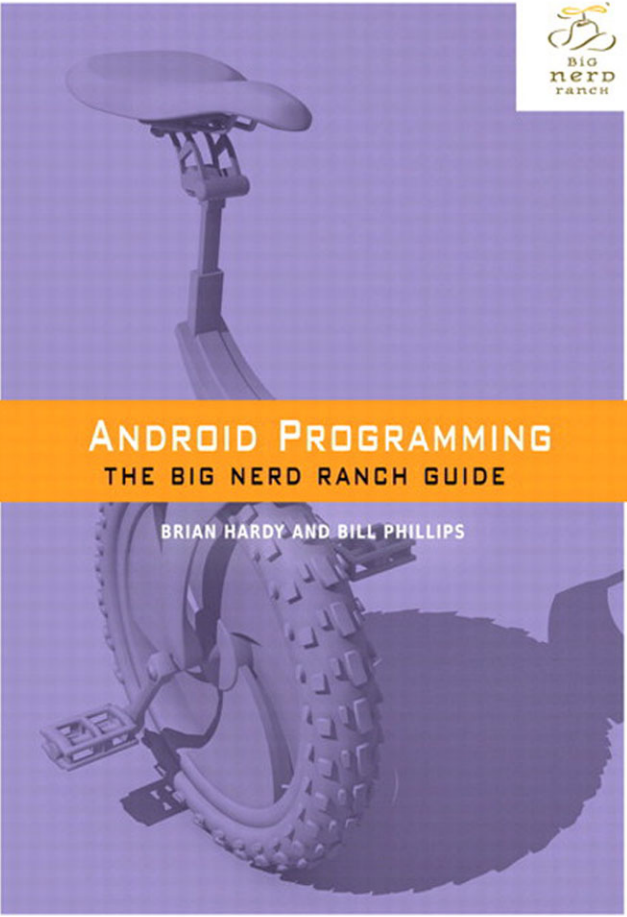

ANDROID PROGRAMMING

THE BIG NERD RANCH GUIDE

BRIAN HARDY AND BILL PHILLIPS

Android Programming

THE BIG NERD RANCH GUIDE

BILL PHILLIPS & BRIAN HARDY

Big Nerd Ranch

Android Programming: The Big Nerd Ranch Guide

by Bill Phillips and Brian Hardy

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Dedication

For Donovan. May he live a life filled with activities and know when to use fragments.

— B.H.

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Learning Android

As a beginning Android programmer, you face a steep learning curve. Learning Android is like moving to a foreign city. Even if you speak the language, it will not feel like home at first. Everyone around you seems to understand things that you are missing. Things you already knew turn out to be dead wrong in this new context.

Android has a culture. That culture speaks Java, but knowing Java is not enough. Getting your head around Android requires learning many new ideas and techniques. It helps to have a guide through unfamiliar territory.

That's where we come in. At Big Nerd Ranch, we believe that to be an Android programmer, you must:

- *write* Android applications
- *understand* what you are writing

This guide will help you do both. We have trained hundreds of professional Android programmers using it. We lead you through writing several Android applications, introducing concepts and techniques as needed. When there are rough spots, when some things are tricky or obscure, you will face it head on, and we will do our best to explain why things are the way they are.

This approach allows you to put what you have learned into practice in a working app right away rather than learning a lot of theory and then having to figure out how to apply it all later.

You will come away with the experience and understanding you need to get going as an Android developer.

Prerequisites

To use this book, you need to be familiar with Java, including classes and objects, interfaces, listeners, packages, inner classes, anonymous inner classes, and generic classes.

If these ideas do not ring a bell, you will be in the weeds by page 2. Start instead with an introductory Java book and return to this book afterward. There are many excellent introductory books available, so you can choose one based on your programming experience and learning style.

If you are comfortable with object-oriented programming concepts, but your Java is a little rusty, you will probably be okay. We will provide some brief reminders about Java specifics (like interfaces and anonymous inner classes). Keep a Java reference handy in case you need more support as you go through the book.

How to Use This Book

This book is not a reference book. Its goal is to get you over the initial hump to where you can get the most out of the reference and recipe books available. It is based on our five-day class at Big Nerd Ranch. As such, it is meant to be worked through from the beginning. Chapters build on each other and skipping around is unproductive.

In our classes, students work through these materials, but they also benefit from the right environment – a dedicated classroom, good food and comfortable board, a group of motivated peers, and an instructor to answer questions.

As a reader, you want your environment to be similar. That means getting a good night's rest and finding a quiet place to work. These things can help, too:

- Start a reading group with your friends or coworkers.
- Arrange to have blocks of focused time to work on chapters.
- Participate in the forum for this book at `forums.bignerdranch.com`.
- Find someone who knows Android to help you out.

How This Book Is Organized

In this book, you will write eight Android apps. A couple are very simple and take only a chapter to create. Others are more complex. The longest app spans thirteen chapters. All are designed to teach you important concepts and techniques and give you direct experience using them.

GeoQuiz	In your first app, you will explore the fundamentals of Android projects, activities, layouts, and explicit intents.
CriminalIntent	The largest app in the book, CriminalIntent lets you keep a record of your colleagues' lapses around the office. You will learn to use fragments, master-detail interfaces, list-backed interfaces, menus, the camera, implicit intents, and more.
HelloMoon	In this small shrine to the Apollo program, you will learn more about fragments, media playback, resources, and localization.
NerdLauncher	Building this custom launcher will give you insight into the intent system and tasks.
RemoteControl	In this toy app, you will learn to use styles, state list drawables, and other tools to create attractive user interfaces.
PhotoGallery	A Flickr client that downloads and displays photos from Flickr's public feed, this app will take you through services, multithreading, accessing web services, and more.
DragAndDraw	In this simple drawing app, you will learn about handling touch events and creating custom views.
RunTracker	This app lets you track and display on a map your travels around town (or around the world). In it, you will learn how to use location services, SQLite databases, loaders, and maps.

Challenges

Most chapters have a section at the end with exercises for you to work through. This is your opportunity to use what you have learned, explore the documentation, and do some problem-solving on your own.

We strongly recommend that you do the challenges. Going off the beaten path and finding your way will solidify your learning and give you confidence with your own projects.

If you get lost, you can always visit `forums.bignerdranch.com` for some assistance.

Are you more curious?

There are also sections at the ends of chapters labeled "For the More Curious." These sections offer deeper explanations or additional information about topics presented in the chapter. The information in these sections is not absolutely essential, but we hope you will find it interesting and useful.

Code Style

There are three areas where our choices differ from what you might see elsewhere in the Android community:

We use anonymous inner classes for listeners.

This is mostly a matter of opinion. We find it makes for cleaner code. It puts the listener's method implementations right where you want to see them. In high performance contexts, anonymous inner classes may cause problems, but for most circumstances they work fine.

After we introduce fragments in Chapter 7, we use them for all user interfaces.

This is something we feel strongly about. Many Android developers still write activity-based code. We would like to challenge that practice. Once you get comfortable with fragments, they are not that difficult to work with. Fragments have clear advantages over activities that make them worth the effort, including flexibility in building and presenting your user interfaces.

We write apps to be compatible with Gingerbread and Froyo devices.

The Android platform has changed with the introduction of Ice Cream Sandwich and Jelly Bean and soon Key Lime Pie. However, the truth is that half of devices in use still run Froyo or Gingerbread. (You will learn about the different and deliciously-named Android versions in Chapter 6.)

Therefore, we intentionally take you through the difficulties involved in writing apps that are backwards-compatible with Froyo or at least Gingerbread. It is easier to learn, teach, and program in Android if you start with the latest platform. But we want you to be able to develop in the real world where Gingerbread phones still make up more than 40% of devices.

Typographical Conventions

To make this book easier to read, certain items appear in certain fonts. Variables, constants, and types appear in a fixed-width font. Class names, interface names, and method names appear in a bold, fixed-width font.

All code and XML listings will be in a fixed-width font. Code or XML that you need to type in is always bold. Code or XML that should be deleted is struck through. For example, in the following method implementation, you are deleting the call to **makeText(…)** and adding the call to **checkAnswer(true)**.

```
@Override
public void onClick(View v) {
    ~~Toast.makeText(QuizActivity.this, R.string.incorrect_toast,~~
                   ~~Toast.LENGTH_SHORT).show();~~
    checkAnswer(true);
}
```

Android Versions

This book teaches Android development for all widely-used versions of Android. As of this writing, that is Android 2.2 (Froyo) - Android 4.2 (Jelly Bean). As Android releases new versions, we will keep track of changes at `forums.bignerdranch.com` and offer notes on using this book with the latest version.

The Necessary Tools

To get started, you will need the ADT (Android Developer Tools) Bundle. This includes:

Eclipse

an integrated development environment used for Android development. Because Eclipse is also written in Java, you can install it on a PC, a Mac, or a Linux computer. The Eclipse user interface follows the “native look-and-feel” of your machine, so your screen may not look *exactly* like screenshots in this book.

Android Developer Tools

a plug-in for Eclipse. This book uses ADT (Android Developer Tools) 21.1. You should make sure you have that version or higher.

Android SDK

the latest version of the Android SDK

Android SDK tools and platform-tools

tools for debugging and testing your apps

A system image for the Android emulator

lets you create and test your apps on different virtual devices

Downloading and installing the ADT Bundle

The ADT Bundle is available from Android’s developer site as a single zip file.

1. Download the bundle from .

2. Extract the zip file to where you want Eclipse and the other tools installed.

3. In the extracted files, find and open the `eclipse` directory and launch Eclipse.

If you are running on Windows, and Eclipse will not start, you may need to install the Java Development Kit (JDK6), which you can download from `www.oracle.com`.

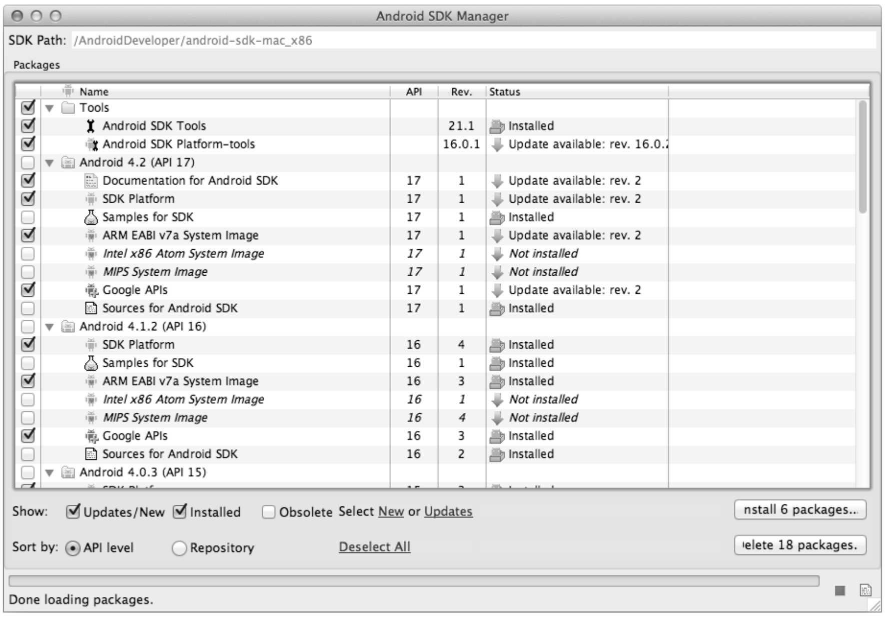
If you are still having problems, return to for more information.

Downloading earlier SDK versions

The ADT Bundle provides the SDK and the emulator system image from the latest platform. However, you will need other platforms to test your apps on earlier versions of Android.

You can get components for each platform using the Android SDK Manager. In Eclipse, select Window → Android SDK Manager.

Figure 1 Android SDK Manager



Android SDK Manager

SDK Path: /AndroidDeveloper/android-sdk-mac_x86

Packages

	Name	API	Rev.	Status
✓	Tools			
✓	Android SDK Tools		21.1	Installed
✓	Android SDK Platform-tools		16.0.1	Update available: rev. 16.0.:
	Android 4.2 (API 17)			
✓	Documentation for Android SDK	17	1	Update available: rev. 2
✓	SDK Platform	17	1	Update available: rev. 2
	Samples for SDK	17	1	Installed
✓	ARM EABI v7a System Image	17	1	Update available: rev. 2
	Intel x86 Atom System Image	*17*	*1*	*Not installed*
	MIPS System Image	*17*	*1*	*Not installed*
✓	Google APIs	17	1	Update available: rev. 2
	Sources for Android SDK	17	1	Installed
	Android 4.1.2 (API 16)			
✓	SDK Platform	16	4	Installed
	Samples for SDK	16	1	Installed
✓	ARM EABI v7a System Image	16	3	Installed
	Intel x86 Atom System Image	*16*	*1*	*Not installed*
	MIPS System Image	*16*	*4*	*Not installed*
✓	Google APIs	16	3	Installed
	Sources for Android SDK	16	2	Installed
	Android 4.0.3 (API 15)			

Show: [✓ Updates/New] [✓ Installed] Obsolete Select New or Updates

Sort by: [✓ API level] Repository Deselect All

nstall 6 packages..

ıelete 18 packages.

Done loading packages.

For every version going back to Android 2.2 (Froyo), we recommend selecting and installing:

- the SDK Platform
- an emulator system image
- the Google APIs

Note that downloading these components may take a while.

The Android SDK Manager is also how to get Android's latest releases, like a new platform or an update of the tools.

A hardware device

The emulator is useful for testing apps. However, it is good to have an actual Android device to run apps on as well. The last app in the book will require a hardware device.

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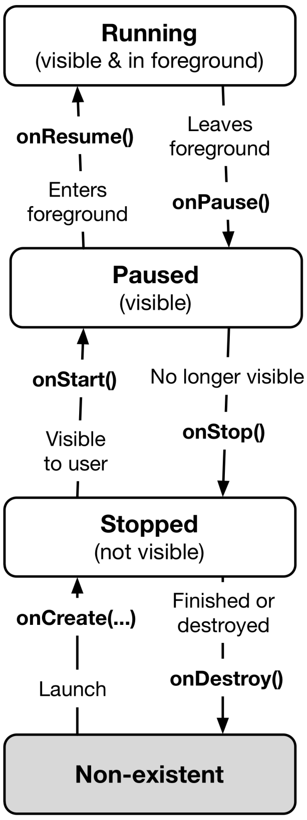
3
The Activity Lifecycle

Every instance of **Activity** has a lifecycle. During this lifecycle, an activity transitions between three possible states: running, paused, and stopped. For each transition, there is an **Activity** method that notifies the activity of the change in its state. Figure 3.1 shows the activity lifecycle, states, and methods.

Figure 3.1 Activity state diagram



Subclasses of **Activity** can take advantage of the methods named in Figure 3.1 to get work done at critical transitions in the activity's lifecycle.

You are already acquainted with one of these methods – **onCreate(Bundle)**. The OS calls this method after the activity instance is created but before it is put on screen.

Typically, an activity overrides **onCreate(…)** to prepare the specifics of its user interface:

- inflating widgets and putting them on screen (in the call to (**setContentView(int)**)
- getting references to inflated widgets
- setting listeners on widgets to handle user interaction
- connecting to external model data

It is important to understand that you never call **onCreate(…)** or any of the other **Activity** lifecycle methods yourself. You override them in your activity subclasses, and Android calls them at the appropriate time.

Logging the Activity Lifecycle

In this section, you are going to override lifecycle methods to eavesdrop on **QuizActivity**'s lifecycle. Each implementation will simply log a message informing you that the method has been called.

Making log messages

In Android, the **android.util.Log** class sends log messages to a shared system-level log. **Log** has several methods for logging messages . Here is the one that you will use most often in this book:

```
    public static int d(String tag, String msg)
```

The **d** stands for "debug" and refers to the level of the log message. (There is more about the **Log** levels in the final section of this chapter.) The first parameter identifies the source of the message, and the second is the contents of the message.

The first string is typically a TAG constant with the class name as its value. This makes it easy to determine the source of a particular message.

In QuizActivity.java, add a TAG constant to **QuizActivity**:

Listing 3.1 Adding TAG constant (QuizActivity.java)

```
public class QuizActivity extends Activity {

    private static final String TAG = "QuizActivity";

    ...

}
```

Next, in **onCreate(…)**, call **Log.d(…)** to log a message.

Listing 3.2 Adding log statement to `onCreate(…)` (`QuizActivity.java`)

```
public class QuizActivity extends Activity {

    ...

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        Log.d(TAG, "onCreate(Bundle) called");
        setContentView(R.layout.activity_quiz);

        ...
```

This code may cause an error regarding the **`Log`** class. If so, press Command+Shift+O (Ctrl+Shift +O) to organize your imports. Eclipse will then ask you to choose which class to import. Choose **`android.util.Log`**.

Now override five more methods in **`QuizActivity`**:

Listing 3.3 Overriding more lifecycle methods (`QuizActivity.java`)

```
    } // End of onCreate(Bundle)

    @Override
    public void onStart() {
        super.onStart();
        Log.d(TAG, "onStart() called");
    }

    @Override
    public void onPause() {
        super.onPause();
        Log.d(TAG, "onPause() called");
    }

    @Override
    public void onResume() {
        super.onResume();
        Log.d(TAG, "onResume() called");
    }

    @Override
    public void onStop() {
        super.onStop();
        Log.d(TAG, "onStop() called");
    }

    @Override
    public void onDestroy() {
        super.onDestroy();
        Log.d(TAG, "onDestroy() called");
    }

}
```

Notice that you call the superclass implementations before you log your messages. These superclass calls are required. Calling the superclass implementation before you do anything else is critical in **`onCreate(…)`**; the order is less important in the other methods.

You may have been wondering about the `@Override` annotation. This asks the compiler to ensure that the class actually has the method that you are attempting to override. For example, the compiler would be able to alert you to the following misspelled method name:

```
public class QuizActivity extends Activity {

    @Override
    public void onCreat(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_quiz);
    }

    ...
```

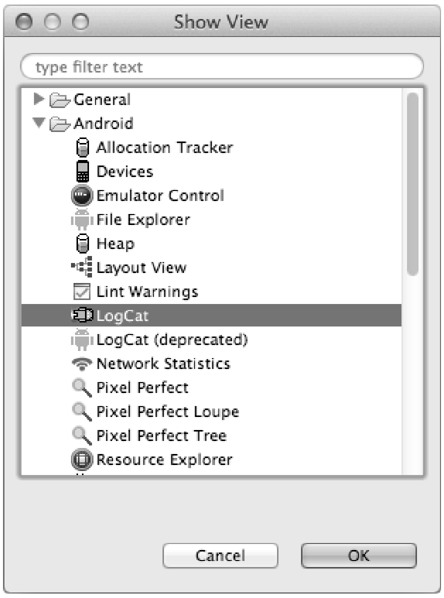
The **`Activity`** class does not have an **`onCreat(Bundle)`** method, so the compiler will complain. Then you can fix the typo rather than accidentally implementing **`QuizActivity.onCreat(Bundle)`**.

Using LogCat

To access to the log while the application is running, you can use LogCat, a log viewer included in the Android SDK tools.

To get to LogCat, select Window → Show View → Other... In the Android folder, find and select LogCat and click OK (Figure 3.2).

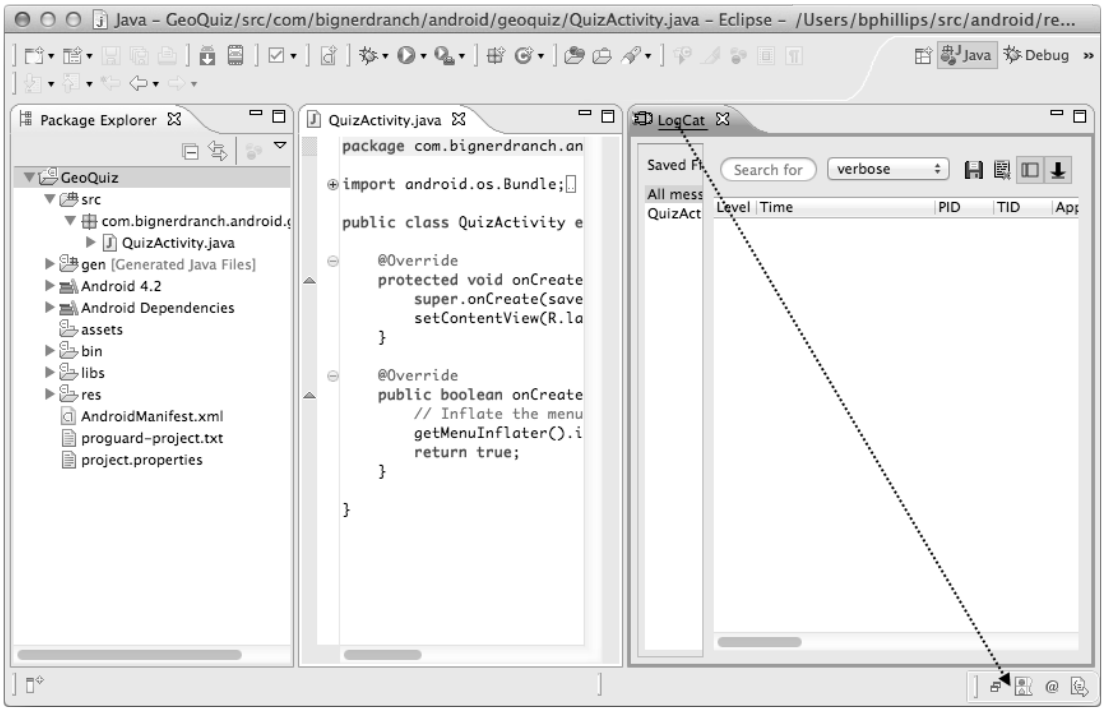
Figure 3.2 Finding LogCat



LogCat will open in the right half of your screen and annoyingly shrink your editor. It would be better if LogCat were at the bottom of the workbench window.

To get it there, drag from the tab of the LogCat view to the toolbar at the bottom-right corner of the workbench.

Figure 3.3 Drag from LogCat tab to bottom-right toolbar

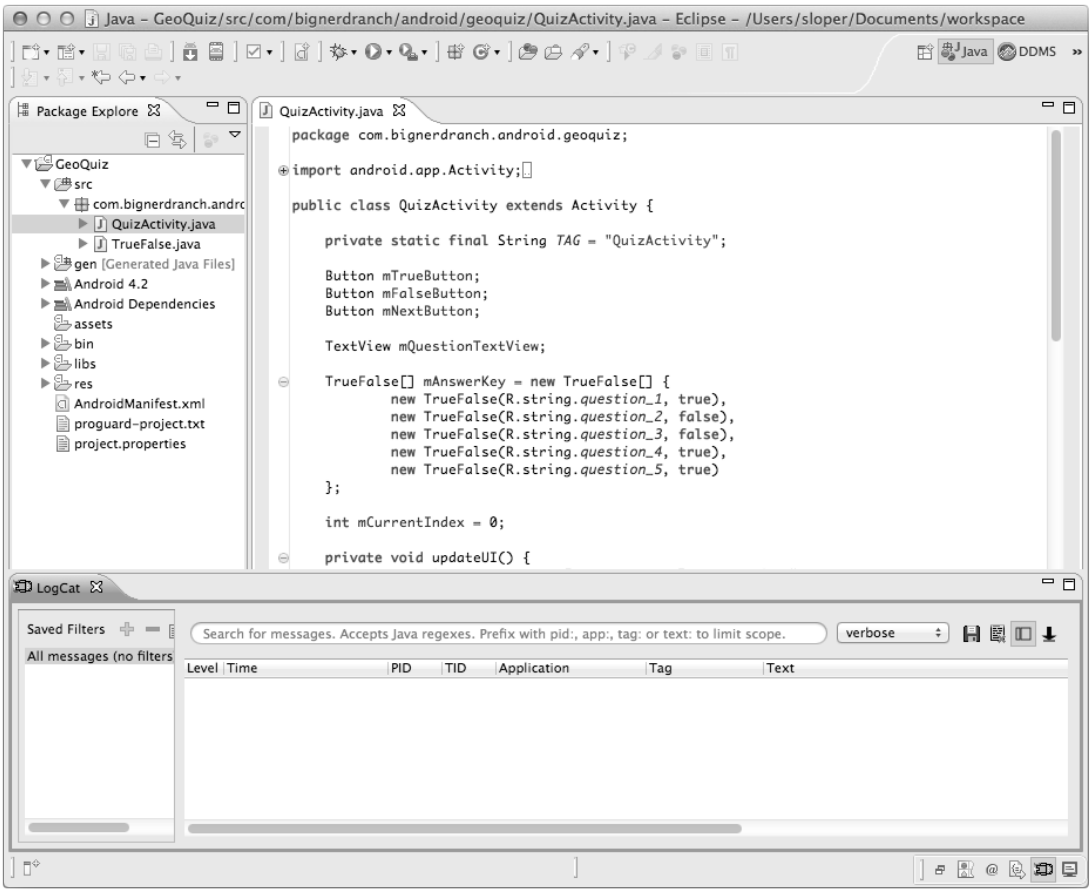


```
package com.bignerdranch.an

import android.os.Bundle;

public class QuizActivity e

    @Override
    protected void onCreate
        super.onCreate(save
        setContentView(R.la
    }

    @Override
    public boolean onCreate
        // Inflate the menu
        getMenuInflater().i
        return true;
    }

}
```

The LogCat view will close, and its icon (a horizontal Andy with Nyan rainbow feet) will appear in the toolbar. Click the icon, and LogCat will reopen at the bottom of the window.

Your Eclipse workbench should now look something like Figure 3.4. You can resize the panes in LogCat by dragging their boundaries. This is true for any of the panes in the Eclipse workbench.

Figure 3.4 Eclipse workbench – now with LogCat



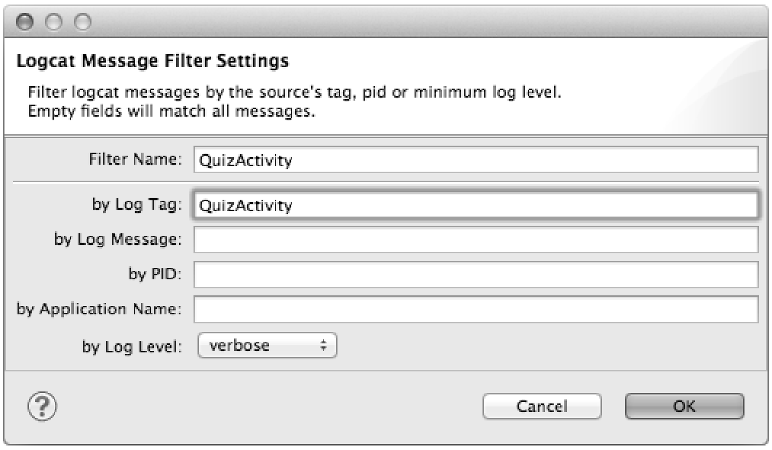
```
package com.bignerdranch.android.geoquiz;

import android.app.Activity;

public class QuizActivity extends Activity {

    private static final String TAG = "QuizActivity";

    Button mTrueButton;
    Button mFalseButton;
    Button mNextButton;

    TextView mQuestionTextView;

    TrueFalse[] mAnswerKey = new TrueFalse[] {
            new TrueFalse(R.string.question_1, true),
            new TrueFalse(R.string.question_2, false),
            new TrueFalse(R.string.question_3, false),
            new TrueFalse(R.string.question_4, true),
            new TrueFalse(R.string.question_5, true)
    };

    int mCurrentIndex = 0;

    private void updateUI() {
```

Run GeoQuiz, and messages will start appearing fast and furiously in LogCat. Most of the messages will be system output. Scroll to the bottom of the log to find your messages. In LogCat's Tag column, you will see the TAG constant you created for **QuizActivity**.

(If you do not see any messages in LogCat, LogCat may be monitoring the wrong device. Select Window → Show View → Other... and open the Devices view. Select the device you are currently running on and then return to LogCat.)

To make your messages easier to find, you can filter the output using the TAG constant. In LogCat, click the green + button at the top of the lefthand pane to create a message filter. Name the filter **QuizActivity** and enter **QuizActivity** in the by Log Tag: field (Figure 3.5).

Figure 3.5 Creating a filter in LogCat



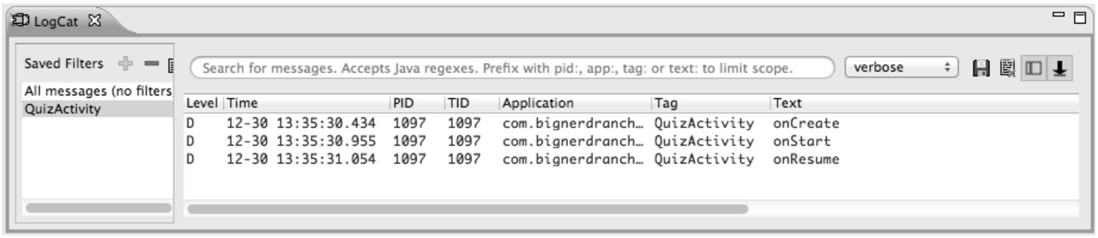
Logcat Message Filter Settings

Filter logcat messages by the source's tag, pid or minimum log level.
Empty fields will match all messages.

Filter Name:	QuizActivity
by Log Tag:	QuizActivity
by Log Message:	
by PID:	
by Application Name:	
by Log Level:	verbose

Click OK, and a new tab will open showing only messages tagged **QuizActivity** (Figure 3.6). Three lifecycle methods were called after GeoQuiz was launched and the initial instance of **QuizActivity** was created.

Figure 3.6 Launching GeoQuiz creates, starts, and resumes an activity



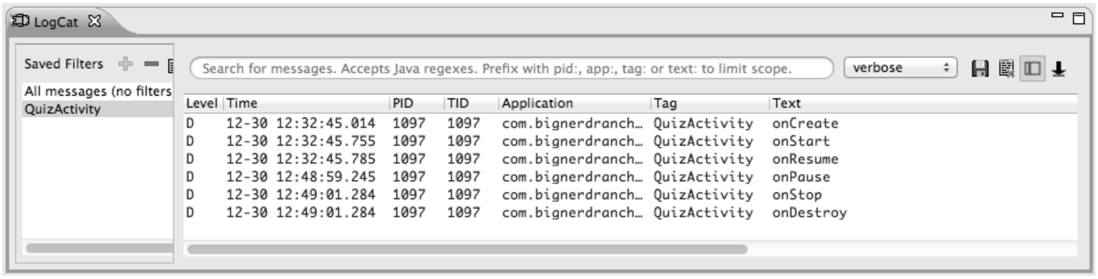
LogCat
Saved Filters
All messages (no filters
QuizActivity
Search for messages. Accepts Java regexes. Prefix with pid:, app:, tag: or text: to limit scope.
verbose

```
Level Time                PID   TID   Application         Tag           Text
D     12-30 13:35:30.434  1097  1097  com.bignerdranch…   QuizActivity  onCreate
D     12-30 13:35:30.955  1097  1097  com.bignerdranch…   QuizActivity  onStart
D     12-30 13:35:31.054  1097  1097  com.bignerdranch…   QuizActivity  onResume
```

(If you are not seeing the filtered list, select the QuizActivity filter from LogCat's lefthand pane.)

Now let's have some fun. Press the Back button on the device and then check LogCat. Your activity received calls to **onPause()**, **onStop()**, and **onDestroy()**.

Figure 3.7 Pressing the Back button destroys the activity



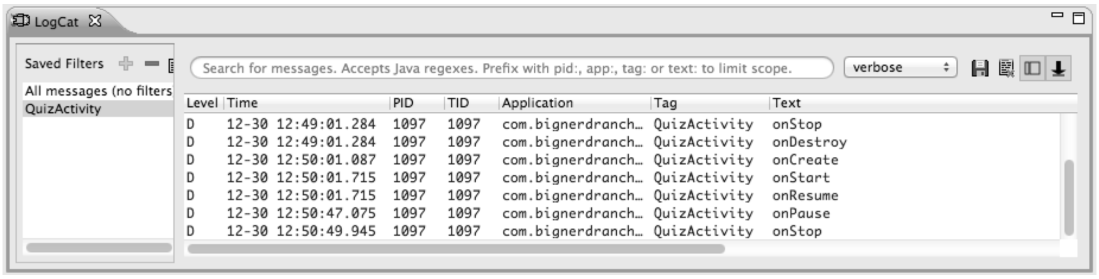
LogCat
Saved Filters
All messages (no filters
QuizActivity
Search for messages. Accepts Java regexes. Prefix with pid:, app:, tag: or text: to limit scope.
verbose

```
Level Time                PID   TID   Application         Tag           Text
D     12-30 12:32:45.014  1097  1097  com.bignerdranch…   QuizActivity  onCreate
D     12-30 12:32:45.755  1097  1097  com.bignerdranch…   QuizActivity  onStart
D     12-30 12:32:45.785  1097  1097  com.bignerdranch…   QuizActivity  onResume
D     12-30 12:48:59.245  1097  1097  com.bignerdranch…   QuizActivity  onPause
D     12-30 12:49:01.284  1097  1097  com.bignerdranch…   QuizActivity  onStop
D     12-30 12:49:01.284  1097  1097  com.bignerdranch…   QuizActivity  onDestroy
```

When you pressed the Back button, you told Android, "I'm done with this activity, and I won't need it anymore." Android then destroyed your activity. This is Android's way of being frugal with your device's limited resources.

Relaunch GeoQuiz. Press the Home button and then check LogCat. Your activity received calls to **`onPause()`** and **`onStop()`**, but not **`onDestroy()`**.

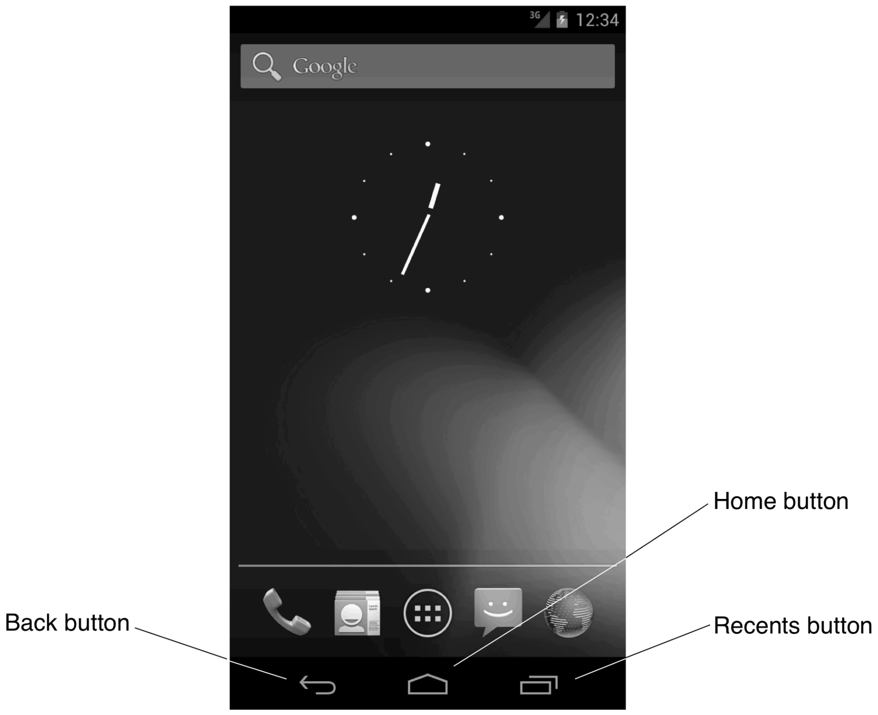
Figure 3.8 Pressing the Home button stops the activity


LogCat
Saved Filters
All messages (no filters
QuizActivity
Search for messages. Accepts Java regexes. Prefix with pid:, app:, tag: or text: to limit scope.
verbose

```
Level Time               PID   TID   Application          Tag           Text
D     12-30 12:49:01.284 1097  1097  com.bignerdranch…    QuizActivity  onStop
D     12-30 12:49:01.284 1097  1097  com.bignerdranch…    QuizActivity  onDestroy
D     12-30 12:50:01.087 1097  1097  com.bignerdranch…    QuizActivity  onCreate
D     12-30 12:50:01.715 1097  1097  com.bignerdranch…    QuizActivity  onStart
D     12-30 12:50:01.715 1097  1097  com.bignerdranch…    QuizActivity  onResume
D     12-30 12:50:47.075 1097  1097  com.bignerdranch…    QuizActivity  onPause
D     12-30 12:50:49.945 1097  1097  com.bignerdranch…    QuizActivity  onStop
```

On the device, pull up the task manager. On newer devices, press the Recents button next to the Home button (Figure 3.9). On devices without a Recents button, long-press the Home button.

Figure 3.9 Home, Back, and Recents buttons



In the task manager, press GeoQuiz and then check LogCat. The activity was started and resumed, but it did not need to be created.

Pressing the Home button tells Android, “I’m going to go look at something else, but I might come back.” Android pauses and stops your activity but tries not to destroy it in case you come back.

However, a stopped activity’s survival is not guaranteed. When the system needs to reclaim memory, it will destroy stopped activities.

Finally, imagine a small pop-up window that only partially covers the activity. When one of these appears, the activity behind it is paused and cannot be interacted with. The activity will be resumed when the pop-up window is dismissed.

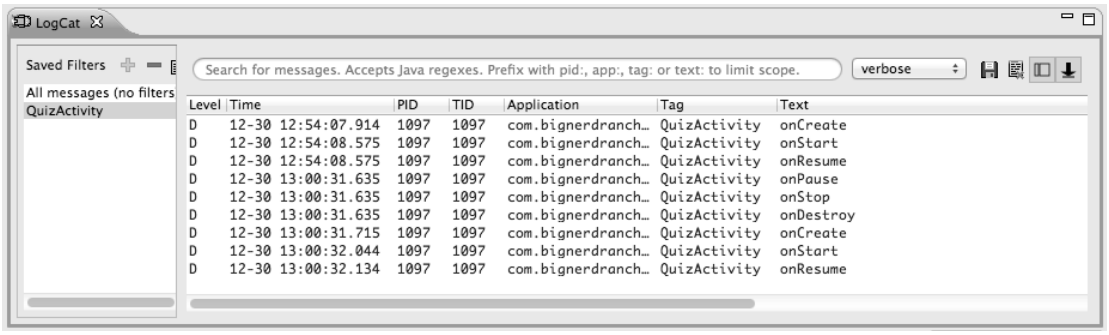
As you continue through the book, you will override the different activity lifecycle methods to do real things for your application. When you do, you will learn more about the uses of each method.

Rotation and the Activity Lifecycle

Let's get back to the bug you found at the end of Chapter 2. Run GeoQuiz, press the Next button to reveal the second question, and then rotate the device. (For the emulator, press Control+F12/Ctrl+F12 to rotate.)

After rotating, GeoQuiz will display the first question again. Check LogCat to see what has happened.

Figure 3.10 **QuizActivity** is dead. Long live **QuizActivity**!



LogCat
Saved Filters
All messages (no filters
QuizActivity
Search for messages. Accepts Java regexes. Prefix with pid:, app:, tag: or text: to limit scope.
verbose

```
Level Time               PID   TID   Application            Tag           Text
D     12-30 12:54:07.914 1097  1097  com.bignerdranch…      QuizActivity  onCreate
D     12-30 12:54:08.575 1097  1097  com.bignerdranch…      QuizActivity  onStart
D     12-30 12:54:08.575 1097  1097  com.bignerdranch…      QuizActivity  onResume
D     12-30 13:00:31.635 1097  1097  com.bignerdranch…      QuizActivity  onPause
D     12-30 13:00:31.635 1097  1097  com.bignerdranch…      QuizActivity  onStop
D     12-30 13:00:31.635 1097  1097  com.bignerdranch…      QuizActivity  onDestroy
D     12-30 13:00:31.715 1097  1097  com.bignerdranch…      QuizActivity  onCreate
D     12-30 13:00:32.044 1097  1097  com.bignerdranch…      QuizActivity  onStart
D     12-30 13:00:32.134 1097  1097  com.bignerdranch…      QuizActivity  onResume
```

When you rotated the device, the instance of **QuizActivity** that you were looking at was destroyed, and a new one was created. Rotate the device again to witness another round of destruction and rebirth.

This is the source of your bug. Each time a new **QuizActivity** is created, `mCurrentIndex` is initialized to `0`, and the user starts over at the first question. You will fix this bug in a moment. First, let's take a closer look at why this happens.

Device configurations and alternative resources

Rotating the device changes the *device configuration*. The *device configuration* is a set of characteristics that describe the current state of an individual device. The characteristics that make up the configuration include screen orientation, screen density, screen size, keyboard type, dock mode, language, and more.

Typically, applications provide alternative resources to match different device configurations. You saw an example of this when you added multiple arrow icons to your project for different screen densities.

Screen density is a fixed component of the device configuration; it cannot change at runtime. On the other hand, some components, like screen orientation, *can* change at runtime.

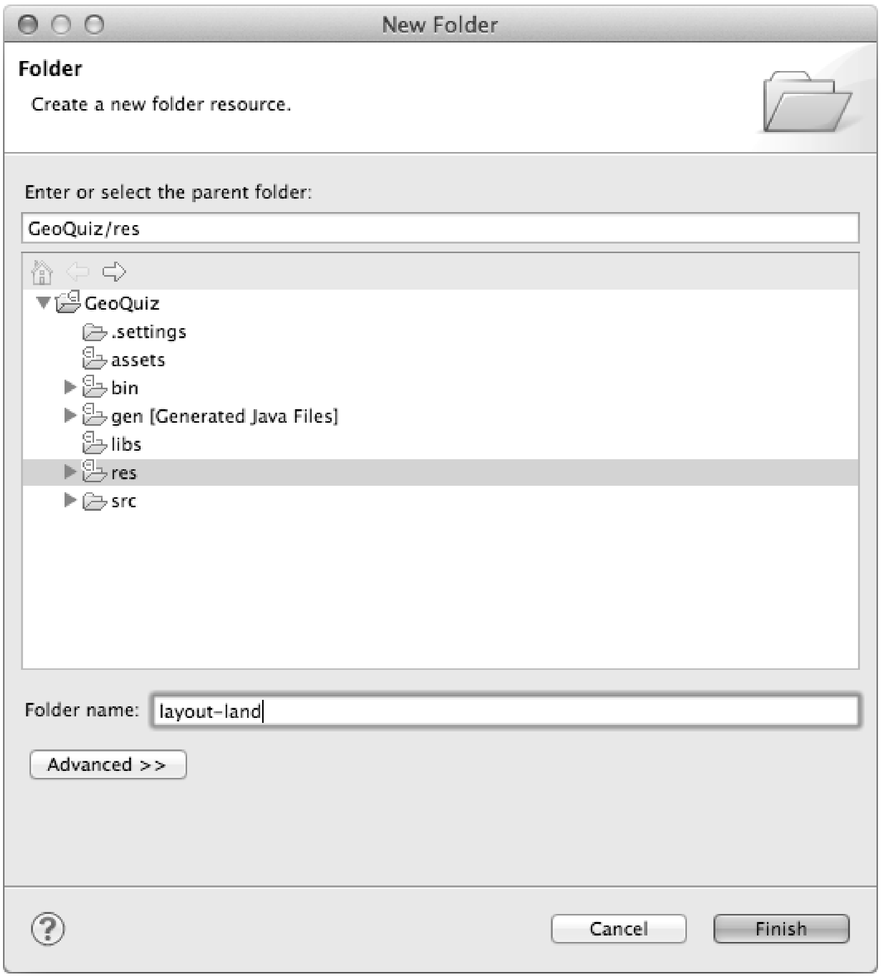
When a *runtime configuration change* occurs, there may be resources that are a better match for the new configuration. To see this in action, let's create an alternative resource for Android to find and use when the device's screen orientation changes to landscape.

Creating a landscape layout

First, minimize LogCat. (If you accidentally close LogCat instead, you can always re-open it from Window → Show View...)

Next, in the package explorer, right-click the `res` directory and create a new folder. Name this folder `layout-land`.

Figure 3.11 Creating a new folder



Copy the `activity_quiz.xml` file from `res/layout/` to `res/layout-land/`. You now have a landscape layout and a default layout. Keep the filename the same. The two layout files must have the same filename so that they can be referenced with the same resource ID.

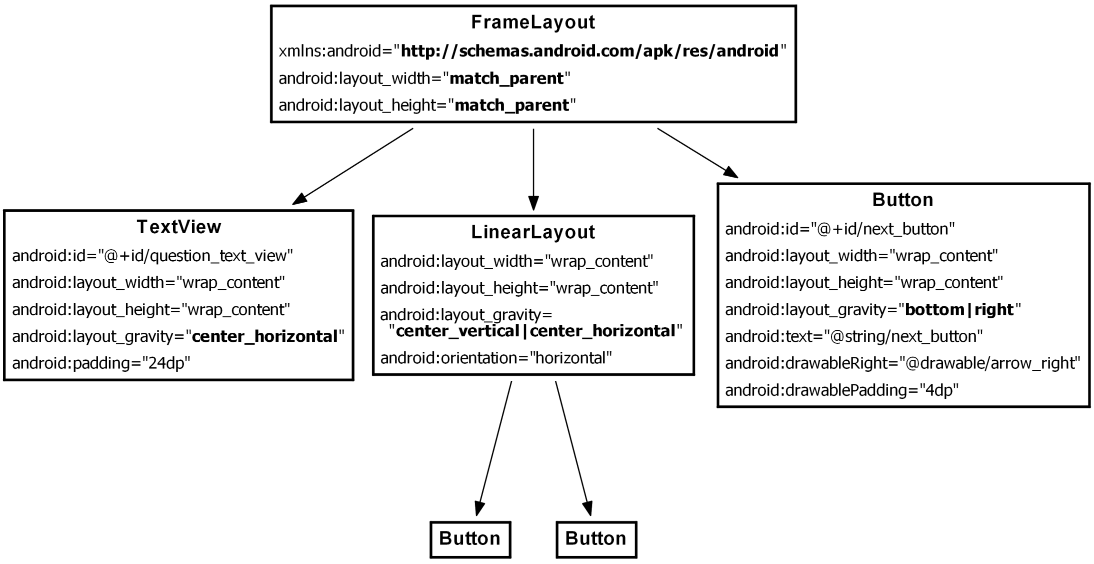
The `-land` suffix is another example of a configuration qualifier. Configuration qualifiers on `res` subdirectories are how Android identifies which resources best match the current device configuration. You can find the list of configuration qualifiers that Android recognizes and the pieces of the device configuration that they refer to at `http://developer.android.com/guide/topics/resources/`

`providing-resources.html`. You will also get more practice working with configuration qualifiers in Chapter 15.

When the device is in landscape orientation, Android will find and use resources in the `res/layout-land` directory. Otherwise, it will stick with the default in `res/layout/`.

Let's make some changes to the landscape layout so that it is different from the default. Figure 3.12 shows the changes that you are going to make.

Figure 3.12 An alternative landscape layout


FrameLayout
xmlns:android="http://schemas.android.com/apk/res/android"
android:layout_width="match_parent"
android:layout_height="match_parent"
TextView
android:id="@+id/question_text_view"
android:layout_width="wrap_content"
android:layout_height="wrap_content"
android:layout_gravity="center_horizontal"
android:padding="24dp"
LinearLayout
android:layout_width="wrap_content"
android:layout_height="wrap_content"
android:layout_gravity="center_vertical|center_horizontal"
android:orientation="horizontal"
Button
android:id="@+id/next_button"
android:layout_width="wrap_content"
android:layout_height="wrap_content"
android:layout_gravity="bottom|right"
android:text="@string/next_button"
android:drawableRight="@drawable/arrow_right"
android:drawablePadding="4dp"
Button
Button

The **`FrameLayout`** will replace the **`LinearLayout`**. **`FrameLayout`** is the simplest **`ViewGroup`** and does not arrange its children in any particular manner. In this layout, child views will be arranged according to their `android:layout_gravity` attributes.

The **`TextView`**, **`LinearLayout`**, and **`Button`** need `android:layout_gravity` attributes. The **`Button`** children of the **`LinearLayout`** will stay exactly the same.

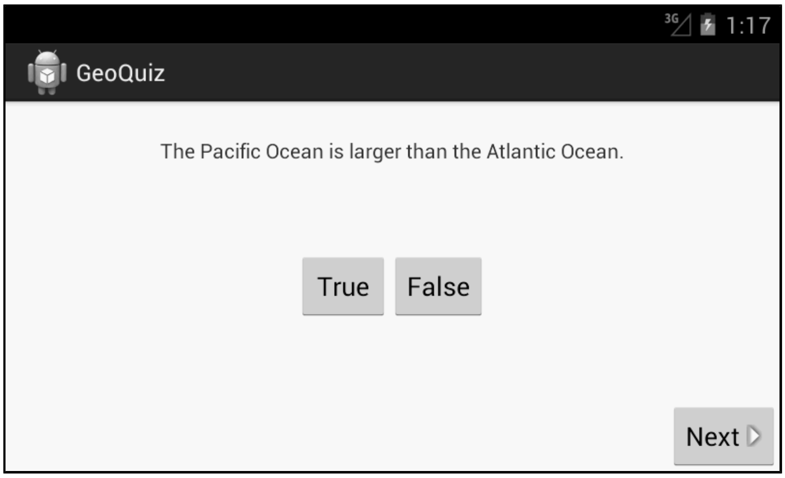
Open `layout-land/activity_quiz.xml` and make the necessary changes using Figure 3.12. You can use Listing 3.4 to check your work.

Listing 3.4 Tweaking the landscape layout (`layout-land/activity_quiz.xml`)

```
~~<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"~~
  ~~android:layout_width="match_parent"~~
  ~~android:layout_height="match_parent"~~
  ~~android:gravity="center"~~
  ~~android:orientation="vertical" >~~

<FrameLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="match_parent"
  android:layout_height="match_parent" >

  <TextView
    android:id="@+id/question_text_view"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_gravity="center_horizontal"
    android:padding="24dp" />

  <LinearLayout
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_gravity="center_vertical|center_horizontal"
    android:orientation="horizontal" >

    ...

  </LinearLayout>

  <Button
    android:id="@+id/next_button"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_gravity="bottom|right"
    android:text="@string/next_button"
    android:drawableRight="@drawable/arrow_right"
    android:drawablePadding="4dp"
    />

~~</LinearLayout>~~
</FrameLayout>
```

Run GeoQuiz again. Rotate the device to landscape to see the new layout. Of course, this is not just a new layout; it is a new **`QuizActivity`** as well.

Figure 3.13 QuizActivity in landscape orientation



Rotate back to portrait to see the default layout and yet another new **QuizActivity**.

Android does the work of determining the best resource for you, but it has to create a new activity from scratch to do it. For a **QuizActivity** to display a different layout, **setContentView(R.layout.activity_quiz)** must be called again. And this will not happen unless **QuizActivity.onCreate(…)** is called again. Thus, Android destroys the current **QuizActivity** on rotation and starts fresh to ensure that it has the resources that best match the new configuration.

Note that Android destroys the current activity and creates a new one whenever any runtime configuration change occurs. A change in keyboard availability or language could also occur at runtime, but a change in screen orientation is the runtime change that occurs most frequently.

Saving Data Across Rotation

Android does a great job of providing alternative resources at the right time. However, destroying and recreating activities on rotation can cause headaches, too, like GeoQuiz's bug of reverting back to the first question when the device is rotated.

To fix this bug, the post-rotation **QuizActivity** needs to know the old value of `mCurrentIndex`. You need a way to save this data across a runtime configuration change, like rotation. One way to do this is to override the **Activity** method

```
    protected void onSaveInstanceState(Bundle outState)
```

This method is normally called by the system before **onPause()**, **onStop()**, and **onDestroy()**.

The default implementation of **onSaveInstanceState(…)** asks all of the activity's views to save their state as data in the **Bundle** object. A **Bundle** is a structure that maps string keys to values of certain limited types.

You have seen this **`Bundle`** before. It is passed into **`onCreate(Bundle)`**

```
    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        ...
```

When you override **`onCreate(…)`**, you call **`onCreate(…)`** on the activity's superclass and pass in the bundle you just received. In the superclass implementation, the saved state of the views is retrieved and used to recreate the activity's view hierarchy.

Overriding onSaveInstanceState(Bundle)

You can override **`onSaveInstanceState(…)`** to save additional data to the bundle and then read that data back in **`onCreate(…)`**. This is how you are going to save the value of `mCurrentIndex` across rotation.

First, in `QuizActivity.java`, add a constant that will be the key for the key-value pair that will be stored in the bundle.

Listing 3.5 Adding a key for the value (`QuizActivity.java`)

```
public class QuizActivity extends Activity {

    private static final String TAG = "QuizActivity";
    private static final String KEY_INDEX = "index";

    Button mTrueButton;
    ...
```

Next, override **`onSaveInstanceState(…)`** to write the value of `mCurrentIndex` to the bundle with the constant as its key.

Listing 3.6 Overriding **`onSaveInstanceState(…)`** (`QuizActivity.java`)

```
        mNextButton.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {
                mCurrentIndex = (mCurrentIndex + 1) % mQuestionBank.length;
                updateQuestion();
            }
        });

        updateQuestion();
    }

    @Override
    public void onSaveInstanceState(Bundle savedInstanceState) {
        super.onSaveInstanceState(savedInstanceState);
        Log.i(TAG, "onSaveInstanceState");
        savedInstanceState.putInt(KEY_INDEX, mCurrentIndex);
    }
```

Finally, in **onCreate(…)**, check for this value. If it exists, assign it to `mCurrentIndex`.

Listing 3.7 Checking bundle in **onCreate(…)** (`QuizActivity.java`)

```
        ...

        if (savedInstanceState != null) {
            mCurrentIndex = savedInstanceState.getInt(KEY_INDEX, 0);
        }

        updateQuestion();
    }
```

Run GeoQuiz and press Next. No matter how many device or user rotations you perform, the newly-minted **QuizActivity** will “remember” what question you were on.

Note that the types that you can save to and restore from a **Bundle** are primitive types and objects that implement the **Serializable** interface. When you are creating custom classes, be sure to implement **Serializable** if you want to save them in **onSaveInstanceState(…)**.

Testing the implementation of **onSaveInstanceState(…)** is a good idea – especially if you are saving and restoring objects. Rotation is easy to test; testing low-memory situations is harder. There is information at the end of this chapter about how to simulate your activity being destroyed by Android to reclaim memory.

The Activity Lifecycle, Revisited

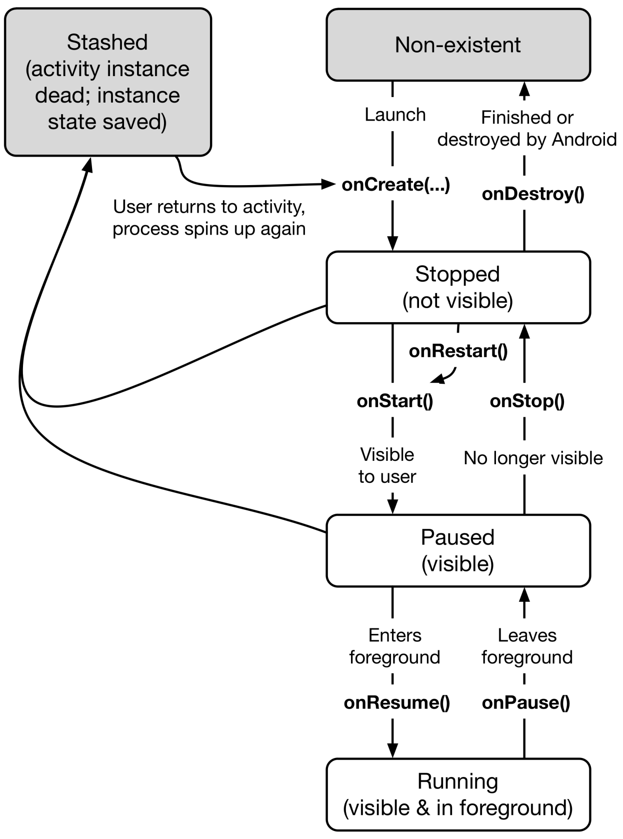
Overriding **onSaveInstanceState(Bundle)** is not just for handling rotation. An activity can also be destroyed if the user navigates away for a while and Android needs to reclaim memory.

Android will never destroy a running activity to reclaim memory – the activity must be in the paused or stopped state to be destroyed. If an activity is paused or stopped, then its **onSaveInstanceState(…)** method has been called.

When **onSaveInstanceState(…)** is called, the data is saved to the **Bundle** object. That **Bundle** object is then stuffed into your activity’s *activity record* by the OS

To understand the activity record, let’s add a *stashed* state to the activity lifecycle (Figure 3.14).

Figure 3.14 The complete activity lifecycle



When your activity is stashed, an **`Activity`** object does not exist, but the activity record object lives on in the OS. The OS can reanimate the activity using the activity record when it needs to.

Note that your activity can pass into the stashed state without **`onDestroy()`** being called. However, you can always rely on **`onPause()`** and **`onSaveInstanceState(…)`** to be called. Typically, you override **`onSaveInstanceState(…)`** to stash data in your **`Bundle`** and **`onPause()`** for anything else that needs to be done.

Under some situations, Android will not only kill your activity but also completely shut down your application's process. This will only happen if the user is not currently looking at your application, but it can (and does) happen. Even in this case, the activity record will live on and enable a quick restart of your activity if the user returns.

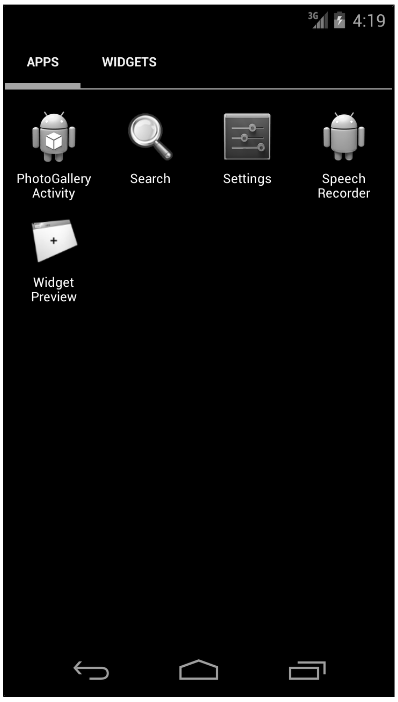
So when does the activity record get snuffed? When the user presses the Back button, your activity really gets destroyed, once and for all. At that point, your activity record is discarded. Activity records are also typically discarded on reboot and may also be discarded if they are not used for a long time.

For the More Curious: Testing onSaveInstanceState(Bundle)

If you are overriding **`onSaveInstanceState(Bundle)`**, you should test that your state is being saved and restored as expected. This is easy to do on the emulator.

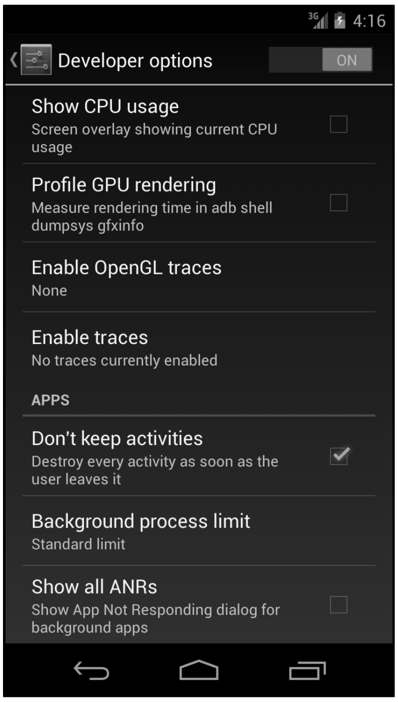
Start up a virtual device. Within the list of applications on the device, find the Settings app. This app is included with most system images used on the emulator.

Figure 3.15 Finding the Settings app



Launch Settings and select Development options. Here you will see many possible settings. Turn on the setting labeled Don’t keep activities.

Figure 3.16 Don’t keep activities selected



Show CPU usage
Screen overlay showing current CPU usage ☐

Profile GPU rendering
Measure rendering time in adb shell dumpsys gfxinfo ☐

Enable OpenGL traces
None

Enable traces
No traces currently enabled

APPS

Don’t keep activities
Destroy every activity as soon as the user leaves it ✓

Background process limit
Standard limit

Show all ANRs
Show App Not Responding dialog for background apps ☐

Now run your app and press the Home button. Pressing Home causes the activity to be paused and stopped. Then the stopped activity will be destroyed just as if the Android OS had reclaimed it for its memory. Then you can restore the app to see if your state was saved as you expected.

Pressing the Back button instead of the Home button will always destroy the activity regardless of whether you have this development setting on. Pressing the Back button tells the OS that the user is done with the activity.

To run the same test on a hardware device, you must install Dev Tools on the device. For more information, visit `http://developer.android.com/tools/debugging/debugging-devtools.html`.

For the More Curious: Logging Levels and Methods

When you use the **`android.util.Log`** class to send log messages, you control not only the content of a message, but also a *level* that specifies how important the message is. Android supports five log levels, shown in Figure 3.17. Each level has a corresponding method in the **`Log`** class. Sending output to the log is as simple as calling the corresponding **`Log`** method.

Figure 3.17 Log levels and methods

Log Level	Method	Notes
ERROR	`Log.e(...)`	Errors
WARNING	`Log.w(...)`	Warnings
INFO	`Log.i(...)`	Informational messages.
DEBUG	`Log.d(...)`	Debug output; may be filtered out.
VERBOSE	`Log.v(...)`	For development only!

In addition, each of the logging methods has two signatures: one which takes a *tag* string and a message string and a second that takes those two arguments plus an instance of **`Throwable`**, which makes it easy to log information about a particular exception that your application might throw. Listing 3.8 shows some sample log method signatures. Use regular Java string concatenation to assemble your message string, or **`String.format`** if you have fancier needs.

Listing 3.8 Different ways of logging in Android

```
// Log a message at "debug" log level
Log.d(TAG, "Current question index: " + mCurrentIndex);

TrueFalse question;
try {
    question = mQuestionBank[mCurrentIndex];
} catch (ArrayIndexOutOfBoundsException ex) {
    // Log a message at "error" log level, along with an exception stack trace
    Log.e(TAG, "Index was out of bounds", ex);
}
```

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