**Fig. 9.45** | View.OnClickListener saveContactButtonClicked and method saveContact. (Part 2 of 2.)

The `saveContact` method (lines 165–215) creates a `ContentValues` object (line 167) and adds to it key–value pairs representing the column names and values to be inserted into or updated in the database (lines 168–181). If the user is adding a new contact (lines 183–198), lines 186–187 use `ContentResolver` method `insert` to invoke `insert` on the `AddressBookContentProvider` and place the new contact into the database. If the insert is successful, the returned `Uri` is non-null and lines 190–192 display a `SnackBar` indicating that the contact was added, then notify the `AddEditFragmentListener` with the contact that was added. Recall that when the app is running on a tablet, this results in the contact’s data being displayed in a `DetailFragment` next to the `ContactsFragment`. If the insert is not successful, lines 195–196 display an appropriate `SnackBar`.

If the user is editing an existing contact (lines 199–214), lines 202–203 use `ContentResolver` method `update` to invoke `update` on the `AddressBookContentProvider` and store the edited contact’s data. If the update is successful, the returned integer is greater than 0 (indicating the specific number of rows updated) and lines 206–208 notify the `AddEditFragmentListener` with the contact that was edited, then display an appropriate message. If the update is not successful, lines 211–212 display an appropriate `SnackBar`.

### 9.12.7 LoaderManager.LoaderCallbacks<Cursor> Methods

Figure 9.46 presents the `AddEditFragment`’s implementations of the methods in interface `LoaderManager.LoaderCallbacks<Cursor>`. These methods are used in class `AddEditFragment` only when the user is editing an existing contact. Method `onCreateLoader` (lines 219–233) creates a `CursorLoader` for the specific contact being edited. Method `on-`

`LoadFinished` (lines 236–267) checks whether the cursor is non-null and, if so, calls cursor method `moveToFirst`. If this method returns true, then a contact matching the `contactUri` was found in the database and lines 241–263 get the contact's information from the Cursor and display it in the GUI. Method `onLoaderReset` is not needed in `AddEditFragment`, so it does nothing.

```

217     // called by LoaderManager to create a Loader
218     @Override
219     public Loader<Cursor> onCreateLoader(int id, Bundle args) {
220         // create an appropriate CursorLoader based on the id argument;
221         // only one Loader in this fragment, so the switch is unnecessary
222         switch (id) {
223             case CONTACT_LOADER:
224                 return new CursorLoader(getActivity(),
225                     contactUri, // Uri of contact to display
226                     null, // null projection returns all columns
227                     null, // null selection returns all rows
228                     null, // no selection arguments
229                     null); // sort order
230             default:
231                 return null;
232         }
233     }
234
235     // called by LoaderManager when loading completes
236     @Override
237     public void onLoadFinished(Loader<Cursor> loader, Cursor data) {
238         // if the contact exists in the database, display its data
239         if (data != null && data.moveToFirst()) {
240             // get the column index for each data item
241             int nameIndex = data.getColumnIndex(Contact.COLUMN_NAME);
242             int phoneIndex = data.getColumnIndex(Contact.COLUMN_PHONE);
243             int emailIndex = data.getColumnIndex(Contact.COLUMN_EMAIL);
244             int streetIndex = data.getColumnIndex(Contact.COLUMN_STREET);
245             int cityIndex = data.getColumnIndex(Contact.COLUMN_CITY);
246             int stateIndex = data.getColumnIndex(Contact.COLUMN_STATE);
247             int zipIndex = data.getColumnIndex(Contact.COLUMN_ZIP);
248
249             // fill EditTexts with the retrieved data
250             nameTextInputLayout.getEditText().setText(
251                 data.getString(nameIndex));
252             phoneTextInputLayout.getEditText().setText(
253                 data.getString(phoneIndex));
254             emailTextInputLayout.getEditText().setText(
255                 data.getString(emailIndex));
256             streetTextInputLayout.getEditText().setText(
257                 data.getString(streetIndex));
258             cityTextInputLayout.getEditText().setText(
259                 data.getString(cityIndex));
260             stateTextInputLayout.getEditText().setText(
261                 data.getString(stateIndex));

```

Fig. 9.46 | `LoaderManager.LoaderCallbacks<Cursor>` methods. (Part 1 of 2.)

```
262         zipTextInputLayout.getEditText().setText(
263             data.getString(zipIndex));
264
265         updateSaveButtonFAB();
266     }
267 }
268
269 // called by LoaderManager when the Loader is being reset
270 @Override
271 public void onLoaderReset(Loader<Cursor> loader) { }
272 }
```

Fig. 9.46 | LoaderManager.LoaderCallbacks<Cursor> methods. (Part 2 of 2.)

## 9.13 DetailFragment Class

The `DetailFragment` class displays one contact's information and provides menu items on the app bar that enable the user to edit or delete that contact.

### 9.13.1 Superclass and Implemented Interface

Figure 9.47 lists the package statement, import statements and the beginning of the `DetailFragment` class definition. The class extends `Fragment` and implements the `LoaderManager.LoaderCallbacks<Cursor>` interface to respond to `LoaderManager` events.

---

```
1 // DetailFragment.java
2 // Fragment subclass that displays one contact's details
3 package com.deitel.addressbook;
4
5 import android.app.AlertDialog;
6 import android.app.Dialog;
7 import android.content.Context;
8 import android.content.DialogInterface;
9 import android.database.Cursor;
10 import android.net.Uri;
11 import android.os.Bundle;
12 import android.support.v4.app.DialogFragment;
13 import android.support.v4.app.Fragment;
14 import android.support.v4.app.LoaderManager;
15 import android.support.v4.content.CursorLoader;
16 import android.support.v4.content.Loader;
17 import android.view.LayoutInflater;
18 import android.view.Menu;
19 import android.view.MenuInflater;
20 import android.view.MenuItem;
21 import android.view.View;
22 import android.view.ViewGroup;
23 import android.widget.TextView;
24
```

Fig. 9.47 | package statement, import statements, superclass and implemented interface. (Part 1 of 2.)

---

```

25 import com.deitel.addressbook.data.DatabaseDescription.Contact;
26
27 public class DetailFragment extends Fragment
28     implements LoaderManager.LoaderCallbacks<Cursor> {
29

```

**Fig. 9.47** | package statement, import statements, superclass and implemented interface.  
(Part 2 of 2.)

### 9.13.2 DetailFragmentListener

Figure 9.48 declares the nested interface `DetailFragmentListener` containing the callback methods that `MainActivity` implements to be notified when the user deletes a contact (line 32) and when the user touches the edit menu item to edit a contact (line 35).

---

```

30     // callback methods implemented by MainActivity
31     public interface DetailFragmentListener {
32         void onContactDeleted(); // called when a contact is deleted
33
34         // pass Uri of contact to edit to the DetailFragmentListener
35         void onEditContact(Uri contactUri);
36     }
37

```

**Fig. 9.48** | Nested interface `DetailFragmentListener`.

### 9.13.3 Fields

Figure 9.49 shows the class's fields:

- The constant `CONTACT_LOADER` (line 38) identifies the `Loader` that queries the `AddressBookContentProvider` to retrieve one contact to display.
- The instance variable `listener` (line 40) refers to the `DetailFragmentListener` (`MainActivity`) that's notified when the user deletes a contact or initiates editing of a contact.
- The instance variable `contactUri` (line 41) represents the contact to display.
- The instance variables at lines 43–49 refer to the `Fragment`'s `TextViews`.

---

```

38     private static final int CONTACT_LOADER = 0; // identifies the Loader
39
40     private DetailFragmentListener listener; // MainActivity
41     private Uri contactUri; // Uri of selected contact
42
43     private TextView nameTextView; // displays contact's name
44     private TextView phoneTextView; // displays contact's phone
45     private TextView emailTextView; // displays contact's email
46     private TextView streetTextView; // displays contact's street
47     private TextView cityTextView; // displays contact's city

```

**Fig. 9.49** | `DetailFragment` fields. (Part 1 of 2.)

---

```

48     private TextView stateTextView; // displays contact's state
49     private TextView zipTextView; // displays contact's zip
50

```

---

**Fig. 9.49** | DetailFragment fields. (Part 2 of 2.)

#### 9.13.4 Overridden Methods `onAttach`, `onDetach` and `onCreateView`

Figure 9.50 contains overridden Fragment methods `onAttach`, `onDetach` and `onCreateView`. Methods `onAttach` and `onDetach` set instance variable `listener` to refer to the host Activity when the `DetailFragment` is attached and to set `listener` to `null` when the `DetailFragment` is detached. The `onCreateView` method (lines 66–95) obtains the selected contact's Uri (lines 74–77). Lines 80–90 inflate the GUI and get references to the `TextViews`. Line 93 uses the Fragment's `LoaderManager` to initialize a `Loader` that the `DetailFragment` will use to get the data for the contact to display.

---

```

51     // set DetailFragmentListener when fragment attached
52     @Override
53     public void onAttach(Context context) {
54         super.onAttach(context);
55         listener = (DetailFragmentListener) context;
56     }
57
58     // remove DetailFragmentListener when fragment detached
59     @Override
60     public void onDetach() {
61         super.onDetach();
62         listener = null;
63     }
64
65     // called when DetailFragmentListener's view needs to be created
66     @Override
67     public View onCreateView(
68         LayoutInflater inflater, ViewGroup container,
69         Bundle savedInstanceState) {
70         super.onCreateView(inflater, container, savedInstanceState);
71         setHasOptionsMenu(true); // this fragment has menu items to display
72
73         // get Bundle of arguments then extract the contact's Uri
74         Bundle arguments = getArguments();
75
76         if (arguments != null)
77             contactUri = arguments.getParcelable(MainActivity.CONTRACT_URI);
78
79         // inflate DetailFragment's layout
80         View view =
81             inflater.inflate(R.layout.fragment_detail, container, false);
82
83         // get the EditTexts
84         nameTextView = (EditText) view.findViewById(R.id.nameEditText);

```

---

**Fig. 9.50** | Overridden methods `onAttach`, `onDetach` and `onCreateView`. (Part 1 of 2.)

---

```

95     phoneTextView = (TextView) view.findViewById(R.id.phoneTextView);
96     emailTextView = (TextView) view.findViewById(R.id.emailTextView);
97     streetTextView = (TextView) view.findViewById(R.id.streetTextView);
98     cityTextView = (TextView) view.findViewById(R.id.cityTextView);
99     stateTextView = (TextView) view.findViewById(R.id.stateTextView);
100    zipTextView = (TextView) view.findViewById(R.id.zipTextView);
101
102    // Load the contact
103    getLoaderManager().initLoader(CONTACT_LOADER, null, this);
104    return view;
105  }
106
107

```

**Fig. 9.50** | Overridden methods `onAttach`, `onDetach` and `onCreateView`. (Part 2 of 2.)

### 9.13.5 Overridden Methods `onCreateOptionsMenu` and `onOptionsItemSelected`

The `DetailFragment` displays in the app bar options for editing the current contact and for deleting it. Method `onCreateOptionsMenu` (Fig. 9.51, lines 98–102) inflates the menu resource file `fragment_details_menu.xml`. Method `onOptionsItemSelected` (lines 105–117) uses the selected `MenuItem`'s resource ID to determine which one was selected. If the user touched the edit option (✉), line 109 calls the `DetailFragmentListener`'s `onEditContact` method with the `contactUri`—`MainActivity` passes this to the `AddEditFragment`. If the user touched the delete option (trash), line 112 calls method `deleteContact` (Fig. 9.52).

---

```

97    // display this fragment's menu items
98    @Override
99    public void onCreateOptionsMenu(Menu menu, MenuInflater inflater) {
100        super.onCreateOptionsMenu(menu, inflater);
101        inflater.inflate(R.menu.fragment_details_menu, menu);
102    }
103
104    // handle menu item selections
105    @Override
106    public boolean onOptionsItemSelected(MenuItem item) {
107        switch (item.getItemId()) {
108            case R.id.action_edit:
109                listener.onEditContact(contactUri); // pass Uri to listener
110                return true;
111            case R.id.action_delete:
112                deleteContact();
113                return true;
114        }
115
116        return super.onOptionsItemSelected(item);
117    }
118

```

**Fig. 9.51** | Overridden methods `onCreateOptionsMenu` and `onOptionsItemSelected`.

### 9.13.6 Method deleteContact and DialogFragment confirmDelete

Method `deleteContact` (Fig. 9.52, lines 120–123) displays a `DialogFragment` (lines 126–157) asking the user to confirm that the currently displayed contact should be deleted. If the user touches `DELETE` in the dialog, lines 147–148 call `ContentResolver` method `delete` (lines 147–148) to invoke the `AddressBookContentProvider`'s `delete` method and remove the contact from the database. Method `delete` receives the `Uri` of the content to delete, a `String` representing the `WHERE` clause that determines what to delete and a `String` array of arguments to insert in the `WHERE` clause. In this case, the last two arguments are `null`, because the row ID of the contact to delete is embedded in the `Uri`—this row ID is extracted from the `Uri` by the `AddressBookContentProvider`'s `delete` method. Line 149 calls the `Listener`'s `onContactDeleted` method so that `MainActivity` can remove the `DetailFragment` from the screen.

---

```

119    // delete a contact
120    private void deleteContact() {
121        // use FragmentManager to display the confirmDelete DialogFragment
122        confirmDelete.show(getFragmentManager(), "confirm delete");
123    }
124
125    // DialogFragment to confirm deletion of contact
126    private final DialogFragment confirmDelete =
127        new DialogFragment() {
128            // create an AlertDialog and return it
129            @Override
130            public Dialog onCreateDialog(Bundle bundle) {
131                // create a new AlertDialog Builder
132                AlertDialog.Builder builder =
133                    new AlertDialog.Builder(getActivity());
134
135                builder.setTitle(R.string.confirm_title);
136                builder.setMessage(R.string.confirm_message);
137
138                // provide an OK button that simply dismisses the dialog
139                builder.setPositiveButton(R.string.button_delete,
140                    new DialogInterface.OnClickListener() {
141                        @Override
142                        public void onClick(
143                            DialogInterface dialog, int button) {
144
145                            // use Activity's ContentResolver to invoke
146                            // delete on the AddressBookContentProvider
147                            getActivity().getContentResolver().delete(
148                                contactUri, null, null);
149                            Listener.onContactDeleted(); // notify listener
150
151                        }
152                    });
153    };

```

---

**Fig. 9.52** | Method `deleteContact` and `DialogFragment confirmDelete`. (Part I of 2.)

---

```

154         builder.setNegativeButton(R.string.button_cancel, null);
155         return builder.create(); // return the AlertDialog
156     }
157 }
158

```

**Fig. 9.52** | Method deleteContact and DialogFragment confirmDelete. (Part 2 of 2.)

### 9.13.7 LoaderManager.LoaderCallback<Cursor> Methods

Figure 9.53 presents the DetailFragment's implementations of the methods in interface LoaderManager.LoaderCallbacks<Cursor>. Method onCreateLoader (lines 160–181) creates a CursorLoader for the specific contact being displayed. Method onLoadFinished (lines 184–206) checks whether the cursor is non-null and, if so, calls cursor method moveToFirst. If this method returns true, then a contact matching the contactUri was found in the database and lines 189–204 get the contact's information from the Cursor and display it in the GUI. Method onLoaderReset is not needed in DetailFragment, so it does nothing.

---

```

159     // called by LoaderManager to create a Loader
160     @Override
161     public Loader<Cursor> onCreateLoader(int id, Bundle args) {
162         // create an appropriate CursorLoader based on the id argument;
163         // only one Loader in this fragment, so the switch is unnecessary
164         CursorLoader cursorLoader;
165
166         switch (id) {
167             case CONTACT_LOADER:
168                 cursorLoader = new CursorLoader(getActivity(),
169                     contactUri, // Uri of contact to display
170                     null, // null projection returns all columns
171                     null, // null selection returns all rows
172                     null, // no selection arguments
173                     null); // sort order
174                 break;
175             default:
176                 cursorLoader = null;
177                 break;
178         }
179
180         return cursorLoader;
181     }
182
183     // called by LoaderManager when loading completes
184     @Override
185     public void onLoadFinished(Loader<Cursor> loader, Cursor data) {
186         // if the contact exists in the database, display its data
187         if (data != null && data.moveToFirst()) {
188             // get the column index for each data item
189             int nameIndex = data.getColumnIndex(Contact.COLUMN_NAME);

```

**Fig. 9.53** | LoaderManager.LoaderCallback<Cursor> methods. (Part 1 of 2.)

```
190     int phoneIndex = data.getColumnIndex(Contact.COLUMN_PHONE);
191     int emailIndex = data.getColumnIndex(Contact.COLUMN_EMAIL);
192     int streetIndex = data.getColumnIndex(Contact.COLUMN_STREET);
193     int cityIndex = data.getColumnIndex(Contact.COLUMN_CITY);
194     int stateIndex = data.getColumnIndex(Contact.COLUMN_STATE);
195     int zipIndex = data.getColumnIndex(Contact.COLUMN_ZIP);
196
197     // fill TextViews with the retrieved data
198     nameTextView.setText(data.getString(nameIndex));
199     phoneTextView.setText(data.getString(phoneIndex));
200     emailTextView.setText(data.getString(emailIndex));
201     streetTextView.setText(data.getString(streetIndex));
202     cityTextView.setText(data.getString(cityIndex));
203     stateTextView.setText(data.getString(stateIndex));
204     zipTextView.setText(data.getString(zipIndex));
205 }
206 }
207
208 // called by LoaderManager when the Loader is being reset
209 @Override
210 public void onLoaderReset(Loader<Cursor> loader) { }
211 }
```

---

Fig. 9.53 | LoaderManager.LoaderCallback<Cursor> methods. (Part 2 of 2.)

## 9.14 Wrap-Up

In this chapter, you created an **Address Book** app for adding, viewing, editing and deleting contact information that's stored in a SQLite database.

You used one activity to host all of the app's **Fragments**. On a phone-sized device, you displayed one **Fragment** at a time. On a tablet, the activity displayed the **Fragment** containing the contact list, and you replaced that with **Fragments** for viewing, adding and editing contacts as necessary. You used the **FragmentManager** and **FragmentTransactions** to dynamically display **Fragments**. You used Android's **Fragment** back stack to provide automatic support for Android's back button. To communicate data between **Fragments** and the host activity, you defined in each **Fragment** subclass a nested interface of callback methods that the host activity implemented.

You used a subclass of **SQLiteOpenHelper** to simplify creating the database and to obtain a **SQLiteDatabase** object for manipulating the database's contents. You also managed database query results via a **Cursor** (package `android.database`).

To access the database asynchronously outside the GUI thread, you defined a subclass of **ContentProvider** that specified how to query, insert, update and delete data. When changes were made to the SQLite database, the **ContentProvider** notified listeners so data could be updated in the GUI. The **ContentProvider** defined **Uris** that it used to determine the tasks to perform.

To invoke the **ContentProvider**'s `query`, `insert`, `update` and `delete` capabilities, we invoked the corresponding methods of the activity's built-in **ContentResolver**. You saw that the **ContentProvider** and **ContentResolver** handle communication for you. The **ContentResolver**'s methods received as their first argument a **Uri** that specified the **ContentProvider** to access. Each **ContentResolver** method invoked the corresponding

method of the `ContentProvider`, which in turn used the `Uri` to help determine the task to perform.

As we've stated previously, long-running operations or operations that block execution until they complete (e.g., file and database access) should be performed outside the GUI thread. You used a `CursorLoader` to perform asynchronous data access. You learned that `Loaders` are created and managed by an `Activity`'s or `Fragment`'s `LoaderManager`, which ties each `Loader`'s lifecycle to that of its `Activity` or `Fragment`. You implemented interface `LoaderManager.LoaderCallbacks` to respond to `Loader` events indicating when a `Loader` should be created, finishes loading its data, or is reset and the data is no longer available.

You defined common GUI component attribute–value pairs as a `style` resource, then applied the `style` to the `TextViews` that display a contact's information. You also defined a border for a `TextView` by specifying a `Drawable` for the `TextView`'s background. The `Drawable` could be an image, but in this app you defined the `Drawable` as a shape in a resource file.

In Chapter 10, we discuss the business side of Android app development. You'll see how to prepare your app for submission to Google Play, including making icons. We'll discuss how to test your apps on devices and publish them on Google Play. We discuss the characteristics of great apps and the Android design guidelines to follow. We provide tips for pricing and marketing your app. We also review the benefits of offering your app for free to drive sales of other products, such as a more feature-rich version of the app or premium content. We show how to use Google Play to track app sales, payments and more.

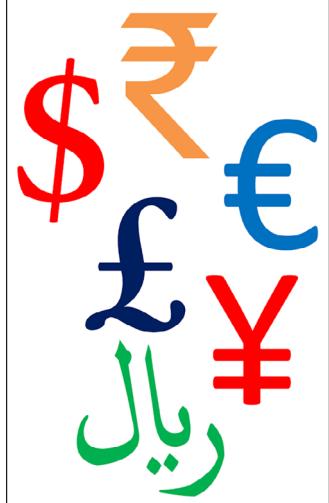
# 10

## Google Play and App Business Issues

### Objectives

In this chapter you'll be introduced to:

- Preparing your apps for publication.
- Pricing your apps and the benefits of free vs. paid apps.
- Monetizing your apps with in-app advertising.
- Selling virtual goods using in-app billing.
- Registering for Google Play.
- Setting up a merchant account.
- Uploading your apps to Google Play.
- Launching Google Play from within an app.
- Other Android app marketplaces.
- Other popular mobile app platforms to which you can port your apps to broaden your market.
- Marketing your apps.



**Outline**

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- 10.2** Preparing Your Apps for Publication
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  - 10.2.3 Icons and Labels
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- 10.10** Managing Your Apps in Google Play
- 10.11** Other Android App Marketplaces
- 10.12** Other Mobile App Platforms and Porting Your Apps
- 10.13** Marketing Your Apps
- 10.14** Wrap-Up

## 10.1 Introduction

In Chapters 2–9, we developed a variety of complete working Android apps. Once you've developed and tested your own apps, both in the emulator and on Android devices, the next step is to submit them to Google Play—and/or other app marketplaces—for distribution to a worldwide audience. In this chapter, we'll discuss

- registering for Google Play and setting up a Google Payments merchant account so that you can sell your apps
- preparing your apps for publication and
- uploading them to Google Play.

In a few cases, we'll refer you to the Android documentation instead of showing the steps in the book, because the steps are likely to change. We'll tell you about additional Android app marketplaces where you can distribute your apps. We'll discuss whether you should offer your apps for free or for a fee, and mention key means for monetizing apps, including in-app advertising, in-app billing and selling virtual goods. We'll provide resources for marketing your apps, and mention other app platforms to which you may port your Android apps to broaden your marketplace.

## 10.2 Preparing Your Apps for Publication

Google provides various documents to help you get ready to release your app. The *Preparing for Release* document

<http://developer.android.com/tools/publishing/preparing.html>

summarizes what you need to do, including:

- getting a *cryptographic key* for *digitally signing* your app

- creating an application *icon*
- including an *End User License Agreement* with your app (optional)
- *versioning* your app (e.g., 1.0, 1.1, 2.0, 2.3, 3.0)
- *compiling* your app for release and
- *testing* the release version of your app on Android devices

[http://developer.android.com/tools/testing/what\\_to\\_test.html](http://developer.android.com/tools/testing/what_to_test.html)

Before publishing your app, you should also read the *Core App Quality* document

<http://developer.android.com/distribute/essentials/quality/core.html>

which provides quality guidelines for all apps, the *Tablet App Quality* document

<http://developer.android.com/distribute/essentials/quality/tablets.html>

which provides guidelines specifically for tablet apps, the *Launch Checklist* for publishing apps on the Google Play store

<http://developer.android.com/distribute/tools/launch-checklist.html>

and the *Localization Checklist* for apps that will be sold in various worldwide markets

<http://developer.android.com/distribute/tools/localization-checklist.html>

The remainder of this section discusses in more detail some of the items you'll need and other considerations before you publish an app.

## 10.2.1 Testing Your App

You should test your app thoroughly on a variety of devices. The app might work perfectly using the emulator on your computer, but problems could arise when running it on particular Android devices. Google's Cloud Test Lab<sup>1</sup>

<https://developers.google.com/cloud-test-lab>

helps you test your app across a wide range of devices.

## 10.2.2 End User License Agreement

You have the option to include an **End User License Agreement (EULA)** with your app. An EULA is an agreement through which you license your software to the user. It typically stipulates terms of use, limitations on redistribution and reverse engineering, product liability, compliance with applicable laws and more. You might want to consult an attorney when drafting an EULA for your app. To view a sample EULA, see

<http://www.rocketlawyer.com/document/end-user-license-agreement.rl>

---

1. Not yet available at the time of this writing.

### 10.2.3 Icons and Labels

Design an icon for your app and provide a text label (a name) that will appear in Google Play and on the user's device. The icon could be your company logo, an image from the app or a custom image. Google's material design documentation provides all the details to consider for your app icons:

<https://www.google.com/design/spec/style/icons.html>

Product icons should be 48-by-48 dp with a 1-dp border. Android scales this to the required size for various screen sizes and densities. For this reason, the guidelines recommend that you design the icon at 192-by-192 dp with a 4-dp edge—larger images that are scaled down to smaller sizes look better than smaller images scaled to larger sizes.

Google Play also displays a high-resolution app icon. This icon should be:

- 512-by-512 pixels
- 32-bit PNG
- 1 MB maximum

Since the app icon is the most important brand asset, having one that's high quality is important. Consider hiring an experienced graphic designer to help you create a compelling, professional icon. Figure 10.1 lists some design sites and firms that offer free, professionally designed icons and paid custom icon design services. Once you've created the icon, you can add it to your project using Android Studio's **Asset Studio** (as you did in Section 4.4.9), which will produce icons at various scaled sizes based on your original icon.

| Company          | URL   | Services   |
|------------------|---|--|
| glyphlab         | <a href="http://www.glyphlab.com/icon_design/">http://www.glyphlab.com/icon_design/</a> | Designs custom icons.                                      |
| Iconiza          | <a href="http://www.iconiza.com">http://www.iconiza.com</a>                             | Designs custom icons for a flat fee and sells stock icons. |
| The Iconfactory  | <a href="http://iconfactory.com/home">http://iconfactory.com/home</a>                   | Custom and stock icons.                                    |
| Rosetta®         | <a href="http://icondesign.rosetta.com/">http://icondesign.rosetta.com/</a>             | Designs custom icons for a fee.                            |
| The Noun Project | <a href="https://thenounproject.com/">https://thenounproject.com/</a>                   | Thousands of icons from many artists.                      |
| Elance®          | <a href="http://www.elance.com">http://www.elance.com</a>                               | Search for freelance icon designers.                       |

**Fig. 10.1** | Some custom app icon design firms.

### 10.2.4 Versioning Your App

It's important to include a *version name* (shown to the users) and a *version code* (an integer version number used internally by Google Play) for your app, and to consider your strategy for numbering updates. For example, the first version name of your app might be 1.0, minor updates might be 1.1 and 1.2, and the next major update might be 2.0. The version code is an integer that typically starts at 1 and is incremented by 1 for each new version of your app that you post. For additional guidelines, see *Versioning Your Applications* at

<http://developer.android.com/tools/publishing/versioning.html>

### 10.2.5 Licensing to Control Access to Paid Apps

The Google Play *licensing service* allows you to create licensing policies to control access to your paid apps. For example, you might use a licensing policy to limit how many simultaneous device installs are allowed. To learn more about the licensing service, visit

<http://developer.android.com/google/play/licensing/index.html>

### 10.2.6 Obfuscating Your Code

You should “obfuscate” any apps you upload to Google Play to discourage reverse engineering of your code and further protect your apps. The free **ProGuard** tool—which runs when you build your app in *release mode*—shrinks the size of your .apk file (the Android app package file that contains your app for installation) and optimizes and obfuscates the code “by removing unused code and renaming classes, fields, and methods with semantically obscure names.”<sup>2</sup> To learn how to set up and use the ProGuard tool, go to

<http://developer.android.com/tools/help/proguard.html>

### 10.2.7 Getting a Private Key for Digitally Signing Your App

Before uploading your app to a device, Google Play or other app marketplaces, you must *digitally sign* the .apk file using a **digital certificate** that identifies you as the app’s author. A digital certificate includes your name or company name, contact information, and more. It can be self-signed using a **private key** (i.e., a secure password used to *encrypt* the certificate); you do not need to purchase a certificate from a third-party certificate authority (though it’s an option). Android Studio automatically digitally signs your app when you execute it in an emulator or on a device for *debugging* purposes. That digital certificate is *not* valid for use with Google Play. For detailed instructions on digitally signing your apps, see *Signing Your Applications* at

<http://developer.android.com/tools/publishing/app-signing.html>

### 10.2.8 Featured Image and Screenshots

The Google Play store shows promotional graphics and screenshots in your app listing—these provide potential buyers with their first impressions of your app.

#### *Featured Image*

The featured image is used by Google Play to promote an app on phones, tablets and via the Google Play website. The following Android Developers Blog post discusses the featured image’s importance and its requirements:

<http://android-developers.blogspot.com/2011/10/android-market-featured-image.html>

#### *Screenshots and Using the Android Device Manager’s Screen Capture Tool*

You may upload a maximum of eight screenshots for each device on which your app runs—smartphone, small tablet, large tablet, Android TV and Android Wear. These

---

2. <http://developer.android.com/tools/help/proguard.html>.

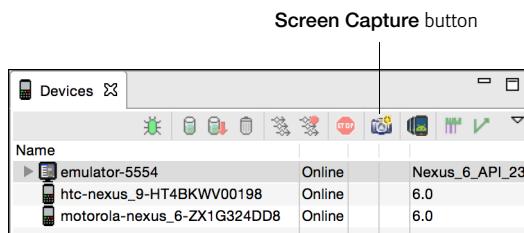
screenshots provide a preview of your app, since users can't test it before downloading it—although they can return an app for a refund within two hours after purchasing it. Choose attractive screenshots that show the app's functionality. Figure 10.2 describes the image requirements.

| Specification | Description   |
|---------------|---|
| Size          | Minimum width or height of 320 pixels and maximum of 3,840 pixels—the maximum dimension may not be more than twice the minimum. |
| Format        | 24-bit PNG or JPEG format with no alpha (transparency) effects.   |

**Fig. 10.2** | Screenshot specifications.

You can use the Android Device Monitor to capture device screenshots—this tool is installed with Android Studio and also helps you debug your apps that are running on emulators and devices. To obtain screenshots:

1. Run your app on an emulator or device.
2. In Android Studio, select **Tools > Android > Android Device Monitor** to open the Android Device Monitor.
3. In the **Devices** tab (Fig. 10.3), select the device from which you'd like to obtain a screen capture.



**Fig. 10.3** | Devices window in the DDMS perspective.

4. Click the **Screen Capture** button to display the **Device Screen Capture** window.
5. After you've ensured that the screen is showing what you'd like to capture, click the **Save** button to save the image.
6. If you wish to change what's on your device's screen before saving an image, make the change on the device (or AVD), then press the **Refresh** button in the **Device Screen Capture** window to recapture the device's screen. You can also click **Rotate** to capture an image in landscape orientation.

For more information on the images you can include with your app listing, visit

<https://support.google.com/googleplay/android-developer/answer/1078870>

### 10.2.9 Promotional App Video

Google Play also allows you to include a URL for a short promotional video that's hosted on YouTube. To use this feature, you must sign up for a YouTube account and upload your video to the site. Figure 10.4 lists several promo video examples. Some videos show a person holding a device and interacting with the app. Others use screen captures. Figure 10.5 lists several video creation tools and services (some free, some paid). In addition, Android Studio provides a **Screen Record** tool in the **Android Monitor** window.

| App                              | URL   |
|----------------------------------|---|
| Pac-Man 256                      | <a href="https://youtu.be/RF0GfRvm-yg">https://youtu.be/RF0GfRvm-yg</a> |
| Angry Birds 2                    | <a href="https://youtu.be/jOUEjknadEY">https://youtu.be/jOUEjknadEY</a> |
| Real Estate and Homes by Trulia® | <a href="https://youtu.be/BJDPKBNuqzE">https://youtu.be/BJDPKBNuqzE</a> |
| Essential Anatomy 3              | <a href="https://youtu.be/xmBqxb0aZr8">https://youtu.be/xmBqxb0aZr8</a> |

**Fig. 10.4** | Examples of promotional videos for apps in Google Play.

| Tools and services | URL   |
|--------------------|---|
| Animoto            | <a href="http://animoto.com">http://animoto.com</a>   |
| Apptamin           | <a href="http://www.apptamin.com">http://www.apptamin.com</a>                               |
| CamStudio™         | <a href="http://camstudio.org">http://camstudio.org</a>                                     |
| Jing               | <a href="http://www.techsmith.com/jing.html">http://www.techsmith.com/jing.html</a>         |
| Camtasia Studio®   | <a href="http://www.techsmith.com/camtasia.html">http://www.techsmith.com/camtasia.html</a> |
| TurboDemo™         | <a href="http://www.turbodemo.com/eng/index.php">http://www.turbodemo.com/eng/index.php</a> |

**Fig. 10.5** | Tools and services for creating promotional videos.

## 10.3 Pricing Your App: Free or Fee

You set the prices for your apps that are distributed through Google Play. Many developers offer their apps for free as a marketing, publicity and branding tool, earning revenue through increased sales of products and services, sales of more feature-rich versions of the same apps and sales of additional content through the apps using *in-app purchase* or *in-app advertising*. Figure 10.6 lists various ways to monetize your apps. The Google Play-specific ways to monetize your apps are listed at

<http://developer.android.com/distribute/monetize/index.html>

### Ways to monetize an app

- Sell the app in Google Play.
- Sell the app in other Android app marketplaces.

**Fig. 10.6** | Ways to monetize an app. (Part 1 of 2.)

### Ways to monetize an app

- Sell paid upgrades.
- Sell virtual goods (Section 10.5).
- Sell an app to a company that brands it as their own.
- Use mobile advertising services for in-app ads (Section 10.4).
- Sell in-app advertising space directly to your customers.
- Use it to drive sales of a more feature-rich version of the app.

**Fig. 10.6** | Ways to monetize an app. (Part 2 of 2.)

#### 10.3.1 Paid Apps

The average price for apps varies widely by category. For example, according to the app discovery site AppBrain (<http://www.appbrain.com>), the average price for puzzle-game apps is \$1.51 and for business apps is \$8.44.<sup>3</sup> Although these prices may seem low, keep in mind that successful apps could sell tens of thousands, hundreds of thousands or even millions of copies.

When setting a price for your app, start by researching your competition. How much do they charge? Do their apps have similar functionality? Is yours more feature-rich? Will offering your app at a lower price than the competition attract users? Is your goal to recoup development costs and generate additional revenue?

If you change your strategy, you can eventually offer your paid app for free. However it's not currently possible to change your free apps to paid.

Financial transactions for paid apps in Google Play are handled by Google Wallet

<http://google.com/wallet>

though customers of some mobile carriers (such as AT&T, Sprint and T-Mobile) can opt to use carrier billing to charge paid apps to their wireless bill. Your earnings are paid to your Google Payments merchant account monthly.<sup>4</sup> You're responsible for paying taxes on the revenue you earn through Google Play.

#### 10.3.2 Free Apps

More than 90% of the apps users download are free, and that percentage has been increasing for several years.<sup>5</sup> Given that users are more likely to download an app if it's free, consider offering a free "lite" version of your app to encourage users to try it. For example, if your app is a game, you might offer a free version with just the first few levels. When the user has finished playing the free levels, the app would offer an option to buy through Google Play your more robust app with numerous game levels. Or, your app would display a message that the user can purchase additional levels from within the app for a more

3. <http://www.appbrain.com/stats/android-market-app-categories>.

4. [http://support.google.com/googleplay/android-developer/answer/137997?hl=en&ref\\_topic=15867](http://support.google.com/googleplay/android-developer/answer/137997?hl=en&ref_topic=15867).

5. <http://www.statista.com/topics/1002/mobile-app-usage/>.

seamless upgrade (see Section 10.5). Many companies use free apps to build brand awareness and drive sales of other products and services (Fig. 10.7).

| Free app                     | Functionality  |
|------------------------------|--|
| Amazon® Mobile               | Browse and purchase items on Amazon.   |
| Bank of America              | Locate ATMs and bank branches in your area, check balances and pay bills.  |
| Best Buy®                    | Browse and purchase items.   |
| CNN                          | Get the latest world news, receive breaking news alerts and watch live video.  |
| Epicurious Recipe            | View thousands of recipes from several Condé Nast magazines, including <i>Gourmet</i> and <i>Bon Appetit</i> .   |
| ESPN® ScoreCenter            | Set up personalized scoreboards to track your favorite college and professional sports teams.  |
| NFL Mobile                   | Get the latest NFL news and updates, live programming, NFL Replay and more.  |
| UPS® Mobile                  | Track shipments, find drop-off locations, get estimated shipping costs and more.   |
| NYTimes                      | Read articles from <i>The New York Times</i> , free of charge.   |
| Pocket Agent™                | State Farm Insurance's app enables you contact an agent, file claims, find local repair centers, check your State Farm bank and mutual fund accounts and more. |
| Progressive® Insurance       | Report a claim and submit photos from the scene of a car accident, find a local agent, get car safety information when you're shopping for a new car and more. |
| USA Today®                   | Read articles from <i>USA Today</i> and get the latest sports scores.  |
| Wells Fargo® Mobile          | Locate ATMs and bank branches in your area, check balances, make transfers and pay bills.  |
| Women's Health Workouts Lite | View numerous workouts from one of the leading women's magazines.  |

**Fig. 10.7** | Companies using free Android apps to build brand awareness.

## 10.4 Monetizing Apps with In-App Advertising

Many developers offer free apps monetized with **in-app advertising**—often banner ads similar to those you find on websites. Mobile advertising networks such as AdMob

<http://www.google.com/admob/>

and Google AdSense for Mobile

<http://www.google.com/adsense/start/>

aggregate advertisers for you and serve relevant ads to your app (see Section 10.13). You earn advertising revenue based on the number of click-throughs. The top 100 free apps might earn a few hundred dollars to a few thousand dollars per day. In-app advertising

does not generate significant revenue for most apps, so if your goal is to recoup development costs and generate profits, you should consider charging a fee for your app.

## 10.5 Monetizing Apps: Using In-App Billing to Sell Virtual Goods

Google Play's **in-app billing** service

<http://developer.android.com/google/play/billing/index.html>

enables you to sell **virtual goods** (e.g., digital content) through apps on devices running Android 2.3 or higher (Fig. 10.8). The in-app billing service is available only for apps purchased through Google Play; it may *not* be used in apps sold through third-party app stores. To use in-app billing, you'll need a Google Play publisher account (see Section 10.6) and a Google Payments merchant account (see Section 10.7). Google pays you 70% of the revenue for all in-app purchases made through your apps.

| Virtual goods            |                        |                  |
|--------------------------|------------------------|------------------|
| Magazine e-subscriptions | Localized guides       | Avatars          |
| Virtual apparel          | Additional game levels | Game scenery     |
| Add-on features          | Ringtones              | Icons            |
| E-cards                  | E-gifts                | Virtual currency |
| Wallpapers               | Images                 | Virtual pets     |
| Audios                   | Videos                 | E-books and more |

**Fig. 10.8** | Virtual goods.

Selling virtual goods can generate higher revenue *per user* than in-app advertising.<sup>6</sup> Some apps that have been particularly successful selling virtual goods include Angry Birds, DragonVale, Zynga Poker, Bejeweled Blitz, NYTimes and Candy Crush Saga. Virtual goods are particularly popular in mobile games.

To implement in-app billing, follow the steps at

[http://developer.android.com/google/play/billing/billing\\_integrate.html](http://developer.android.com/google/play/billing/billing_integrate.html)

For additional information about in-app billing, including subscriptions, sample apps, security best practices, testing and more, visit

[http://developer.android.com/google/play/billing/billing\\_overview.html](http://developer.android.com/google/play/billing/billing_overview.html)

You also can take the free *Selling In-app Products* training class at

<http://developer.android.com/training/in-app-billing/index.html>

6. [http://www.businessinsider.com/its-morning-in-venture-capital-2012-5?utm\\_source=readme&utm\\_medium=rightrail&utm\\_term=&utm\\_content=6&utm\\_campaign=recirc](http://www.businessinsider.com/its-morning-in-venture-capital-2012-5?utm_source=readme&utm_medium=rightrail&utm_term=&utm_content=6&utm_campaign=recirc).

### In-App Purchase for Apps Sold Through Other App Marketplaces

If you choose to sell your apps through other marketplaces (see Section 10.11), several third-party mobile payment providers can enable you to build *in-app purchase* into your apps using APIs from mobile payment providers (Fig. 10.9)—you cannot use Google Play’s in-app billing. Start by building the additional *locked functionality* (e.g., game levels, avatars) into your app. When the user opts to make a purchase, the in-app purchasing tool handles the financial transaction and returns a message to the app verifying payment. The app then unlocks the additional functionality.

| Provider                       | URL   | Description  |
|--------------------------------|---|--|
| PayPal Mobile Payments Library | <a href="https://developer.paypal.com/webapps/developer/docs/classic/mobile/gs_MPL/">https://developer.paypal.com/webapps/developer/docs/classic/mobile/gs_MPL/</a> | Users click the <b>Pay with PayPal</b> button, log into their PayPal account, then click <b>Pay</b> .  |
| Amazon In-App Purchasing       | <a href="https://developer.amazon.com/appsandservices/apis/earn/in-app-purchasing">https://developer.amazon.com/appsandservices/apis/earn/in-app-purchasing</a>     | In-app purchase for apps sold through the Amazon App Store for Android.  |
| Samsung In-App Purchase        | <a href="http://developer.samsung.com/in-app-purchase">http://developer.samsung.com/in-app-purchase</a>   | In-app purchase for apps designed specifically for Samsung devices.  |
| Boku                           | <a href="http://www.boku.com">http://www.boku.com</a>   | Users click <b>Pay by Mobile</b> , enter their mobile phone number, then complete the transaction by replying to a text message sent to their phone. |

**Fig. 10.9** | Mobile payment providers for in-app purchase.

## 10.6 Registering at Google Play

To publish your apps on Google Play, you must register for an account at

<http://play.google.com/apps/publish>

There’s a one-time \$25 registration fee. Unlike other popular mobile platforms, *Google Play has no approval process for uploading apps*, though there is some automated malware testing. You must, however, adhere to the *Google Play Developer Program Policies*. If your app is in violation of these policies, it can be removed at any time; serious or repeated violations may result in account termination (Fig. 10.10).

### Violations of the *Google Play Content Policy for Developers*

- Infringing on others’ intellectual property rights (e.g., trademarks, patents and copyrights).
- Illegal activities.
- Invading personal privacy.
- Interfering with the services of other parties.
- Harming the user’s device or personal data.
- Gambling.

**Fig. 10.10** | Some violations of the *Google Play Content Policy for Developers* (<http://play.google.com/about/developer-content-policy.html#showlanguages>). (Part 1 of 2.)

### Violations of the Google Play Content Policy for Developers

- Creating a “spammy” user experience (e.g., misleading the user about the app’s purpose).
- Adversely impacting a user’s service charges or a wireless carrier’s network.
- Impersonation or deception.
- Promoting hate or violence.
- Providing pornographic or obscene content, or anything unsuitable for children under age 18.
- Ads in system-level notifications and widgets.

**Fig. 10.10** | Some violations of the *Google Play Content Policy for Developers* (<http://play.google.com/about/developer-content-policy.html#showlanguages>). (Part 2 of 2.)

## 10.7 Setting Up a Google Payments Merchant Account

To sell your apps on Google Play, you’ll need a **Google Payments merchant account**, available to Google Play developers in over 150 countries.<sup>7</sup> Once you’ve registered and logged into Google Play at

<http://play.google.com/apps/publish/>

click the **set up a merchant account** link and provide

- information by which Google can contact you and
- customer-support contact information where users can contact you.

## 10.8 Uploading Your Apps to Google Play

Once you’ve prepared your files and you’re ready to upload your app, review the steps in the *Launch Checklist* at:

<http://developer.android.com/distribute/tools/launch-checklist.html>

Then log into Google Play at <http://play.google.com/apps/publish> (Section 10.6) and click the **Publish an Android App on Google Play** button to begin the upload process. You will be asked to upload the following assets:

1. *App .apk file* that includes the app’s code files, assets, resources and the manifest file.
2. At least *two screenshots* of your app to be included in Google Play. You may include screenshots for an Android phone, 7" tablet, 10" tablet, Android TV and Android Wear.
3. *High-resolution app icon* (512-by-512 pixels) to be included in Google Play.
4. *Feature graphic* is used by the Google Play Editorial team to promote apps and on your app’s product page. This image must be 1024 pixels wide by 500 pixels tall in JPEG format or 24-bit PNG format with no alpha (transparency).
5. *Promotional graphic* (optional) for Google Play to be used by Google if they decide to promote your app (for examples, check out some of the graphics for fea-

7. [http://support.google.com/googleplay/android-developer/answer/150324?hl=en&ref\\_topic=15867](http://support.google.com/googleplay/android-developer/answer/150324?hl=en&ref_topic=15867).

tured apps on Google Play). The graphic must be 180 pixels wide by 120 pixels tall in JPEG format or 24-bit PNG format with no alpha (transparency).

6. *Promotional video* (optional) to be included in Google Play. You may include a URL for a promotional video for your app (e.g., a YouTube link to a video that demonstrates how your app works).

In addition to app assets, you will be asked to provide the following additional listing details for Google Play:

1. *Language*. By default, your app will be listed in English. If you'd like to list it in additional languages, select them from the list provided (Fig. 10.11).

| Language              |                 |                       |                         |
|-----------------------|-----------------|-----------------------|-------------------------|
| Afrikaans             | English (UK)    | Khmer                 | Romansh                 |
| Amharic               | Estonian        | Korean (South)        | Russian                 |
| Arabic                | Filipino        | Kyrgyz                | Serbian                 |
| Armenian              | Finnish         | Lao                   | Sinhala                 |
| Azerbaijani           | French          | Latvian               | Slovak                  |
| Basque                | French (Canada) | Lithuanian            | Slovenian               |
| Belarusian            | Galician        | Macedonian            | Spanish (Latin America) |
| Bengali               | Georgian        | Malay                 | Spanish (Spain)         |
| Bulgarian             | German          | Malayalam             | Spanish (US)            |
| Burmese               | Greek           | Marathi               | Swahili                 |
| Catalan               | Hebrew          | Mongolian             | Swedish                 |
| Chinese (Simplified)  | Hindi           | Nepali                | Tamil                   |
| Chinese (Traditional) | Hungarian       | Norwegian             | Telugu                  |
| Croatian              | Icelandic       | Persian               | Thai                    |
| Czech                 | Indonesian      | Polish                | Turkish                 |
| Danish                | Italian         | Portuguese (Brazil)   | Ukrainian               |
| Dutch                 | Japanese        | Portuguese (Portugal) | Vietnamese              |
| English               | Kannada         | Romanian              | Zulu                    |

**Fig. 10.11** | Languages for listing apps in Google Play.

2. *Title*. The title of your app as it will appear in Google Play (30 characters maximum). It does *not* need to be unique among all Android apps.
3. *Short description*. A short description of your app (80 characters maximum).
4. *Description*. A description of your app and its features (4,000 characters maximum). It's recommended that you use the last portion of the description to explain why the app requires each permission and how it's used.
5. *Recent changes*. A walkthrough of any changes specific to the latest version of your app (500 characters maximum).

6. *Promo text.* The promotional text for marketing your app (80 characters max).
7. *Application type.* Choose **Applications** or **Games**.
8. *Category.* Select the category that best suits your game or app.
9. *Price.* To sell your app for a fee, you'll need to set up a merchant account.
10. *Content rating.* You may select **High Maturity**, **Medium Maturity**, **Low Maturity** or **Everyone**. For more information, see *Rating your application content for Google Play* at

<http://support.google.com/googleplay/android-developer/answer/188189>

11. *Locations.* By default, the app will be listed in all current and future Google Play countries. If you do not want your app to be available in all these countries, you may pick and choose specific ones where you'd like your app to be listed.
12. *Website.* A **Visit Developer's Website** link will be included in your app's listing in Google Play. Provide a direct link to the page on your website where users interested in downloading your app can find more information, including marketing copy, feature listings, additional screenshots, instructions, etc.
13. *E-mail.* Your e-mail address will also be included in Google Play, so that customers can contact you with questions, report errors, etc.
14. *Phone number.* Sometimes your phone number is included in Google Play. Therefore it's recommended that you leave this field blank unless you provide phone support. You may want to provide a customer-service phone number on your website.
15. *Privacy policy.* A link to your privacy policy.

In addition, if you sell in-app products or use any Google services, you must add your in-app products and specify the services you use. For information on adding in-app products, visit

[http://developer.android.com/google/play/billing/billing\\_admin.html](http://developer.android.com/google/play/billing/billing_admin.html)

## 10.9 Launching Play Store from Within Your App

To drive additional sales of your apps, you can launch the **Play Store** app (Google Play) from within your app (typically by including a button) so that the user can download other apps you've published or purchase a related app with functionality beyond that of the previously downloaded "lite" version. You also can launch the **Play Store** app to enable users to download the latest updates.

There are two ways to launch the **Play Store** app. First, you can bring up Google Play search results for apps with a specific developer name, package name or string of characters. For example, if you want to encourage users to download other apps you've published, you could include a button in your app that, when touched, launches the **Play Store** app and initiates a search for apps containing your name or company name. The second option is to bring the user to the details page in the **Play Store** app for a specific app. To learn about launching **Play Store** from within an app, see *Linking Your Products* at

<http://developer.android.com/distribute/tools/promote/linking.html>

## 10.10 Managing Your Apps in Google Play

The *Google Play Developer Console* allows you to manage your account and your apps, check users' star ratings for your apps (1 to 5 stars), respond to users' comments, track the overall number of installs of each app and the number of active installs (installs minus uninstalls). You can view installation trends and the distribution of app downloads across Android versions, devices, and more. Crash reports list any crash and freeze information from users. If you've made upgrades to your app, you can easily publish the new version. You can remove the app from Google Play, but users who downloaded it previously may keep it on their devices. Users who uninstalled the app will be able to reinstall it even after it's been removed (it will remain on Google's servers unless it's removed for violating the Terms of Service).

## 10.11 Other Android App Marketplaces

You may choose to make your apps available through other Android app marketplaces (Fig. 10.12), or through your own website using services such as AndroidLicenser (<http://www.androidlicenser.com>). To learn more about releasing your app through a website see

[http://developer.android.com/tools/publishing/  
publishing\\_overview.html](http://developer.android.com/tools/publishing/publishing_overview.html)

| Marketplace        | URL   |
|--------------------|---|
| Amazon Appstore    | <a href="https://developer.amazon.com/public/solutions/platforms/android">https://developer.amazon.com/public/solutions/platforms/android</a> |
| Opera Mobile Store | <a href="http://android.oms.apps.opera.com/en_us/">http://android.oms.apps.opera.com/en_us/</a>   |
| Moborobo           | <a href="http://www.moborobo.com">http://www.moborobo.com</a>   |
| Appitalism®        | <a href="http://www.appitalism.com/index.html">http://www.appitalism.com/index.html</a>   |
| GetJar             | <a href="http://www.getjar.com">http://www.getjar.com</a>   |
| SlideMe            | <a href="http://www.slideme.org">http://www.slideme.org</a>   |
| AndroidPIT         | <a href="http://www.androidpit.com">http://www.androidpit.com</a>   |

**Fig. 10.12** | Other Android app marketplaces.

## 10.12 Other Mobile App Platforms and Porting Your Apps

According to [statista.com](http://www.statista.com/statistics/266488/forecast-of-mobile-app-downloads/), users will download approximately 225 billion apps in 2016 and almost 270 billion in 2017.<sup>8</sup> By porting your Android apps to other mobile app platforms (Fig. 10.13), especially to iOS (for iPhone, iPad and iPod Touch devices), you could reach an even bigger audience. There are various tools to help you port your apps. For example, Microsoft provides tools that iOS and Android developers can use to port apps to Windows, and similar tools exist for porting Android apps to iOS and vice versa.<sup>9</sup> Various cross-platform app-development tools are also available (Fig. 10.14).

8. <http://www.statista.com/statistics/266488/forecast-of-mobile-app-downloads/>.  
 9. <http://www.wired.com/2015/04/microsoft-unveils-tools-moving-android-ios-apps-onto-windows/>.

| Platform    | URL   |
|-------------|---|
| Android     | <a href="http://developer.android.com">http://developer.android.com</a>                             |
| iOS (Apple) | <a href="http://developer.apple.com/ios">http://developer.apple.com/ios</a>                         |
| Windows     | <a href="https://dev.windows.com/en-us/windows-apps">https://dev.windows.com/en-us/windows-apps</a> |

**Fig. 10.13** | Popular mobile app platforms.

| Tool                  | Website   |
|-----------------------|---|
| Appcelerator Titanium | <a href="http://www.appcelerator.com/product/">http://www.appcelerator.com/product/</a>   |
| PhoneGap              | <a href="http://phonegap.com/">http://phonegap.com/</a>   |
| Sencha                | <a href="https://www.sencha.com/">https://www.sencha.com/</a>   |
| Visual Studio         | <a href="https://www.visualstudio.com/en-us/features/mobile-app-development-vs.aspx">https://www.visualstudio.com/en-us/features/mobile-app-development-vs.aspx</a> |
| Xamarin               | <a href="https://xamarin.com/">https://xamarin.com/</a>   |

**Fig. 10.14** | Several tools for developing cross-platform mobile apps—there are many more.

## 10.13 Marketing Your Apps

Once your app has been published, you'll want to market it to your audience.<sup>10</sup> *Viral marketing* through social media sites such as Facebook, Twitter, Google+ and YouTube can help you get your message out. These sites have tremendous visibility. According to a Pew Research Center study, 71% of adults on the Internet use social networks.<sup>11</sup> Figure 10.15 lists some of the most popular social media sites. Also, e-mail and electronic newsletters are still effective and often inexpensive marketing tools.

| Name      | URL   | Description                      |
|-----------|---|----------------------------------|
| Facebook  | <a href="http://www.facebook.com">http://www.facebook.com</a> | Social networking                |
| Instagram | <a href="https://instagram.com/">https://instagram.com/</a>   | Photo and video sharing          |
| Twitter   | <a href="http://www.twitter.com">http://www.twitter.com</a>   | Microblogging, social networking |
| Google+   | <a href="http://plus.google.com">http://plus.google.com</a>   | Social networking                |
| Vine      | <a href="http://vine.co">http://vine.co</a>                   | Social video sharing             |
| Tumblr    | <a href="http://www.tumblr.com">http://www.tumblr.com</a>     | Blogging                         |
| Groupon   | <a href="http://www.groupon.com">http://www.groupon.com</a>   | Daily deals                      |

**Fig. 10.15** | Popular social media sites. (Part I of 2.)

- 
10. There are many books about mobile app marketing. Check out the latest ones at <http://amzn.to/1ZgpYxZ>.
  11. [http://bits.blogs.nytimes.com/2015/01/09/americans-use-more-online-social-networks/?\\_r=0](http://bits.blogs.nytimes.com/2015/01/09/americans-use-more-online-social-networks/?_r=0).

| Name       | URL   | Description                    |
|------------|---|--------------------------------|
| Foursquare | <a href="http://www.foursquare.com">http://www.foursquare.com</a> | Check-in                       |
| Snapchat   | <a href="http://www.snapchat.com">http://www.snapchat.com</a>     | Video messaging                |
| Pinterest  | <a href="http://www.pinterest.com">http://www.pinterest.com</a>   | Online pinboard                |
| YouTube    | <a href="http://www.youtube.com">http://www.youtube.com</a>       | Video sharing                  |
| LinkedIn   | <a href="http://www.linkedin.com">http://www.linkedin.com</a>     | Social networking for business |
| Flickr     | <a href="http://www.flickr.com">http://www.flickr.com</a>         | Photo sharing                  |

**Fig. 10.15** | Popular social media sites. (Part 2 of 2.)

### *Facebook*

Facebook, the premier social networking site, has nearly 1.5 billion active users<sup>12</sup> with almost one billion active daily.<sup>13</sup> It's an excellent resource for *viral marketing*. Start by setting up an official Facebook page for your app or business. Use the page to post app information, news, updates, reviews, tips, videos, screenshots, high scores for games, user feedback and links to Google Play, where users can download your app. For example, we post news and updates about Deitel publications on our Facebook page at <http://www.facebook.com/DeitelFan>.

Next, you need to spread the word. Encourage your co-workers and friends to "like" your Facebook page and ask their friends to do so as well. As people interact with your page, stories will appear in their friends' news feeds, building awareness to a growing audience.

### *Twitter*

Twitter is a microblogging, social networking site with approximately 1 billion users and 316 million monthly active users.<sup>14</sup> You post tweets—messages of 140 characters or less. Twitter then distributes your tweets to all of your followers (at the time of this writing, one famous pop star had over 40 million followers). Many people use Twitter to track news and trends. Tweet about your app—include announcements about new releases, tips, facts, comments from users, etc. Also, encourage your colleagues and friends to tweet about your app. Use a *hashtag* (#) to reference your app. For example, when tweeting about *Android 6 for Programmers* on our @deitel Twitter feed, we use the hashtag #AndroidFP3. Others may use this hashtag as well to write comments about the book. This enables you to easily search tweets for related messages.

### *Viral Video*

Viral video—shared on video sites (e.g., YouTube), on social networking sites (e.g., Facebook, Instagram, Twitter, Google+), through e-mail, etc.—is another great way to spread the word about your app. If you create a compelling video, perhaps one that's humorous or even outrageous, it may quickly rise in popularity and may be tagged by users across multiple social networks.

12. <http://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/>.

13. <http://expandedramblings.com/index.php/by-the-numbers-17-amazing-facebook-stats/>.

14. <http://www.statisticbrain.com/twitter-statistics/>.

***E-Mail Newsletters***

If you have an e-mail newsletter, use it to promote your app. Include links to Google Play, where users can download the app. Also include links to your social networking pages, where users can stay up-to-date with the latest news about your app.

***App Reviews***

Contact influential bloggers and app review sites (Fig. 10.16) and tell them about your app. Provide them with a promotional code to download your app for free (see Section 10.3). Influential bloggers and reviewers receive many requests, so keep yours concise and informative. Many app reviewers post video app reviews on YouTube and other sites (Fig. 10.17).

| Android app review site   | URL   |
|---------------------------|---|
| Appolicious™              | <a href="http://www.androidapps.com">http://www.androidapps.com</a>                                   |
| AppBrain                  | <a href="http://www.appbrain.com">http://www.appbrain.com</a>   |
| AppZoom                   | <a href="http://www.appzoom.com">http://www.appzoom.com</a>   |
| Appstorm                  | <a href="http://android.appstorm.net">http://android.appstorm.net</a>                                 |
| Best Android Apps Review  | <a href="http://www.bestandroidappsreview.com">http://www.bestandroidappsreview.com</a>               |
| Android App Review Source | <a href="http://www.androidappreviewsource.com">http://www.androidappreviewsource.com</a>             |
| Androinica                | <a href="http://www.androinica.com">http://www.androinica.com</a>                                     |
| AndroidLib                | <a href="http://www.androlib.com">http://www.androlib.com</a>   |
| Android and Me            | <a href="http://www.androidandme.com">http://www.androidandme.com</a>                                 |
| AndroidGuys               | <a href="http://www.androidguys.com/category/reviews">http://www.androidguys.com/category/reviews</a> |
| Android Police            | <a href="http://www.androidpolice.com">http://www.androidpolice.com</a>                               |
| AndroidPIT                | <a href="http://www.androidpit.com">http://www.androidpit.com</a>                                     |
| Phandroid                 | <a href="http://phandroid.com">http://phandroid.com</a>   |

**Fig. 10.16** | Android app review sites.

| Android app review video site | URL   |
|-------------------------------|---|
| State of Tech                 | <a href="http://http://stateoftech.net/">http://http://stateoftech.net/</a>                             |
| Crazy Mike's Apps             | <a href="http://crazymikesapps.com">http://crazymikesapps.com</a>                                       |
| Appolicious™                  | <a href="http://www.appvee.com/?device_filter=android">http://www.appvee.com/?device_filter=android</a> |
| Life of Android™              | <a href="http://www.lifeofandroid.com/video/">http://www.lifeofandroid.com/video/</a>                   |

**Fig. 10.17** | Android app review video sites.

***Internet Public Relations***

The public relations industry uses media outlets to help companies get their message out to consumers. Public relations practitioners incorporate blogs, tweets, podcasts, RSS feeds

and social media into their PR campaigns. Figure 10.18 lists some free and fee-based Internet public relations resources, including press-release distribution sites, press-release writing services and more.

| Internet public relations resource | URL   | Description  |
|------------------------------------|---|--|
| <b>Free Services</b>               |   |  |
| PRWeb®                             | <a href="http://www.prweb.com">http://www.prweb.com</a>             | Online press-release distribution service with <i>free</i> and <i>fee-based</i> services.  |
| ClickPress™                        | <a href="http://www.clickpress.com">http://www.clickpress.com</a>   | Submit news stories for approval ( <i>free</i> of charge). If approved, they'll be available on the ClickPress site and to news search engines. For a <i>fee</i> , ClickPress will distribute your press releases globally to top financial newswires. |
| PRLlog                             | <a href="http://www.prlog.org/pub/">http://www.prlog.org/pub/</a>   | <i>Free</i> press-release submission and distribution.   |
| Newswire                           | <a href="http://www.newswire.com">http://www.newswire.com</a>       | <i>Free</i> and <i>fee-based</i> press-release submission and distribution.  |
| openPR®                            | <a href="http://www.openpr.com">http://www.openpr.com</a>           | <i>Free</i> press-release publication.   |
| <b>Fee-Based Services</b>          |   |  |
| PR Leap                            | <a href="http://www.prleap.com">http://www.prleap.com</a>           | Online press-release distribution service.   |
| Marketwired                        | <a href="http://www.marketwired.com">http://www.marketwired.com</a> | Press-release distribution service allows you to target your audience by geography, industry, etc.   |
| Mobility PR                        | <a href="http://www.mobilitypr.com">http://www.mobilitypr.com</a>   | Public relations services for companies in the mobile industry.  |
| eReleases                          | <a href="http://www.ereleases.com">http://www.ereleases.com</a>     | Press-release distribution and services including press-release writing, proofreading and editing. Check out the tips for writing effective press releases.  |

**Fig. 10.18** | Internet public relations resources.

### Mobile Advertising Networks

Purchasing advertising spots (e.g., in other apps, online, in newspapers and magazines or on radio and television) is another way to market your app. Mobile advertising networks (Fig. 10.19) specialize in advertising Android (and other) mobile apps on mobile platforms. Many of these networks can target audiences by location, wireless carrier, platform (e.g., Android, iOS, Windows, BlackBerry) and more. Most apps don't make much money, so be careful how much you spend on advertising.

| Mobile ad networks | URL   |
|--------------------|---|
| AdMob (by Google)  | <a href="http://www.google.com/admob/">http://www.google.com/admob/</a>       |
| Medialets          | <a href="http://www.medialets.com">http://www.medialets.com</a>               |
| Tapjoy®            | <a href="http://www.tapjoy.com">http://www.tapjoy.com</a>                     |
| Millennial Media®  | <a href="http://www.millennialmedia.com/">http://www.millennialmedia.com/</a> |
| Smaato®            | <a href="http://www.smaato.com">http://www.smaato.com</a>                     |
| mMedia™            | <a href="http://mmedia.com">http://mmedia.com</a>                             |
| InMobi™            | <a href="http://www.inmobi.com">http://www.inmobi.com</a>                     |

**Fig. 10.19** | Mobile advertising networks.

You also can use mobile advertising networks to monetize your free apps by including ads (e.g., banners, videos) in your apps. The average eCPM (effective cost per 1,000 impressions) for ads in Android apps varies by network, device, world region, etc. Most ads on Android pay are based on the *click-through rate (CTR)* of the ads rather than the number of impressions generated. Like eCPM, CTRs vary based on the app, the device, targeting of the ads by the ad network and more. If your app has a lot of users and the CTRs of the ads in your apps are high, you may earn substantial advertising revenue. Also, your ad network may serve you higher-paying ads, thus increasing your earnings.

## 10.14 Wrap-Up

In this chapter, we walked through the process of registering for Google Play and setting up a Google Wallet account so you can sell your apps. We discussed how to prepare apps for submission to Google Play, including testing them on the emulator and on Android devices, and the various resources you'll need to submit your app to Google Play. We walked through the steps for uploading your apps to Google Play. We showed you alternative Android app marketplaces. We provided tips for pricing your apps, and resources for monetizing them with in-app advertising and in-app sales of virtual goods. And we included resources for marketing your apps, once they're available through Google Play.

## Staying in Contact with the Authors and Deitel & Associates, Inc.

We hope you enjoyed reading *Android 6 for Programmers* as much as we enjoyed writing it. We'd appreciate your feedback. Please send your questions, comments and suggestions to [deitel@deitel.com](mailto:deitel@deitel.com). To stay up-to-date with the latest news about *Android 6 for Programmers*, and Deitel publications and corporate training, sign up for the *Deitel® Buzz Online* e-mail newsletter at

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