The Busy Coder's Guide to Android Development

by Mark L. Murphy

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Preface

Welcome to the Book!

Thanks!

Thanks for your interest in developing applications for Android! Increasingly, people will access Internet-based services using so-called "non-traditional" means, such as mobile devices. The more we do in that space now, the more that people will help invest in that space to make it easier to build more powerful mobile applications in the future. Android is new – Android-powered devices appeared on the scene first in late 2008 – but it likely will rapidly grow in importance due to the size and scope of the Open Handset Alliance.

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

Prerequisites

If you are interested in programming for Android, you will need at least basic understanding of how to program in Java. Android programming is done using Java syntax, plus a class library that resembles a subset of the Java SE library (plus Android-specific extensions). If you have not programmed in Java before, you probably should learn how that works before attempting to dive into programming for Android.

The book does not cover in any detail how to download or install the Android development tools, either the Eclipse IDE flavor or the standalone flavor. The Android Web site covers this quite nicely. The material in the book should be relevant whether you use the IDE or not. You should download, install, and test out the Android development tools from the Android Web site before trying any of the examples listed in this book.

Some chapters may reference material in previous chapters, though usually with a link back to the preceding section of relevance.

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- Typographical errors
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Icons used in the sample code were provided by the Nuvola icon set.

PART I – Core Concepts

CHAPTER 1

The Big Picture

Android devices, by and large, will be mobile phones. While the Android technology is being discussed for use in other areas (e.g., car dashboard "PCs"), for the most part, you can think of Android as being used on phones.

For developers, this has benefits and drawbacks.

On the plus side, circa 2008, Android-style smartphones are sexy. Offering Internet services over mobile devices dates back to the mid-1990's and the Handheld Device Markup Language (HDML). However, only in recent years have phones capable of Internet access taken off. Now, thanks to trends like text messaging and to products like Apple's iPhone, phones that can serve as Internet access devices are rapidly gaining popularity. So, working on Android applications gives you experience with an interesting technology (Android) in a fast-moving market segment (Internet-enabled phones), which is always a good thing.

The problem comes when you actually have to program the darn things.

Anyone with experience in programming for PDAs or phones has felt the pain of phones simply being *small* in all sorts of dimensions:

- Screens are small (you won't get comments like, "is that a 24-inch LCD in your pocket, or...?")
- Keyboards, if they exist, are small

- Pointing devices, if they exist, are annoying (as anyone who has lost their stylus will tell you) or inexact (large fingers and "multi-touch" LCDs are not a good mix)
- CPU speed and memory are tight compared to desktops and servers you may be used to
- You can have any programming language and development framework you want, so long as it was what the device manufacturer chose and burned into the phone's silicon
- And so on

Moreover, applications running on a phone have to deal with the fact that they're *on a phone*.

People with mobile phones tend to get very irritated when those phones don't work, which is why the "can you hear me now?" ad campaign from Verizon Wireless has been popular for the past few years. Similarly, those same people will get irritated at you if your program "breaks" their phone:

- ...by tying up the CPU such that calls can't be received
- ...by not working properly with the rest of the phone's OS, such that your application doesn't quietly fade to the background when a call comes in or needs to be placed
- ...by crashing the phone's operating system, such as by leaking memory like a sieve

Hence, developing programs for a phone is a different experience than developing desktop applications, Web sites, or back-end server processes. You wind up with different-looking tools, different-behaving frameworks, and "different than you're used to" limitations on what you can do with your program.

What Android tries to do is meet you halfway:

- You get a commonly-used programming language (Java) with some commonly used libraries (e.g., some Apache Commons APIs), with support for tools you may be used to (Eclipse)

- You get a fairly rigid and uncommon framework in which your programs need to run so they can be "good citizens" on the phone and not interfere with other programs or the operation of the phone itself

As you might expect, much of this book deals with that framework and how you write programs that work within its confines and take advantage of its capabilities.

What Androids Are Made Of

When you write a desktop application, you are "master of your own domain". You launch your main window and any child windows – like dialog boxes – that are needed. From your standpoint, you are your own world, leveraging features supported by the operating system, but largely ignorant of any other program that may be running on the computer at the same time. If you do interact with other programs, it is typically through an API, such as using JDBC (or frameworks atop it) to communicate with MySQL or another database.

Android has similar concepts, but packaged differently, and structured to make phones more crash-resistant.

Activities

The building block of the user interface is the **activity**. You can think of an activity as being the Android analogue for the window or dialog in a desktop application.

While it is possible for activities to not have a user interface, most likely your "headless" code will be packaged in the form of content providers or services, described below.

Content Providers

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

Intents

Intents are system messages, running around the inside of the device, notifying applications of various events, from hardware state changes (e.g., an SD card was inserted), to incoming data (e.g., an SMS message arrived), to application events (e.g., your activity was launched from the device's main menu). Not only can you respond to intents, but you can create your own, to launch other activities, or to let you know when specific situations arise (e.g., raise such-and-so intent when the user gets within 100 meters of this-and-such location).

Services

Activities, content providers, and intent receivers are all short-lived and can be shut down at any time. Services, on the other hand, are designed to keep running, if needed, independent of any activity. You might use a service for checking for updates to an RSS feed, or to play back music even if the controlling activity is no longer operating.

Stuff At Your Disposal

Storage

You can package data files with your application, for things that do not change, such as icons or help files. You also can carve out a small bit of space on the device itself, for databases or files containing user-entered or retrieved data needed by your application. And, if the user supplies bulk storage, like an SD card, you can read and write files on there as needed.

Network

Android devices will generally be Internet-ready, through one communications medium or another. You can take advantage of the Internet access at any level you wish, from raw Java sockets all the way up to a built-in WebKit-based Web browser widget you can embed in your application.

Multimedia

Android devices have the ability to play back and record audio and video. While the specifics may vary from device to device, you can query the device to learn its capabilities and then take advantage of the multimedia capabilities as you see fit, whether that is to play back music, take pictures with the camera, or use the microphone for audio note-taking.

GPS

Android devices will frequently have access to location providers, such as GPS, that can tell your applications where the device is on the face of the Earth. In turn, you can display maps or otherwise take advantage of the location data, such as tracking a device's movements if the device has been stolen.

Phone Services

And, of course, Android devices are typically phones, allowing your software to initiate calls, send and receive SMS messages, and everything else you expect from a modern bit of telephony technology.

CHAPTER 2

Project Structure

The Android build system is organized around a specific directory tree structure for your Android project, much like any other Java project. The specifics, though, are fairly unique to Android and what it all does to prepare the actual application that will run on the device or emulator. Here's a quick primer on the project structure, to help you make sense of it all, particularly for the sample code referenced in this book.

Root Contents

When you create a new Android project (e.g., via `activitycreator`), you get seven key items in the project's root directory:

- `AndroidManifest.xml`, which is an XML file describing the application being built and what components – activities, services, etc. – are being supplied by that application
- `build.xml`, which is an Ant script for compiling the application and installing it on the device
- `bin/`, which holds the application once it is compiled
- `libs/`, which holds any third-party Java JARs your application requires
- `src/`, which holds the Java source code for the application
- `res/`, which holds "resources", such as icons, GUI layouts, and the like, that get packaged with the compiled Java in the application

- `assets/`, which hold other static files you wish packaged with the application for deployment onto the device

The Sweat Off Your Brow

When you created the project (e.g., via `activitycreator`), you supplied the fully-qualified class name of the "main" activity for the application (e.g., `com.commonsware.android.SomeDemo`). You will then find that your project's `src/` tree already has the namespace directory tree in place, plus a stub `Activity` subclass representing your main activity (e.g., `src/com/commonsware/android/SomeDemo.java`). You are welcome to modify this file and add others to the `src/` tree as needed to implement your application.

The first time you compile the project (e.g., via `ant`), out in the "main" activity's namespace directory, the Android build chain will create `R.java`. This contains a number of constants tied to the various resources you placed out in the `res/` directory tree. You should not modify `R.java` yourself, letting the Android tools handle it for you. You will see throughout many of the samples where we reference things in `R.java` (e.g., referring to a layout's identifier via `R.layout.main`).

And Now, The Rest of the Story

You will also find that your project has a `res/` directory tree. This holds "resources" – static files that are packaged along with your application, either in their original form or, occasionally, in a preprocessed form. Some of the subdirectories you will find or create under `res/` include:

- `res/drawable/` for images (PNG, JPEG, etc.)
- `res/layout/` for XML-based UI layout specifications
- `res/menu/` for XML-based menu specifications
- `res/raw/` for general-purpose files (e.g,. a CSV file of account information)
- `res/values/` for strings, dimensions, and the like

- `res/xml/` for other general-purpose XML files you wish to ship

We will cover all of these, and more, in later chapters of this book.

What You Get Out Of It

When you compile your project (via `ant` or the IDE), the results go into the `bin/` directory under your project root. Specifically:

- `bin/classes/` holds the compiled Java classes
- `bin/classes.dex` holds the executable created from those compiled Java classes
- `bin/yourapp.ap_` holds your application's resources, packaged as a ZIP file (where `yourapp` is the name of your application)
- `bin/yourapp-debug.apk` or `bin/yourapp-unsigned.apk` is the actual Android application (where `yourapp` is the name of your application)

The `.apk` file is a ZIP archive containing the `.dex` file, the compiled edition of your resources (`resources.arsc`), any un-compiled resources (such as what you put in `res/raw/`) and the `AndroidManifest.xml` file. It is also digitally signed, with the `-debug` portion of the filename indicating it has been signed using a debug key that works with the emulator, or `-unsigned` indicating that you built your application for release (`ant release`), but the APK still needs to be signed using `jarsigner` and an official key.

CHAPTER 3

Inside the Manifest

The foundation for any Android application is the manifest file: `AndroidManifest.xml` in the root of your project. Here is where you declare what all is inside your application – the activities, the services, and so on. You also indicate how these pieces attach themselves to the overall Android system; for example, you indicate which activity (or activities) should appear on the device's main menu (a.k.a., launcher).

When you create your application, you will get a starter manifest generated for you. For a simple application, offering a single activity and nothing else, the auto-generated manifest will probably work out fine, or perhaps require a few minor modifications. On the other end of the spectrum, the manifest file for the Android API demo suite is over 1,000 lines long. Your production Android applications will probably fall somewhere in the middle.

Most of the interesting bits of the manifest will be described in greater detail in the chapters on their associated Android features. For example, the `service` element will be described in greater detail in the chapter on creating services. For now, we just need to understand what the role of the manifest is and its general overall construction.

In The Beginning, There Was the Root, And It Was Good

The root of all manifest files is, not surprisingly, a `manifest` element:

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.commonsware.android.search">
...
</manifest>
```

Note the namespace declaration. Curiously, the generated manifests only apply it on the attributes, not the elements (e.g., it's `manifest`, not `android:manifest`). However, that pattern works, so unless Android changes, stick with their pattern.

The biggest piece of information you need to supply on the `manifest` element is the `package` attribute (also curiously not-namespaced). Here, you can provide the name of the Java package that will be considered the "base" of your application. Then, everywhere else in the manifest file that needs a class name, you can just substitute a leading dot as shorthand for the package. For example, if you needed to refer to `com.commonsware.android.search.Snicklefritz` in this manifest shown above, you could just use `.Snicklefritz`, since `com.commonsware.android.search` is defined as the application's package.

Permissions, Instrumentations, and Applications (Oh, My!)

Underneath the `manifest` element, you will find:

- `uses-permission` elements, to indicate what permissions your application will need in order to function properly – see the chapter on permissions for more details
- `permission` elements, to declare permissions that activities or services might require other applications hold in order to use your application's data or logic – again, more details are forthcoming in the chapter on permissions
- `instrumentation` elements, to indicate code that should be invoked on key system events, such as starting up activities, for the purposes of logging or monitoring
- `uses-library` elements, to hook in optional Android components, such as mapping services

- an `application` element, defining the guts of the application that the manifest describes

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.commonsware.android">
  <uses-permission
    android:name="android.permission.ACCESS_LOCATION" />
  <uses-permission
    android:name="android.permission.ACCESS_GPS" />
  <uses-permission
    android:name="android.permission.ACCESS_ASSISTED_GPS" />
  <uses-permission
    android:name="android.permission.ACCESS_CELL_ID" />
  <application>
...
  </application>
</manifest>
```

In the preceding example, the manifest has `uses-permission` elements to indicate some device capabilities the application will need – in this case, permissions to allow the application to determine its current location. And, there is the `application` element, whose contents will describe the activities, services, and whatnot that make up the bulk of the application itself.

Your Application Does Something, Right?

The real meat of the manifest file are the children of the `application` element.

By default, when you create a new Android project, you get a single `activity` element:

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonsware.android.skeleton">
    <application>
        <activity android:name=".Now" android:label="Now">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>
</manifest>
```

This element supplies android:name for the class implementing the activity, android:label for the display name of the activity, and (frequently) an intent-filter child element describing under what conditions this activity will be displayed. The stock activity element sets up your activity to appear in the launcher, so users can choose to run it. As we'll see later in this book, you can have several activities in one project, if you so choose.

You may also have one or more receiver elements, indicating non-activities that should be triggered under certain conditions, such as when an SMS message comes in. These are called intent receivers and are described mid-way through the book.

You may have one or more provider elements, indicating content providers – components that supply data to your activities and, with your permission, other activities in other applications on the device. These wrap up databases or other data stores into a single API that any application can use. Later, we'll see how to create content providers and how to use content providers that you or others create.

Finally, you may have one or more service elements, describing services – long-running pieces of code that can operate independent of any activity. The quintessential example is the MP3 player, where you want the music to keep playing even if the user pops open other activities and the MP3 player's user interface is "misplaced". Two chapters late in the book cover how to create and use services.

PART II – Activities

CHAPTER 4

Creating a Skeleton Application

Every programming language or environment book starts off with the ever-popular "Hello, World!" demonstration: just enough of a program to prove you can build things, not so much that you cannot understand what is going on. However, the typical "Hello, World!" program has no interactivity (e.g., just dumps the words to a console), and so is really boring.

This chapter demonstrates a simple project, but one using Advanced Push-Button Technology™ and the current time, to show you how a simple Android activity works.

Begin at the Beginning

To work with anything in Android, you need a project. With ordinary Java, if you wanted, you could just write a program as a single file, compile it with `javac`, and run it with `java`, without any other support structures. Android is more complex, but to help keep it manageable, Google has supplied tools to help create the project. If you are using an Android-enabled IDE, such as Eclipse with the Android plugin, you can create a project inside of the IDE (e.g., select **File** > **New** > **Project**, then choose **Android** > **Android Project**).

If you are using tools that are not Android-enabled, you can use the `activitycreator` script, found in the `tools/` directory in your SDK installation. Just pass `activitycreator` the package name of the activity you want to create and a `--out` switch indicating where the project files should be generated. For example:

```
activitycreator --out /path/to/my/project/dir \
com.commonsware.android.Now
```

You will wind up with a handful of pre-generated files, as described in a previous chapter.

For the purposes of the samples shown in this book, you can download their project directories in a ZIP file on the CommonsWare Web site. These projects are ready for use; you do not need to run `activitycreator` on those unpacked samples.

The Activity

Your project's `src/` directory contains the standard Java-style tree of directories based upon the Java package you chose when you created the project (e.g., `com.commonsware.android` results in `src/com/commonsware/android/`). Inside the innermost directory you should find a pre-generated source file named `Now.java`, which where your first activity will go.

Open `Now.java` in your editor and paste in the following code:

```
package com.commonsware.android.skeleton;

import android.app.Activity;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import java.util.Date;

public class Now extends Activity implements View.OnClickListener {
  Button btn;

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

    btn = new Button(this);
    btn.setOnClickListener(this);
    updateTime();
    setContentView(btn);
  }

  public void onClick(View view) {
    updateTime();
  }

  private void updateTime() {
    btn.setText(new Date().toString());
  }
}
```

Or, if you download the source files off the Web site, you can just use the `Now` project directly.

Dissecting the Activity

Let's examine this piece by piece:

```
package com.commonsware.android.skeleton;

import android.app.Activity;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import java.util.Date;
```

The package declaration needs to be the same as the one you used when creating the project. And, like any other Java project, you need to import any classes you reference. Most of the Android-specific classes are in the `android` package.

Remember that not every Java SE class is available to Android programs! Visit the Android class reference to see what is and is not available.

```
public class Now extends Activity implements View.OnClickListener {
  Button btn;
```

Activities are public classes, inheriting from the `android.Activity` base class. In this case, the activity holds a button (`btn`). Since, for simplicity, we want to trap all button clicks just within the activity itself, we also have the activity class implement `OnClickListener`.

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

  btn = new Button(this);
  btn.setOnClickListener(this);
  updateTime();
  setContentView(btn);
}
```

The `onCreate()` method is invoked when the activity is started. The first thing you should do is chain upward to the superclass, so the stock Android activity initialization can be done.

In our implementation, we then create the button instance (`new Button(this)`), tell it to send all button clicks to the activity instance itself (via `setOnClickListener()`), call a private `updateTime()` method (see below), and then set the activity's content view to be the button itself (via `setContentView()`).

We will discuss that magical `Bundle icicle` in a later chapter. For the moment, consider it an opaque handle that all activities receive upon creation.

```
public void onClick(View view) {
  updateTime();
}
```

In Swing, a `JButton` click raises an `ActionEvent`, which is passed to the `ActionListener` configured for the button. In Android, a button click causes `onClick()` to be invoked in the `OnClickListener` instance configured for the button. The listener is provided the view that triggered the click (in this case, the button). All we do here is call that private `updateTime()` method:

```
private void updateTime() {
  btn.setText(new Date().toString());
}
```

When we open the activity (`onCreate()`) or when the button is clicked (`onClick()`), we update the button's label to be the current time via `setText()`, which functions much the same as the `JButton` equivalent.

Building and Running the Activity

To build the activity, either use your IDE's built-in Android packaging tool, or run ant in the base directory of your project. Then, to run the activity:

- Launch the emulator (e.g., run `tools/emulator` from your Android SDK installation)

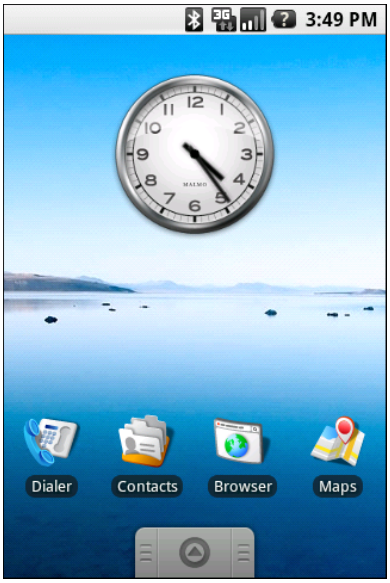


Figure 1. The Android home screen

- Install the package (e.g., run `tools/adb install /path/to/this/example/bin/Now.apk` from your Android SDK installation)
- View the list of installed applications in the emulator and find the "Now" application

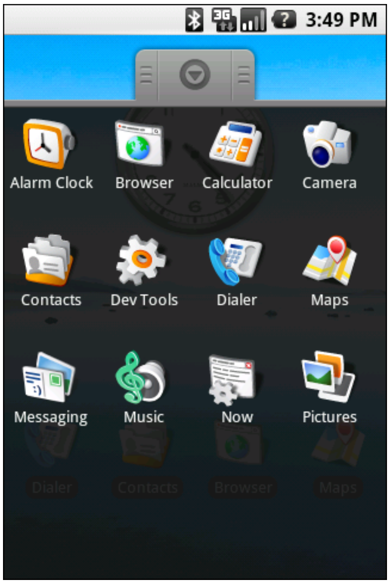
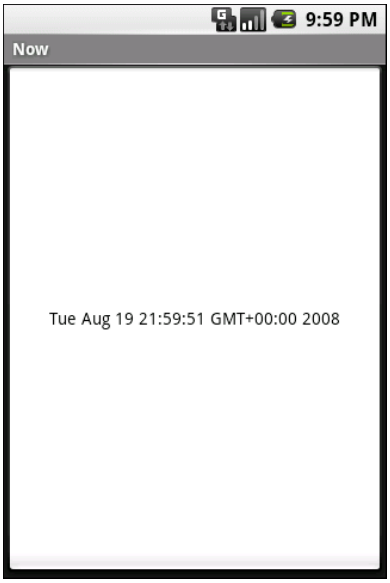


Figure 2. The Android application "launcher"

- Open that application

You should see an activity screen akin to:



```
Tue Aug 19 21:59:51 GMT+00:00 2008
```

Figure 3. The Now demonstration activity

Clicking the button – in other words, pretty much anywhere on the phone's screen – will update the time shown in the button's label.

Note that the label is centered horizontally and vertically, as those are the default styles applied to button captions. We can control that formatting, which will be covered in a later chapter.

After you are done gazing at the awesomeness of Advanced Push-Button Technology™, you can click the back button on the emulator to return to the launcher.

CHAPTER 5

Using XML-Based Layouts

While it is technically possible to create and attach widgets to our activity purely through Java code, the way we did in the preceding chapter, the more common approach is to use an XML-based layout file. Dynamic instantiation of widgets is reserved for more complicated scenarios, where the widgets are not known at compile-time (e.g., populating a column of radio buttons based on data retrieved off the Internet).

With that in mind, it's time to break out the XML and learn out to lay out Android activity views that way.

What Is an XML-Based Layout?

As the name suggests, an XML-based layout is a specification of widgets' relationships to each other – and to containers – encoded in XML format. Specifically, Android considers XML-based layouts to be resources, and as such layout files are stored in the `res/layout` directory inside your Android project.

Each XML file contains a tree of elements specifying a layout of widgets and containers that make up one `View`. The attributes of the XML elements are properties, describing how a widget should look or how a container should behave. For example, if a `Button` element has an attribute value of `android:textStyle = "bold"`, that means that the text appearing on the face of the button should be rendered in a boldface font style.

Android's SDK ships with a tool (`aapt`) which uses the layouts. This tool should be automatically invoked by your Android tool chain (e.g., Eclipse, Ant's `build.xml`). Of particular importance to you as a developer is that `aapt` generates the `R.java` source file within your project, allowing you to access layouts and widgets within those layouts directly from your Java code, as will be demonstrated .

Why Use XML-Based Layouts?

Most everything you do using XML layout files can be achieved through Java code. For example, you could use `setTypeface()` to have a button render its text in bold, instead of using a property in an XML layout. Since XML layouts are yet another file for you to keep track of, we need good reasons for using such files.

Perhaps the biggest reason is to assist in the creation of tools for view definition, such as a GUI builder in an IDE like Eclipse or a dedicated Android GUI designer like DroidDraw. Such GUI builders could, in principle, generate Java code instead of XML. The challenge is re-reading the definition in to support edits – that is far simpler if the data is in a structured format like XML than in a programming language. Moreover, keeping the generated bits separated out from hand-written code makes it less likely that somebody's custom-crafted source will get clobbered by accident when the generated bits get re-generated. XML forms a nice middle ground between something that is easy for tool-writers to use and easy for programmers to work with by hand as needed.

Also, XML as a GUI definition format is becoming more commonplace. Microsoft's XAML, Adobe's Flex, and Mozilla's XUL all take a similar approach to that of Android: put layout details in an XML file and put programming smarts in source files (e.g., Javascript for XUL). Many less-well-known GUI frameworks, such as ZK, also use XML for view definition. While "following the herd" is not necessarily the best policy, it does have the advantage of helping to ease the transition into Android from any other XML-centered view description language.

OK, So What Does It Look Like?

Here is the `Button` from the previous chapter's sample application, converted into an XML layout file:

```
<?xml version="1.0" encoding="utf-8"?>
<Button xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/button"
    android:text=""
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"/>
```

The class name of the widget – `Button` – forms the name of the XML element. Since `Button` is an Android-supplied widget, we can just use the bare class name. If you create your own widgets as subclasses of `android.view.View`, you would need to provide a full package declaration as well (e.g., `com.commonsware.android.MyWidget`).

The root element needs to declare the Android XML namespace:

```
xmlns:android="http://schemas.android.com/apk/res/android"
```

All other elements will be children of the root and will inherit that namespace declaration.

Because we want to reference this button from our Java code, we need to give it an identifier via the `android:id` attribute. We will cover this concept in greater detail .

The remaining attributes are properties of this `Button` instance:

- `android:text` indicates the initial text to be displayed on the button face (in this case, an empty string)
- `android:layout_width` and `android:layout_height` tell Android to have the button's width and height fill the "parent", in this case the entire screen – these attributes will be covered in greater detail in a later chapter

Since this single widget is the only content in our activity's view, we only need this single element. Complex views will require a whole tree of elements, representing the widgets and containers that control their positioning. All the remaining chapters of this book will use the XML layout form whenever practical, so there are dozens of other examples of more complex layouts for you to peruse.

What's With the @ Signs?

Many widgets and containers only need to appear in the XML layout file and do not need to be referenced in your Java code. For example, a static label (`TextView`) frequently only needs to be in the layout file to indicate where it should appear. These sorts of elements in the XML file do not need to have the `android:id` attribute to give them a name.

Anything you *do* want to use in your Java source, though, needs an `android:id`.

The convention is to use `@+id/...` as the `id` value, where the `...` represents your locally-unique name for the widget in question. In the XML layout example in the preceding section, `@+id/button` is the identifier for the `Button` widget.

Android provides a few special `android:id` values, of the form `@android:id/...` – we will see some of these in various chapters of this book.

And We Attach These to the Java...How?

Given that you have painstakingly set up the widgets and containers for your view in an XML layout file named `main.xml` stored in `res/layout`, all you need is one statement in your activity's `onCreate()` callback to use that layout:

```
setContentView(R.layout.main);
```

This is the same setContentView() we used earlier, passing it an instance of a View subclass (in that case, a Button). The Android-built View, constructed from our layout, is accessed from that code-generated R class. All of the layouts are accessible under R.layout, keyed by the base name of the layout file – main.xml results in R.layout.main.

To access our identified widgets, use findViewById(), passing it the numeric identifier of the widget in question. That numeric identifier was generated by Android in the R class as R.id.something (where something is the specific widget you are seeking). Those widgets are simply subclasses of View, just like the Button instance we created in the previous chapter.

The Rest of the Story

In the original Now demo, the button's face would show the current time, which would reflect when the button was last pushed (or when the activity was first shown, if the button had not yet been pushed).

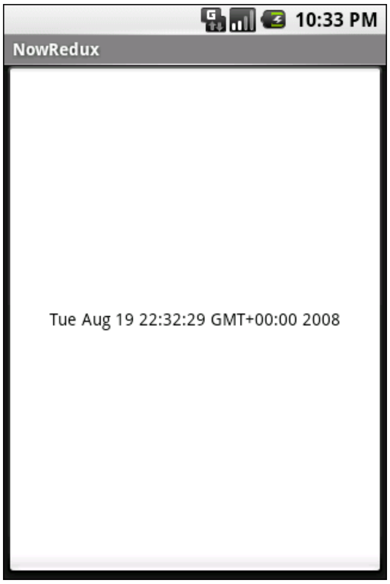
Most of that logic still works, even in this revised demo (NowRedux). However, rather than instantiating the Button in our activity's onCreate() callback, we can reference the one from the XML layout:

```java
package com.commonsware.android.layouts;

import android.app.Activity;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import java.util.Date;

public class NowRedux extends Activity
  implements View.OnClickListener {
  Button btn;

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

    setContentView(R.layout.main);

    btn=(Button)findViewById(R.id.button);
    btn.setOnClickListener(this);
    updateTime();
  }

  public void onClick(View view) {
    updateTime();
  }

  private void updateTime() {
    btn.setText(new Date().toString());
  }
}
```

The first difference is that rather than setting the content view to be a view we created in Java code, we set it to reference the XML layout (`setContentView(R.layout.main)`). The `R.java` source file will be updated when we rebuild this project to include a reference to our layout file (stored as `main.xml` in our project's `res/layout` directory).

The other difference is that we need to get our hands on our `Button` instance, for which we use the `findViewById()` call. Since we identified our button as `@+id/button`, we can reference the button's identifier as `R.id.button`. Now, with the `Button` instance in hand, we can set the callback and set the label as needed.

The results look the same as with the original `Now` demo:



```
Tue Aug 19 22:32:29 GMT+00:00 2008
```

Figure 4. The NowRedux sample activity

CHAPTER 6

Employing Basic Widgets

Every GUI toolkit has some basic widgets: fields, labels, buttons, etc. Android's toolkit is no different in scope, and the basic widgets will provide a good introduction as to how widgets work in Android activities.

Assigning Labels

The simplest widget is the label, referred to in Android as a `TextView`. Like in most GUI toolkits, labels are bits of text not editable directly by users. Typically, they are used to identify adjacent widgets (e.g., a "Name:" label before a field where one fills in a name).

In Java, you can create a label by creating a `TextView` instance. More commonly, though, you will create labels in XML layout files by adding a `TextView` element to the layout, with an `android:text` property to set the value of the label itself. If you need to swap labels based on certain criteria, such as internationalization, you may wish to use a resource reference in the XML instead, as will be described later in this book.

`TextView` has numerous other properties of relevance for labels, such as:

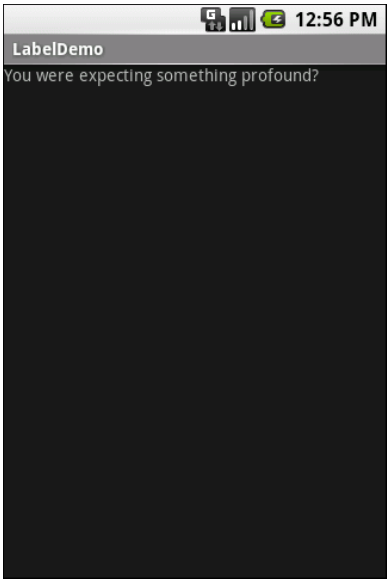
- `android:typeface` to set the typeface to use for the label (e.g., `monospace`)
- `android:textStyle` to indicate that the typeface should be made bold (`bold`), italic (`italic`), or bold and italic (`bold_italic`)

- android:textColor to set the color of the label's text, in RGB hex format (e.g., #FF0000 for red)

For example, in the Label project, you will find the following layout file:

```
<?xml version="1.0" encoding="utf-8"?>
<TextView xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="wrap_content"
  android:text="You were expecting something profound?"
  />
```

Just that layout alone, with the stub Java source provided by Android's project builder (e.g., activityCreator), gives you:



You were expecting something profound?

Figure 5. The LabelDemo sample application

Button, Button, Who's Got the Button?

We've already seen the use of the Button widget in the previous two chapters. As it turns out, Button is a subclass of TextView, so everything discussed in the preceding section in terms of formatting the face of the button still holds.

Fleeting Images

Android has two widgets to help you embed images in your activities: ImageView and ImageButton. As the names suggest, they are image-based analogues to TextView and Button, respectively.

Each widget takes an android:src attribute (in an XML layout) to specify what picture to use. These usually reference a drawable resource, described in greater detail in the chapter on resources. You can also set the image content based on a Uri from a content provider via setImageURI().

ImageButton, a subclass of ImageView, mixes in the standard Button behaviors, for responding to clicks and whatnot.

For example, take a peek at the main.xml layout from the ImageView sample project:

```
<?xml version="1.0" encoding="utf-8"?>
<ImageView xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/icon"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:adjustViewBounds="true"
    android:src="@drawable/molecule"
    />
```

The result, just using the code-generated activity, is simply the image:

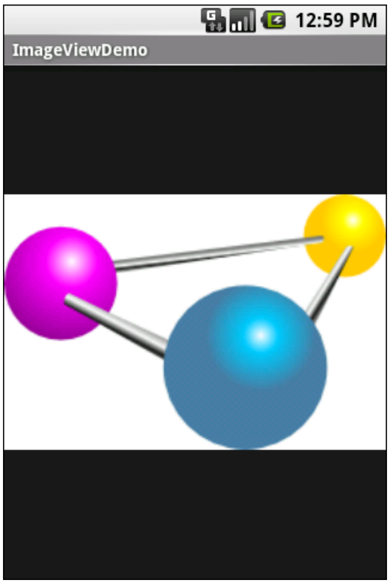


Figure 6. The ImageViewDemo sample application

Fields of Green. Or Other Colors.

Along with buttons and labels, fields are the third "anchor" of most GUI toolkits. In Android, they are implemented via the `EditText` widget, which is a subclass of the `TextView` used for labels.

Along with the standard `TextView` properties (e.g., `android:textStyle`), `EditText` has many others that will be useful for you in constructing fields, including:

- `android:autoText`, to control if the field should provide automatic spelling assistance
- `android:capitalize`, to control if the field should automatically capitalize the first letter of entered text (e.g., first name, city)
- `android:digits`, to configure the field to accept only certain digits
- `android:singleLine`, to control if the field is for single-line input or multiple-line input (e.g., does <Enter> move you to the next widget or add a newline?)

Beyond those, you can configure fields to use specialized input methods, such as `android:numeric` for numeric-only input, `android:password` for shrouded password input, and `android:phoneNumber` for entering in phone numbers. If you want to create your own input method scheme (e.g., postal codes, Social Security numbers), you need to create your own implementation of the `InputMethod` interface, then configure the field to use it via `android:inputMethod`. You can see an example of this in the appendix discussing the TourIt sample application.

For example, from the `Field` project, here is an XML layout file showing an `EditText`:

```xml
<?xml version="1.0" encoding="utf-8"?>
<EditText xmlns:android="http://schemas.android.com/apk/res/android"
  android:id="@+id/field"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  android:singleLine="false"
  />
```

Note that `android:singleLine` is false, so users will be able to enter in several lines of text.

For this project, the `FieldDemo.java` file populates the input field with some prose:

```java
package com.commonsware.android.basic;

import android.app.Activity;
import android.os.Bundle;
import android.widget.EditText;

public class FieldDemo extends Activity {
  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    EditText fld=(EditText)findViewById(R.id.field);
    fld.setText("Licensed under the Apache License, Version 2.0 " +
            "(the \"License\"); you may not use this file " +
            "except in compliance with the License. You may " +
            "obtain a copy of the License at " +
            "http://www.apache.org/licenses/LICENSE-2.0");
  }
}
```

The result, once built and installed into the emulator, is:

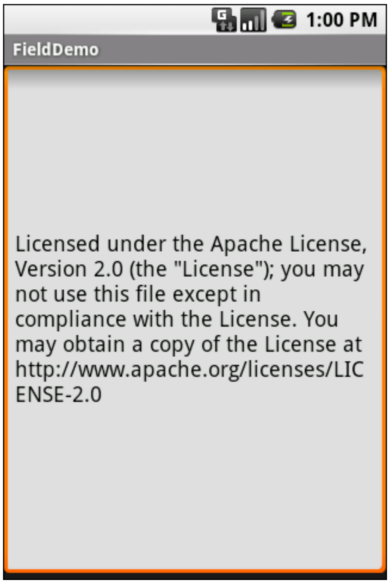


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Figure 7. The FieldDemo sample application

NOTE: Android's emulator only allows one application in the launcher per unique Java package. Since all the demos in this chapter share the `com.commonsware.android.basic` package, you will only see one of these demos in your emulator's launcher at any one time.

Another flavor of field is one that offers auto-completion, to help users supply a value without typing in the whole text. That is provided in Android as the `AutoCompleteTextView` widget, discussed in greater detail later in this book.

Just Another Box to Check

The classic checkbox has two states: checked and unchecked. Clicking the checkbox toggles between those states to indicate a choice (e.g., "Add rush delivery to my order").

In Android, there is a `CheckBox` widget to meet this need. It has `TextView` as an ancestor, so you can use `TextView` properties like `android:textColor` to format the widget.

Within Java, you can invoke:

- `isChecked()` to determine if the checkbox has been checked
- `setChecked()` to force the checkbox into a checked or unchecked state
- `toggle()` to toggle the checkbox as if the user checked it

Also, you can register a listener object (in this case, an instance of `OnCheckedChangeListener`) to be notified when the state of the checkbox changes.

For example, from the `CheckBox` project, here is a simple checkbox layout:

```
<?xml version="1.0" encoding="utf-8"?>
<CheckBox xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/check"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="This checkbox is: unchecked" />
```

The corresponding `CheckBoxDemo.java` retrieves and configures the behavior of the checkbox:

```
public class CheckBoxDemo extends Activity
  implements CompoundButton.OnCheckedChangeListener {
  CheckBox cb;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    cb=(CheckBox)findViewById(R.id.check);
    cb.setOnCheckedChangeListener(this);
  }

  public void onCheckedChanged(CompoundButton buttonView,
                                 boolean isChecked) {
    if (isChecked) {
      cb.setText("This checkbox is: checked");
    }
    else {
      cb.setText("This checkbox is: unchecked");
    }
  }
}
```

Note that the activity serves as its own listener for checkbox state changes since it implements the `OnCheckedChangeListener` interface (via `cb.setOnCheckedChangeListener(this)`). The callback for the listener is `onCheckedChanged()`, which receives the checkbox whose state has changed and what the new state is. In this case, we update the text of the checkbox to reflect what the actual box contains.

The result? Clicking the checkbox immediately updates its text, as shown below:

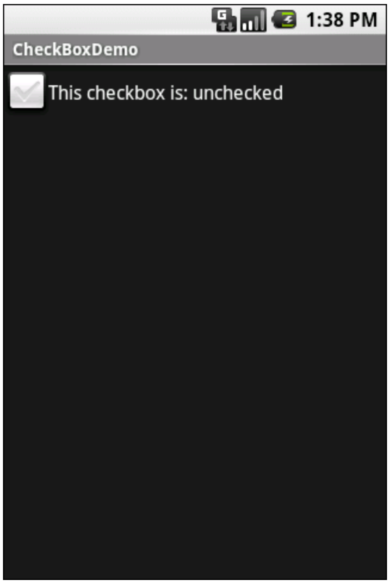


Figure 8. The CheckBoxDemo sample application, with the checkbox unchecked

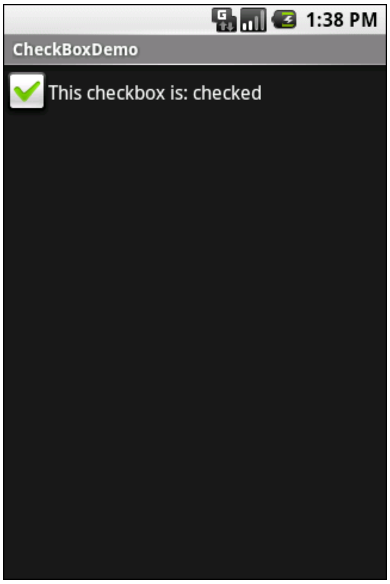


Figure 9. The same application, now with the checkbox checked

Turn the Radio Up

As with other implementations of radio buttons in other toolkits, Android's radio buttons are two-state, like checkboxes, but can be grouped such that only one radio button in the group can be checked at any time.

Like `CheckBox`, `RadioButton` inherits from `CompoundButton`, which in turn inherits from `TextView`. Hence, all the standard `TextView` properties for font face, style, color, etc. are available for controlling the look of radio buttons. Similarly, you can call `isChecked()` on a `RadioButton` to see if it is selected, `toggle()` to select it, and so on, like you can with a `CheckBox`.

Most times, you will want to put your `RadioButton` widgets inside of a `RadioGroup`. The `RadioGroup` indicates a set of radio buttons whose state is tied, meaning only one button out of the group can be selected at any time. If you assign an `android:id` to your `RadioGroup` in your XML layout, you can access the group from your Java code and invoke:

- `check()` to check a specific radio button via its ID (e.g., `group.check(R.id.radio1)`)
- `clearCheck()` to clear all radio buttons, so none in the group are checked
- `getCheckedRadioButtonId()` to get the ID of the currently-checked radio button (or `-1` if none are checked)

For example, from the `RadioButton` sample application, here is an XML layout showing a `RadioGroup` wrapping a set of `RadioButton` widgets:

```
<?xml version="1.0" encoding="utf-8"?>
<RadioGroup
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
    <RadioButton android:id="@+id/radio1"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:text="Rock" />
    <RadioButton android:id="@+id/radio2"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:text="Scissors" />

    <RadioButton android:id="@+id/radio3"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:text="Paper" />
</RadioGroup>
```

Using the stock Android-generated Java for the project and this layout, you get:

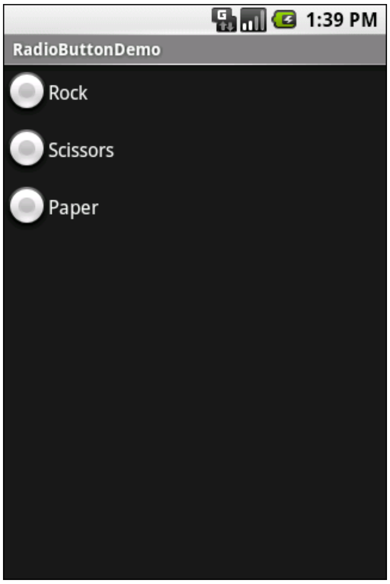


Figure 10. The RadioButtonDemo sample application

Note that the radio button group is initially set to be completely unchecked at the outset. To pre-set one of the radio buttons to be checked, use either `setChecked()` on the `RadioButton` or `check()` on the `RadioGroup` from within your `onCreate()` callback in your activity.

It's Quite a View

All widgets, including the ones shown above, extend `View`, and as such give all widgets an array of useful properties and methods beyond those already described.

Useful Properties

Some of the properties on `View` most likely to be used include:

- Controls the focus sequence:
    - `android:nextFocusDown`
    - `android:nextFocusLeft`
    - `android:nextFocusRight`
    - `android:nextFocusUp`
- `android:visibility`, which controls whether the widget is initially visible
- `android:background`, which typically provides an RGB color value (e.g., `#00FF00` for green) to serve as the background for the widget

Useful Methods

You can toggle whether or not a widget is enabled via `setEnabled()` and see if it is enabled via `isEnabled()`. One common use pattern for this is to disable some widgets based on a `CheckBox` or `RadioButton` selection.

You can give a widget focus via `requestFocus()` and see if it is focused via `isFocused()`. You might use this in concert with disabling widgets as mentioned above, to ensure the proper widget has the focus once your disabling operation is complete.

To help navigate the tree of widgets and containers that make up an activity's overall view, you can use:

- `getParent()` to find the parent widget or container
- `findViewById()` to find a child widget with a certain ID
- `getRootView()` to get the root of the tree (e.g., what you provided to the activity via `setContentView()`)

CHAPTER 7

Working with Containers

Containers pour a collection of widgets (and possibly child containers) into specific layouts you like. If you want a form with labels on the left and fields on the right, you will need a container. If you want OK and Cancel buttons to be beneath the rest of the form, next to one another, and flush to right side of the screen, you will need a container. Just from a pure XML perspective, if you have multiple widgets (beyond `RadioButton` widgets in a `RadioGroup`), you will need a container just to have a root element to place the widgets inside.

Most GUI toolkits have some notion of layout management, frequently organized into containers. In Java/Swing, for example, you have layout managers like `BoxLayout` and containers that use them (e.g., `Box`). Some toolkits stick strictly to the box model, such as XUL and Flex, figuring that any desired layout can be achieved through the right combination of nested boxes.

Android, through `LinearLayout`, also offers a "box" model, but in addition supports a range of containers providing different layout rules. In this chapter, we will look at three commonly-used containers: `LinearLayout` (the box model), `RelativeLayout` (a rule-based model), and `TableLayout` (the grid model), along with `ScrollView`, a container designed to assist with implementing scrolling containers. In the next chapter, we will examine some more esoteric containers.

Thinking Linearly

As noted above, `LinearLayout` is a box model – widgets or child containers are lined up in a column or row, one after the next. This works similar to `FlowLayout` in Java/Swing, `vbox` and `hbox` in Flex and XUL, etc.

Flex and XUL use the box as their primary unit of layout. If you want, you can use `LinearLayout` in much the same way, eschewing some of the other containers. Getting the visual representation you want is mostly a matter of identifying where boxes should nest and what properties those boxes should have, such as alignment vis a vis other boxes.

Concepts and Properties

To configure a `LinearLayout`, you have five main areas of control besides the container's contents: the orientation, the fill model, the weight, the gravity, and the padding.

Orientation

Orientation indicates whether the `LinearLayout` represents a row or a column. Just add the `android:orientation` property to your `LinearLayout` element in your XML layout, setting the value to be `horizontal` for a row or `vertical` for a column.

The orientation can be modified at runtime by invoking `setOrientation()` on the `LinearLayout`, supplying it either `HORIZONTAL` or `VERTICAL`.

Fill Model

Let's imagine a row of widgets, such as a pair of radio buttons. These widgets have a "natural" size based on their text. Their combined sizes probably do not exactly match the width of the Android device's screen – particularly since screens come in various sizes. We then have the issue of what to do with the remaining space.

All widgets inside a `LinearLayout` must supply `android:layout_width` and `android:layout_height` properties to help address this issue. These properties' values have three flavors:

- You can provide a specific dimension, such as `125px` to indicate the widget should take up exactly 125 pixels
- You can provide `wrap_content`, which means the widget should fill up its natural space, unless that is too big, in which case Android can use word-wrap as needed to make it fit
- You can provide `fill_parent`, which means the widget should fill up all available space in its enclosing container, after all other widgets are taken care of

The latter two flavors are the most common, as they are independent of screen size, allowing Android to adjust your view to fit the available space.

Weight

But, what happens if we have two widgets that should split the available free space? For example, suppose we have two multi-line fields in a column, and we want them to take up the remaining space in the column after all other widgets have been allocated their space.

To make this work, in addition to setting `android:layout_width` (for rows) or `android:layout_height` (for columns) to `fill_parent`, you must also set `android:layout_weight`. This property indicates what proportion of the free space should go to that widget. If you set `android:layout_weight` to be the same value for a pair of widgets (e.g., `1`), the free space will be split evenly between them. If you set it to be `1` for one widget and `2` for another widget, the second widget will use up twice the free space that the first widget does. And so on.

Gravity

By default, everything is left- and top-aligned. So, if you create a row of widgets via a horizontal `LinearLayout`, the row will start flush on the left side of the screen.

If that is not what you want, you need to specify a gravity. Using `android:layout_gravity` on a widget (or calling `setGravity()` at runtime on the widget's Java object), you can tell the widget and its container how to align it vis a vis the screen.

For a column of widgets, common gravity values are `left`, `center_horizontal`, and `right` for left-aligned, centered, and right-aligned widgets respectively.

For a row of widgets, the default is for them to be aligned so their texts are aligned on the baseline (the invisible line that letters seem to "sit on"), though you may wish to specify a gravity of `center_vertical` to center the widgets along the row's vertical midpoint.

Padding

By default, widgets are tightly packed next to each other. If you want to increase the whitespace between widgets, you will want to use the `android:padding` property (or by calling `setPadding()` at runtime on the widget's Java object).

The padding specifies how much space there is between the boundaries of the widget's "cell" and the actual widget contents. Padding is analogous to the margins on a word processing document – the page size might be 8.5"x11", but 1" margins would leave the actual text to reside within a 6.5"x9" area.

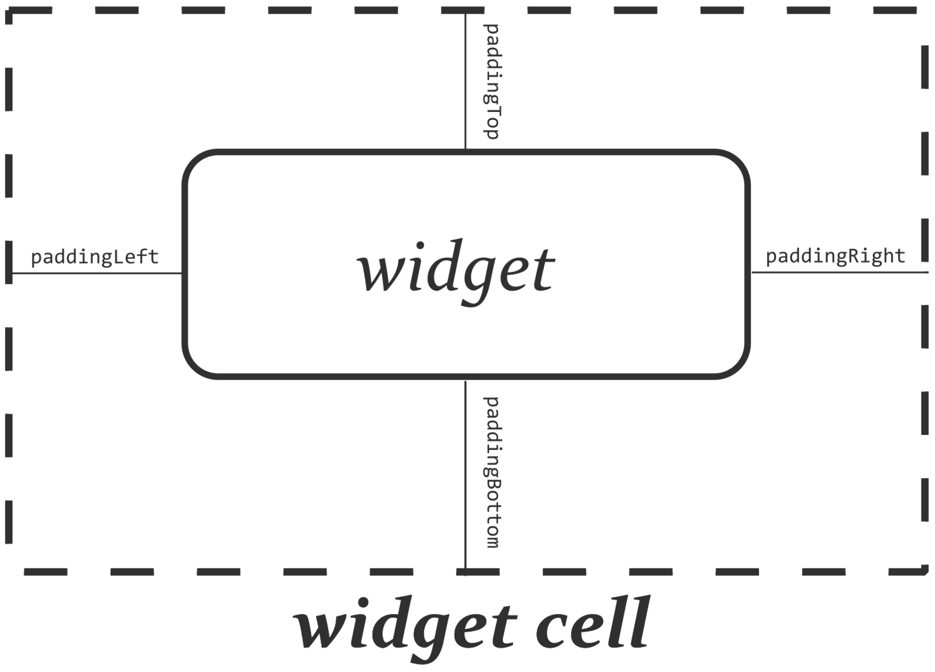


Figure 11. The relationship between a widget, its cell, and the padding values

The `android:padding` property allows you to set the same padding on all four sides of the widget, with the widget's contents itself centered within that padded-out area. If you want the padding to differ on different sides, use `android:paddingLeft`, `android:paddingRight`, `android:paddingTop`, and `android:paddingBottom`.

The value of the padding is a dimension, such as `5px` for 5 pixels' worth of padding.

Example

Let's look at an example (`Linear`) that shows `LinearLayout` properties set both in the XML layout file and at runtime.

Here is the layout:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <RadioGroup android:id="@+id/orientation"
    android:orientation="horizontal"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:padding="5px">
    <RadioButton
      android:id="@+id/horizontal"
      android:text="horizontal" />
    <RadioButton
      android:id="@+id/vertical"
      android:text="vertical" />
  </RadioGroup>
  <RadioGroup android:id="@+id/gravity"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:padding="5px">
    <RadioButton
      android:id="@+id/left"
      android:text="left" />
    <RadioButton
      android:id="@+id/center"
      android:text="center" />
    <RadioButton
      android:id="@+id/right"
      android:text="right" />
  </RadioGroup>
</LinearLayout>
```

Note that we have a `LinearLayout` wrapping two `RadioGroup` sets. `RadioGroup` is a subclass of `LinearLayout`, so our example demonstrates nested boxes as if they were all `LinearLayout` containers.

The top `RadioGroup` sets up a row (`android:orientation = "horizontal"`) of `RadioButton` widgets. The `RadioGroup` has `5px` of padding on all sides, separating it from the other `RadioGroup`. The width and height are both set to `wrap_content`, so the radio buttons will only take up the space that they need.

The bottom `RadioGroup` is a column (`android:orientation = "vertical"`) of three `RadioButton` widgets. Again, we have `5px` of padding on all sides and a "natural" height (`android:layout_height = "wrap_content"`). However, we have set android:layout_width to be fill_parent, meaning the column of radio buttons "claims" the entire width of the screen.

To adjust these settings at runtime based on user input, we need some Java code:

```java
package com.commonsware.android.containers;

import android.app.Activity;
import android.os.Bundle;
import android.text.TextWatcher;
import android.widget.LinearLayout;
import android.widget.RadioGroup;
import android.widget.EditText;

public class LinearLayoutDemo extends Activity
  implements RadioGroup.OnCheckedChangeListener {
  RadioGroup orientation;
  RadioGroup gravity;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    orientation=(RadioGroup)findViewById(R.id.orientation);
    orientation.setOnCheckedChangeListener(this);
    gravity=(RadioGroup)findViewById(R.id.gravity);
    gravity.setOnCheckedChangeListener(this);
  }

  public void onCheckedChanged(RadioGroup group, int checkedId) {
    if (group==orientation) {
      if (checkedId==R.id.horizontal) {
        orientation.setOrientation(LinearLayout.HORIZONTAL);
      }
      else {
        orientation.setOrientation(LinearLayout.VERTICAL);
      }
    }
    else if (group==gravity) {
      if (checkedId==R.id.left) {
        gravity.setGravity(0x03);    // left
      }
      else if (checkedId==R.id.center) {
        gravity.setGravity(0x01);    // center_horizontal
      }
      else if (checkedId==R.id.right) {
        gravity.setGravity(0x05);    // right
      }
    }
  }
}
```

In `onCreate()`, we look up our two `RadioGroup` containers and register a listener on each, so we are notified when the radio buttons change state (`setOnCheckedChangeListener(this)`). Since the activity implements `OnCheckedChangeListener`, the activity itself is the listener.

In `onCheckedChanged()` (the callback for the listener), we see which `RadioGroup` had a state change. If it was the orientation group, we adjust the orientation based on the user's selection. If it was the gravity group, we adjust the gravity based on the user's selection.

Here is the result when it is first launched inside the emulator:

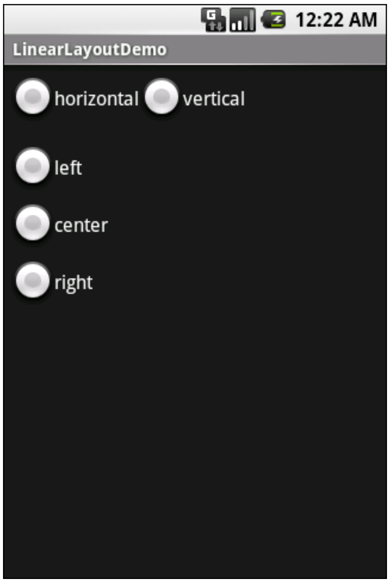


Figure 12. The LinearLayoutDemo sample application, as initially launched

If we toggle on the "vertical" radio button, the top `RadioGroup` adjusts to match:

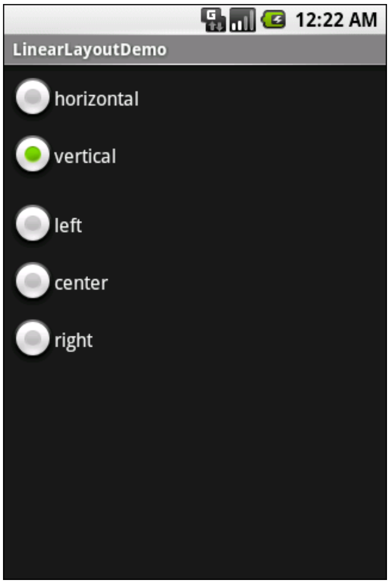


Figure 13. The same application, with the vertical radio button selected

If we toggle the "center" or "right" radio buttons, the bottom `RadioGroup` adjusts to match:

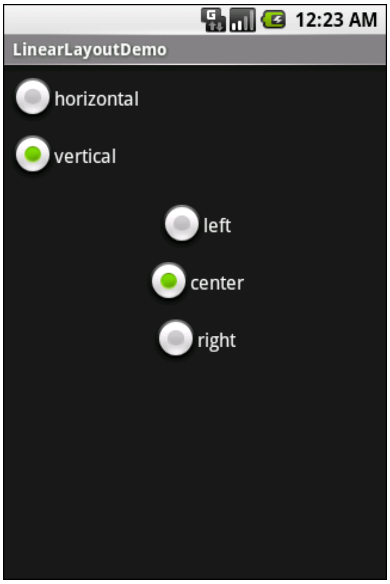


Figure 14. The same application, with the vertical and center radio buttons selected

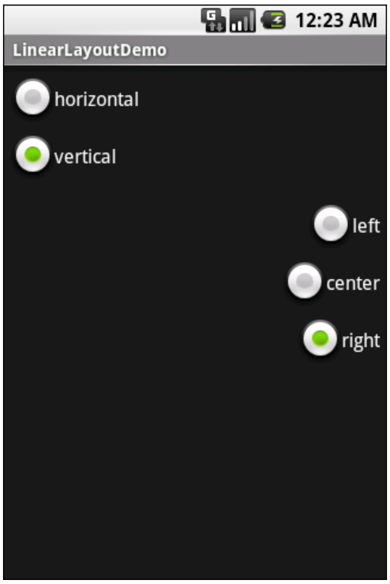


Figure 15. The same application, with the vertical and right radio buttons selected

All Things Are Relative

`RelativeLayout`, as the name suggests, lays out widgets based upon their relationship to other widgets in the container and the parent container. You can place Widget X below and to the left of Widget Y, or have Widget Z's bottom edge align with the bottom of the container, and so on.

This is reminiscent of James Elliot's RelativeLayout for use with Java/Swing.

Concepts and Properties

To make all this work, we need ways to reference other widgets within an XML layout file, plus ways to indicate the relative positions of those widgets.

Positions Relative to Container

The easiest relations to set up are tying a widget's position to that of its container:

- `android:layout_alignParentTop` says the widget's top should align with the top of the container
- `android:layout_alignParentBottom` says the widget's bottom should align with the bottom of the container
- `android:layout_alignParentLeft` says the widget's left side should align with the left side of the container
- `android:layout_alignParentRight` says the widget's right side should align with the right side of the container
- `android:layout_centerHorizontal` says the widget should be positioned horizontally at the center of the container
- `android:layout_centerVertical` says the widget should be positioned vertically at the center of the container
- `android:layout_centerInParent` says the widget should be positioned both horizontally and vertically at the center of the container

All of these properties take a simple boolean value (`true` or `false`).

Note that the padding of the widget is taken into account when performing these various alignments. The alignments are based on the widget's overall cell (combination of its natural space plus the padding).

Relative Notation in Properties

The remaining properties of relevance to `RelativeLayout` take as a value the identity of a widget in the container. To do this:

1. Put identifiers (`android:id` attributes) on all elements that you will need to address, of the form `@+id/...`

2. Reference other widgets using the same identifier value without the plus sign (`@id/...`)

For example, if Widget A is identified as `@+id/widget_a`, Widget B can refer to Widget A in one of its own properties via the identifier `@id/widget_a`.

Positions Relative to Other Widgets

There are four properties that control position of a widget vis a vis other widgets:

- `android:layout_above` indicates that the widget should be placed above the widget referenced in the property
- `android:layout_below` indicates that the widget should be placed below the widget referenced in the property
- `android:layout_toLeftOf` indicates that the widget should be placed to the left of the widget referenced in the property
- `android:layout_toRightOf` indicates that the widget should be placed to the right of the widget referenced in the property

Beyond those four, there are five additional properties that can control one widget's alignment relative to another:

- `android:layout_alignTop` indicates that the widget's top should be aligned with the top of the widget referenced in the property
- `android:layout_alignBottom` indicates that the widget's bottom should be aligned with the bottom of the widget referenced in the property
- `android:layout_alignLeft` indicates that the widget's left should be aligned with the left of the widget referenced in the property
- `android:layout_alignRight` indicates that the widget's right should be aligned with the right of the widget referenced in the property
- `android:layout_alignBaseline` indicates that the baselines of the two widgets should be aligned

The last one is useful for aligning labels and fields so that the text appears "natural". Since fields have a box around them and labels do not, `android:layout_alignTop` would align the top of the field's box with the top of the label, which will cause the text of the label to be higher on-screen than the text entered into the field.

So, if we want Widget B to be positioned to the right of Widget A, in the XML element for Widget B, we need to include `android:layout_toRight = "@id/widget_a"` (assuming `@id/widget_a` is the identity of Widget A).

Order of Evaluation

What makes this even more complicated is the order of evaluation. Android makes a single pass through your XML layout and computes the size and position of each widget in sequence. This has a few ramifications:

- You cannot reference a widget that has not been defined in the file yet
- You must be careful that any uses of `fill_parent` in `android:layout_width` or `android:layout_height` do not "eat up" all the space before subsequent widgets have been defined

Example

With all that in mind, let's examine a typical "form" with a field, a label, plus a pair of buttons labeled "OK" and "Cancel".

Here is the XML layout, pulled from the `Relative` sample project:

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="wrap_content"
  android:padding="5px">
  <TextView android:id="@+id/label"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="URL:"
    android:paddingTop="15px"/>
  <EditText
    android:id="@+id/entry"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:layout_toRightOf="@id/label"
    android:layout_alignBaseline="@id/label"/>
  <Button
    android:id="@+id/ok"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_below="@id/entry"
    android:layout_alignRight="@id/entry"
    android:text="OK" />
  <Button
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_toLeftOf="@id/ok"
    android:layout_alignTop="@id/ok"
    android:text="Cancel" />
</RelativeLayout>
```

First, we open up the `RelativeLayout`. In this case, we want to use the full width of the screen (`android:layout_width = "fill_parent"`), only as much height as we need (`android:layout_height = "wrap_content"`), and have a 5-pixel pad between the boundaries of the container and its contents (`android:padding = "5px"`).

Next, we define the label, which is fairly basic, except for its own 15-pixel padding (`android:padding = "15px"`). More on that in a moment.

After that, we add in the field. We want the field to be to the right of the label, have their texts aligned along the baseline, and for the field to take up the rest of this "row" in the layout. Those are handled by three properties:

- `android:layout_toRight = "@id/label"`
- `android:layout_alignBaseline = "@id/label"`
- `android:layout_alignBaseline = "@id/label"`

If we were to skip the 16-pixel padding on the label, we would find that the top of the field is clipped off. That's because of the 16-pixel padding on the container itself. The `android:layout_alignBaseline = "@id/label"` simply aligns the baselines of the label and field. The label, by default, has its top aligned with the top of the parent. But the label is shorter than the field because of the field's box. Since the field is dependent on the label's position, and the label's position is already defined (because it appeared first in the XML), the field winds up being too high and has the top of its box clipped off by the container's padding.

You may find yourself running into these sorts of problems as you try to get your `RelativeLayout` to behave the way you want it to.

The solution to this conundrum, used in the XML layout shown above, is to give the label 16 pixels' worth of padding on the top. This pushes the label down far enough that the field will not get clipped.

Here are some "solutions" that do not work:

- You cannot use `android:layout_alignParentTop` on the field, because you cannot have two properties that both attempt to set the vertical position of the field. In this case, `android:layout_alignParentTop` conflicts with the later `android:layout_alignBaseline = "@id/label"` property, and the last one in wins. So, you either have the top aligned properly or the baselines aligned properly, but not both.
- You cannot define the field first, then put the label to the left of the field, because you cannot "forward reference" labeled widgets – you must define the widget before you can reference it by its ID.

Going back to the example, the OK button is set to be below the field (`android:layout_below = "@id/entry"`) and have its right side align with the right side of the field (`android:layout_alignRight = "@id/entry"`). The Cancel button is set to be to the left of the OK button (`android:layout_toLeft = "@id/ok"`) and have its top aligned with the OK button (`android:layout_alignTop = "@id/ok"`).

With no changes to the auto-generated Java code, the emulator gives us:

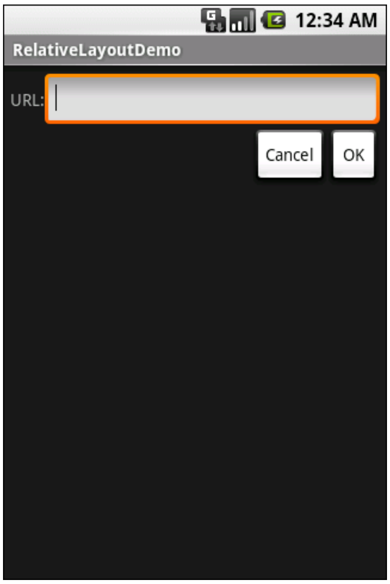


Figure 16. The RelativeLayoutDemo sample application

Tabula Rasa

If you like HTML tables, spreadsheet grids, and the like, you will like Android's `TableLayout` – it allows you to position your widgets in a grid to your specifications. You control the number of rows and columns, which columns might shrink or stretch to accommodate their contents, and so on.

`TableLayout` works in conjunction with `TableRow`. `TableLayout` controls the overall behavior of the container, with the widgets themselves poured into one or more `TableRow` containers, one per row in the grid.

Concepts and Properties

For all this to work, we need to figure out how widgets work with rows and columns, plus how to handle widgets that live outside of rows.

Putting Cells in Rows

Rows are declared by you, the developer, by putting widgets as children of a `TableRow` inside the overall `TableLayout`. You, therefore, control directly how many rows appear in the table.

The number of columns are determined by Android; you control the number of columns in an indirect fashion.

First, there will be at least one column per widget in your longest row. So if you have three rows, one with two widgets, one with three widgets, and one with four widgets, there will be at least four columns.

However, a widget can take up more than one column by including the `android:layout_span` property, indicating the number of columns the widget spans. This is akin to the `colspan` attribute one finds in table cells in HTML:

```
<TableRow>
  <TextView android:text="URL:" />
  <EditText
    android:id="@+id/entry"
    android:layout_span="3"/>
</TableRow>
```

In the above XML layout fragment, the field spans three columns.

Ordinarily, widgets are put into the first available column. In the above fragment, the label would go in the first column (column `0`, as columns are counted starting from `0`), and the field would go into a spanned set of three columns (columns `1` through `3`). However, you can put a widget into a different column via the `android:layout_column` property, specifying the `0`-based column the widget belongs to:

```
<TableRow>
  <Button
    android:id="@+id/cancel"
    android:layout_column="2"
    android:text="Cancel" />
  <Button android:id="@+id/ok" android:text="OK" />
</TableRow>
```

In the preceding XML layout fragment, the Cancel button goes in the third column (column `2`). The OK button then goes into the next available column, which is the fourth column.

Non-Row Children of TableLayout

Normally, `TableLayout` contains only `TableRow` elements as immediate children. However, it is possible to put other widgets in between rows. For those widgets, `TableLayout` behaves a bit like `LinearLayout` with vertical orientation. The widgets automatically have their width set to `fill_parent`, so they will fill the same space that the longest row does.

One pattern for this is to use a plain `View` as a divider (e.g., `<View android:layout_height = "2px" android:background = "#0000FF" />` as a two-pixel-high blue bar across the width of the table).

Stretch, Shrink, and Collapse

By default, each column will be sized according to the "natural" size of the widest widget in that column (taking spanned columns into account). Sometimes, though, that does not work out very well, and you need more control over column behavior.

You can place an `android:stretchColumns` property on the `TableLayout`. The value should be a single column number (again, `0`-based) or a comma-delimited list of column numbers. Those columns will be stretched to take up any available space yet on the row. This helps if your content is narrower than the available space.

Conversely, you can place a `android:shrinkColumns` property on the `TableLayout`. Again, this should be a single column number or a comma-delimited list of column numbers. The columns listed in this property will try to word-wrap their contents to reduce the effective width of the column – by default, widgets are not word-wrapped. This helps if you have columns with potentially wordy content that might cause some columns to be pushed off the right side of the screen.

You can also leverage an `android:collapseColumns` property on the `TableLayout`, again with a column number or comma-delimited list of column numbers. These columns will start out "collapsed", meaning they will be part of the table information but will be invisible. Programmatically, you can collapse and un-collapse columns by calling `setColumnCollapsed()` on the `TableLayout`. You might use this to allow users to control which columns are of importance to them and should be shown versus which ones are less important and can be hidden.

You can also control stretching and shrinking at runtime via `setColumnStretchable()` and `setColumnShrinkable()`.

Example

The XML layout fragments shown above, when combined, give us a `TableLayout` rendition of the "form" we created for `RelativeLayout`, with the addition of a divider line between the label/field and the two buttons (found in the `Table` demo):

```
<?xml version="1.0" encoding="utf-8"?>
<TableLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  android:stretchColumns="1">
  <TableRow>
    <TextView
        android:text="URL:" />
    <EditText android:id="@+id/entry"
      android:layout_span="3"/>
  </TableRow>
  <View
    android:layout_height="2px"
    android:background="#0000FF" />
  <TableRow>
    <Button android:id="@+id/cancel"
      android:layout_column="2"
      android:text="Cancel" />
    <Button android:id="@+id/ok"
      android:text="OK" />
  </TableRow>
</TableLayout>
```

When compiled against the generated Java code and run on the emulator, we get:

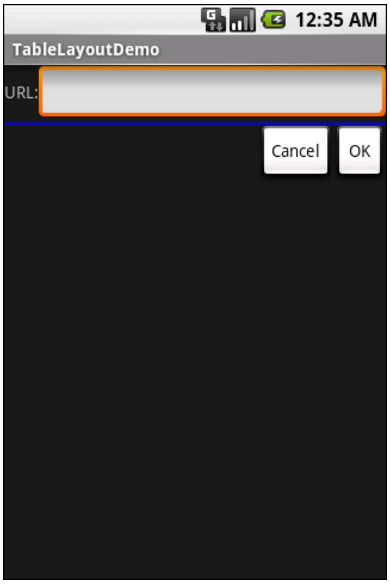


Figure 17. The TableLayoutDemo sample application

Scrollwork

Phone screens tend to be small, which requires developers to use some tricks to present a lot of information in the limited available space. One trick for doing this is to use scrolling, so only part of the information is visible at one time, the rest available via scrolling up or down.

`ScrollView` is a container that provides scrolling for its contents. You can take a layout that might be too big for some screens, wrap it in a `ScrollView`, and still use your existing layout logic. It just so happens that the user can only see part of your layout at one time, the rest available via scrolling.

For example, here is a `ScrollView` used in an XML layout file (from the `Scroll` demo):

```
<?xml version="1.0" encoding="utf-8"?>
<ScrollView
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="wrap_content">
  <TableLayout
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:stretchColumns="0">
    <TableRow>
      <View
        android:layout_height="80px"
        android:background="#000000"/>
      <TextView android:text="#000000"
        android:paddingLeft="4px"
        android:layout_gravity="center_vertical" />
    </TableRow>
    <TableRow>
      <View
        android:layout_height="80px"
        android:background="#440000" />
      <TextView android:text="#440000"
        android:paddingLeft="4px"
        android:layout_gravity="center_vertical" />
    </TableRow>
    <TableRow>
      <View
        android:layout_height="80px"
        android:background="#884400" />
      <TextView android:text="#884400"
        android:paddingLeft="4px"
        android:layout_gravity="center_vertical" />
    </TableRow>
    <TableRow>
      <View
        android:layout_height="80px"
        android:background="#aa8844" />
      <TextView android:text="#aa8844"
        android:paddingLeft="4px"
        android:layout_gravity="center_vertical" />
    </TableRow>
    <TableRow>
      <View
        android:layout_height="80px"
        android:background="#ffaa88" />
      <TextView android:text="#ffaa88"
        android:paddingLeft="4px"
        android:layout_gravity="center_vertical" />
    </TableRow>
    <TableRow>
      <View
        android:layout_height="80px"
        android:background="#ffffaa" />
      <TextView android:text="#ffffaa"
        android:paddingLeft="4px"
        android:layout_gravity="center_vertical" />
    </TableRow>
    <TableRow>
      <View
        android:layout_height="80px"
        android:background="#ffffff" />
      <TextView android:text="#ffffff"
        android:paddingLeft="4px"
        android:layout_gravity="center_vertical" />
    </TableRow>
  </TableLayout>
</ScrollView>
```

Without the `ScrollView`, the table would take up at least 560 pixels (7 rows at 80 pixels each, based on the `View` declarations). There may be some devices with screens capable of showing that much information, but many will be smaller. The `ScrollView` lets us keep the table as-is, but only present part of it at a time.

On the stock Android emulator, when the activity is first viewed, you see:

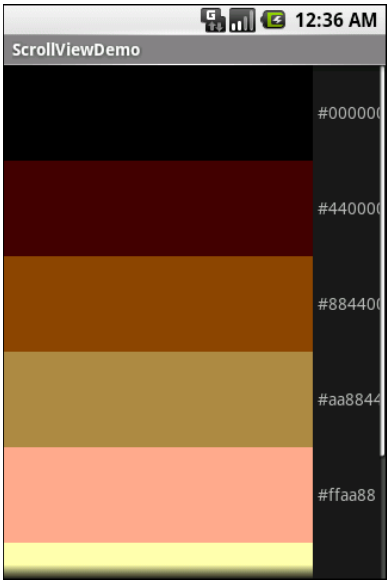


Figure 18. The ScrollViewDemo sample application

Notice how only five rows and part of the sixth are visible. By pressing the up/down buttons on the directional pad, you can scroll up and down to see the remaining rows. Also note how the right side of the content gets clipped by the scrollbar – be sure to put some padding on that side or otherwise ensure your own content does not get clipped in that fashion.

CHAPTER 8

Using Selection Widgets

Back in the chapter on basic widgets, you saw how fields could have constraints placed upon them to limit possible input, such as numeric-only or phone-number-only. These sorts of constraints help users "get it right" when entering information, particularly on a mobile device with cramped keyboards.

Of course, the ultimate in constrained input is to select a choice from a set of items, such as the radio buttons seen earlier. Classic UI toolkits have listboxes, comboboxes, drop-down lists, and the like for that very purpose. Android has many of the same sorts of widgets, plus others of particular interest for mobile devices (e.g., the `Gallery` for examining saved photos).

Moreover, Android offers a flexible framework for determining what choices are available in these widgets. Specifically, Android offers a framework of data adapters that provide a common interface to selection lists ranging from static arrays to database contents. Selection views – widgets for presenting lists of choices – are handed an adapter to supply the actual choices.

Adapting to the Circumstances

In the abstract, adapters provide a common interface to multiple disparate APIs. More specifically, in Android's case, adapters provide a common interface to the data model behind a selection-style widget, such as a listbox.

This use of Java interfaces is fairly common (e.g., Java/Swing's model adapters for `JTable`), and Java is far from the only environment offering this sort of abstraction (e.g., Flex's XML data-binding framework accepts XML inlined as static data or retrieved from the Internet).

Android's adapters are responsible for providing the roster of data for a selection widget plus converting individual elements of data into specific views to be displayed inside the selection widget. The latter facet of the adapter system may sound a little odd, but in reality it is not that different from other GUI toolkits' ways of overriding default display behavior. For example, in Java/Swing, if you want a `JList`-backed listbox to actually be a checklist (where individual rows are a checkbox plus label, and clicks adjust the state of the checkbox), you inevitably wind up calling `setCellRenderer()` to supply your own `ListCellRenderer`, which in turn converts strings for the list into `JCheckBox`-plus-`JLabel` composite widgets.

Using ArrayAdapter

The easiest adapter to use is `ArrayAdapter` – all you need to do is wrap one of these around a Java array or `java.util.List` instance, and you have a fully-functioning adapter:

```
String[] items={"this", "is", "a",
                "really", "silly", "list"};
new ArrayAdapter<String>(this,
  android.R.layout.simple_list_item_1, items);
```

The `ArrayAdapter` constructor takes three parameters:

- The `Context` to use (typically this will be your activity instance)
- The resource ID of a view to use (such as a built-in system resource ID, as shown above)
- The actual array or list of items to show

By default, the `ArrayAdapter` will invoke `toString()` on the objects in the list and wrap each of those strings in the view designated by the supplied resource. `android.R.layout.simple_list_item_1` simply turns those strings into TextView objects. Those TextView widgets, in turn, will be shown the list or spinner or whatever widget uses this ArrayAdapter.

You can subclass ArrayAdapter and override getView() to "roll your own" views:

```
public View getView(int position, View convertView,
                     ViewGroup parent) {
  if (convertView==null) {
    convertView=new TextView(this);
  }

  convertView.setText(buildStringFor(position));

  return(convertView);
}
```

Here, getView() receives three parameters:

- The index of the item in the array to show in the view
- An existing view to update with the data for this position (if one already existed, such as from scrolling – if null, you need to instantiate your own)
- The widget that will contain this view, if needed for instantiating the view

In the example shown above, the adapter still returns a TextView, but uses a different behavior for determining the string that goes in the view. A later chapter will cover fancier ListViews.

Other Key Adapters

Here are some other adapters in Android that you will likely use, some of which will be covered in greater detail later in this book:

- CursorAdapter converts a Cursor, typically from a content provider, into something that can be displayed in a selection view
- SimpleAdapter converts data found in XML resources

- ActivityAdapter and ActivityIconAdapter provide you with the names or icons of activities that can be invoked upon a particular intent

Lists of Naughty and Nice

The classic listbox widget in Android is known as ListView. Include one of these in your layout, invoke setAdapter() to supply your data and child views, and attach a listener via setOnItemSelectedListener() to find out when the selection has changed. With that, you have a fully-functioning listbox.

However, if your activity is dominated by a single list, you might well consider creating your activity as a subclass of ListActivity, rather than the regular Activity base class. If your main view is just the list, you do not even need to supply a layout – ListActivity will construct a full-screen list for you. If you do want to customize the layout, you can, so long as you identify your ListView as @android:id/list, so ListActivity knows which widget is the main list for the activity.

For example, here is a layout pulled from the List sample project:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent" >
  <TextView
    android:id="@+id/selection"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"/>
  <ListView
    android:id="@android:id/list"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:drawSelectorOnTop="false"
    />
</LinearLayout>
```

It is just a list with a label on top to show the current selection.

The Java code to configure the list and connect the list with the label is:

```
public class ListViewDemo extends ListActivity {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue", "purus"};

  /** Called with the activity is first created. */
  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    setListAdapter(new ArrayAdapter<String>(this,
                       android.R.layout.simple_list_item_1,
                       items));
    selection=(TextView)findViewById(R.id.selection);
  }

  public void onListItemClick(ListView parent, View v, int position,
                               long id) {
   selection.setText(items[position]);
  }
}
```

With `ListActivity`, you can set the list adapter via `setListAdapter()` – in this case, providing an `ArrayAdapter` wrapping an array of nonsense strings. To find out when the list selection changes, override `onListItemClick()` and take appropriate steps based on the supplied child view and position (in this case, updating the label with the text for that position).

The results?

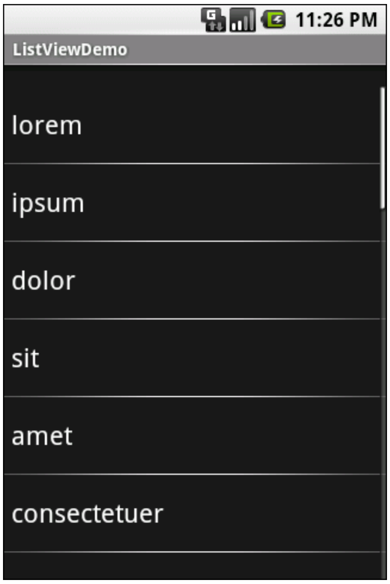


Figure 19. The ListViewDemo sample application

Spin Control

In Android, the `Spinner` is the equivalent of the drop-down selector you might find in other toolkits (e.g., `JComboBox` in Java/Swing). Pressing the left and right buttons on the D-pad iterates over children. Pressing the center button on the D-pad displays, by default, a small list (akin to a `ListView`) appears to show a few items at a time, instead of the one-item-at-a-time perspective the unexpanded `Spinner` itself provides.

As with `ListView`, you provide the adapter for data and child views via `setAdapter()` and hook in a listener object for selections via `setOnItemSelectedListener()`.

If you want to tailor the view used when displaying the drop-down perspective, you need to configure the adapter, not the `Spinner` widget. Use the `setDropDownViewResource()` method to supply the resource ID of the view to use.

For example, culled from the `Spinner` sample project, here is an XML layout for a simple view with a `Spinner`:

```xml
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <TextView
    android:id="@+id/selection"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    />
  <Spinner android:id="@+id/spinner"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:drawSelectorOnTop="true"
  />
</LinearLayout>
```

This is the same view as shown in the previous section, just with a `Spinner` instead of a `ListView`. The `Spinner` property `android:drawSelectorOnTop` controls whether the arrows are drawn on the selector button on the right side of the `Spinner` UI.

To populate and use the `Spinner`, we need some Java code:

```java
public class SpinnerDemo extends Activity
  implements AdapterView.OnItemSelectedListener {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue", "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    selection=(TextView)findViewById(R.id.selection);

    Spinner spin=(Spinner)findViewById(R.id.spinner);
    spin.setOnItemSelectedListener(this);

    ArrayAdapter<String> aa=new ArrayAdapter<String>(this,
                             android.R.layout.simple_spinner_item,
                              items);

    aa.setDropDownViewResource(
      android.R.layout.simple_spinner_dropdown_item);
    spin.setAdapter(aa);
  }

  public void onItemSelected(AdapterView parent, View v,
                                int position, long id) {
    selection.setText(items[position]);
  }

  public void onNothingSelected(AdapterView parent) {
    selection.setText("");
  }
}
```

Here, we attach the activity itself as the selection listener (`spin.setOnItemSelectedListener(this)`). This works because the activity implements the `OnItemSelectedListener` interface. We configure the adapter not only with the list of fake words, but also with a specific resource to use for the drop-down view (via `aa.setDropDownViewResource()`). Also note the use of `android.R.layout.simple_spinner_item` as the built-in `View` for showing items in the spinner itself. Finally, we implement the callbacks required by `OnItemSelectedListener` to adjust the selection label based on user input.

What we get is:

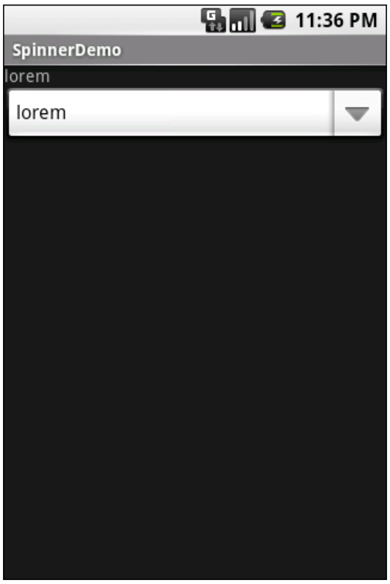


Figure 20. The SpinnerDemo sample application, as initially launched

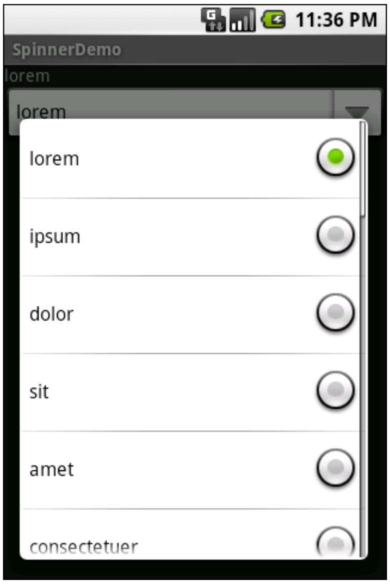


Figure 21. The same application, with the spinner drop-down list displayed

Grid Your Lions (Or Something Like That...)

As the name suggests, `GridView` gives you a two-dimensional grid of items to choose from. You have moderate control over the number and size of the columns; the number of rows is dynamically determined based on the number of items the supplied adapter says are available for viewing.

There are a few properties which, when combined, determine the number of columns and their sizes:

- `android:numColumns` spells out how many columns there are, or, if you supply a value of `auto_fit`, Android will compute the number of columns based on available space and the properties listed below.
- `android:verticalSpacing` and its counterpart `android:horizontalSpacing` indicate how much whitespace there should be between items in the grid.
- `android:columnWidth` indicates how many pixels wide each column should be.
- `android:stretchMode` indicates, for grids with `auto_fit` for `android:numColumns`, what should happen for any available space not taken up by columns or spacing – this should be `columnWidth` to have the columns take up available space or `spacingWidth` to have the whitespace between columns absorb extra space. For example, suppose the screen is 320 pixels wide, and we have `android:columnWidth` set to `100` and `android:horizontalSpacing` set to `5`. Three columns would use 310 pixels (three columns of 100 pixels and two whitespaces of 5 pixels). With `android:stretchMode` set to `columnWidth`, the three columns will each expand by 3-4 pixels to use up the remaining 10 pixels. With `android:stretchMode` set to `spacingWidth`, the two whitespaces will each grow by 5 pixels to consume the remaining 10 pixels.

Otherwise, the `GridView` works much like any other selection widget – use `setAdapter()` to provide the data and child views, invoke `setOnItemSelectedListener()` to register a selection listener, etc.

For example, here is a XML layout from the `Grid` sample project, showing a `GridView` configuration:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <TextView
    android:id="@+id/selection"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    />
  <GridView
    android:id="@+id/grid"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:verticalSpacing="35px"
    android:horizontalSpacing="5px"
    android:numColumns="auto_fit"
    android:columnWidth="100px"
    android:stretchMode="columnWidth"
    android:gravity="center"
    />
</LinearLayout>
```

For this grid, we take up the entire screen except for what our selection label requires. The number of columns is computed by Android (`android:numColumns = "auto_fit"`) based on 5-pixel horizontal spacing (`android:horizontalSpacing = "5"`), 100-pixel columns (`android:columnWidth = "100"`), with the columns absorbing any "slop" width left over (`android:stretchMode = "columnWidth"`).

The Java code to configure the `GridView` is:

```
public class GridDemo extends Activity
  implements AdapterView.OnItemSelectedListener {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue", "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    selection=(TextView)findViewById(R.id.selection);

    GridView g=(GridView) findViewById(R.id.grid);
    g.setAdapter(new FunnyLookingAdapter(this,
                       android.R.layout.simple_list_item_1,
                       items));
    g.setOnItemSelectedListener(this);
  }

  public void onItemSelected(AdapterView parent, View v,
                             int position, long id) {
    selection.setText(items[position]);
  }

  public void onNothingSelected(AdapterView parent) {
    selection.setText("");
  }

  private class FunnyLookingAdapter extends ArrayAdapter {
    Context ctxt;

    FunnyLookingAdapter(Context ctxt, int resource,
                       String[] items) {
      super(ctxt, resource, items);

      this.ctxt=ctxt;
    }

    public View getView(int position, View convertView,
                         ViewGroup parent) {
      TextView label=(TextView)convertView;

      if (convertView==null) {
        convertView=new TextView(ctxt);
        label=(TextView)convertView;
      }

      label.setText(items[position]);

      return(convertView);
    }
  }
}
```

For the grid cells, rather than using auto-generated `TextView` widgets as in the previous sections, we create our own views, by subclassing `ArrayAdapter` and overriding `getView()`. In this case, we wrap the funny-looking strings in our own `TextView` widgets, just to be different. If `getView()` receives a

`TextView`, we just reset its text; otherwise, we create a new `TextView` instance and populate it.

With the 35-pixel vertical spacing from the XML layout (`android:verticalSpacing = "35"`), the grid overflows the boundaries of the emulator's screen:

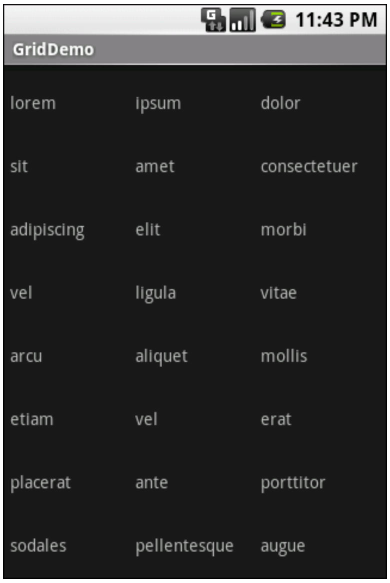


Figure 22. The GridDemo sample application, as initially launched

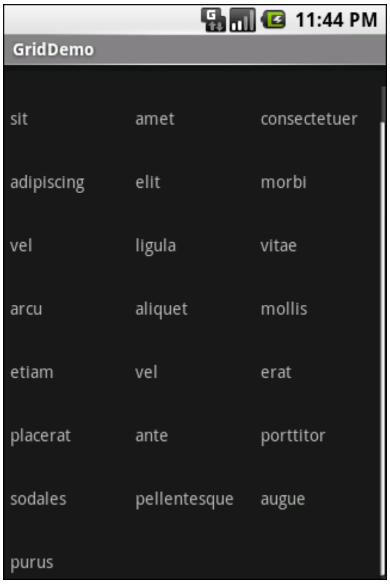


Figure 23. The same application, scrolled to the bottom of the grid

Fields: Now With 35% Less Typing!

The `AutoCompleteTextView` is sort of a hybrid between the `EditText` (field) and the `Spinner`. With auto-completion, as the user types, the text is treated as a prefix filter, comparing the entered text as a prefix against a list of candidates. Matches are shown in a selection list that, like with `Spinner`, folds down from the field. The user can either type out an entry (e.g., something not in the list) or choose an entry from the list to be the value of the field.

`AutoCompleteTextView` subclasses `EditText`, so you can configure all the standard look-and-feel aspects, such as font face and color.

In addition, `AutoCompleteTextView` has a `android:completionThreshold` property, to indicate the minimum number of characters a user must enter before the list filtering begins.

You can give `AutoCompleteTextView` an adapter containing the list of candidate values via `setAdapter()`. However, since the user could type something not in the list, `AutoCompleteTextView` does not support selection listeners. Instead, you can register a `TextWatcher`, like you can with any `EditText`, to be notified when the text changes. These events will occur either because of manual typing or from a selection from the drop-down list.

Below we have a familiar-looking XML layout, this time containing an `AutoCompleteTextView` (pulled from the `AutoComplete` sample application):

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <TextView
    android:id="@+id/selection"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    />
  <AutoCompleteTextView android:id="@+id/edit"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:completionThreshold="3"/>
</LinearLayout>
```

The corresponding Java code is:

```
public class AutoCompleteDemo extends Activity
  implements TextWatcher {
  TextView selection;
  AutoCompleteTextView edit;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue", "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    selection=(TextView)findViewById(R.id.selection);
    edit=(AutoCompleteTextView)findViewById(R.id.edit);
    edit.addTextChangedListener(this);

    edit.setAdapter(new ArrayAdapter<String>(this,
                             android.R.layout.simple_list_item_1,
                             items));
  }

  public void onTextChanged(CharSequence s, int start, int before,
                                int count) {
    selection.setText(edit.getText());
  }

  public void beforeTextChanged(CharSequence s, int start,
                                    int count, int after) {
    // needed for interface, but not used
  }

  public void afterTextChanged(Editable s) {
    // needed for interface, but not used
  }
}
```

This time, our activity implements `TextWatcher`, which means our callbacks are `onTextChanged()` and `beforeTextChanged()`. In this case, we are only interested in the former, and we update the selection label to match the `AutoCompleteTextView`'s current contents.

Here we have the results:

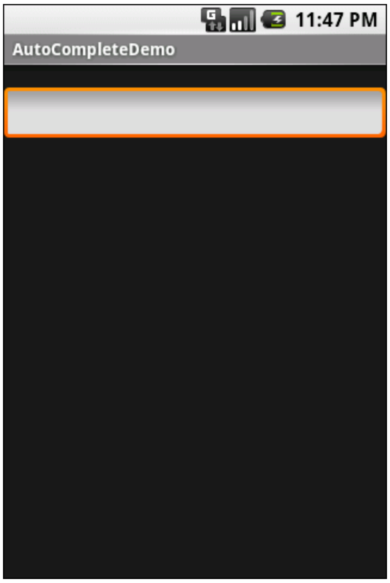


Figure 24. The AutoCompleteDemo sample application, as initially launched

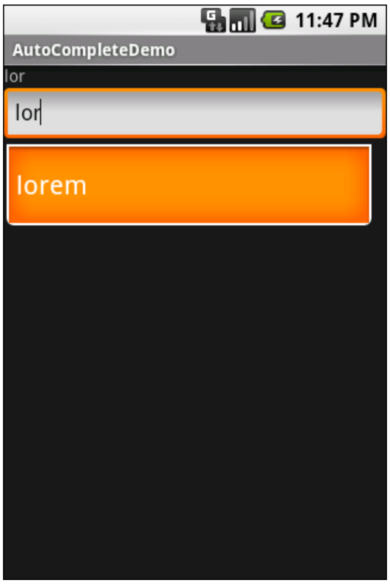


Figure 25. The same application, after a few matching letters were entered, showing the auto-complete drop-down

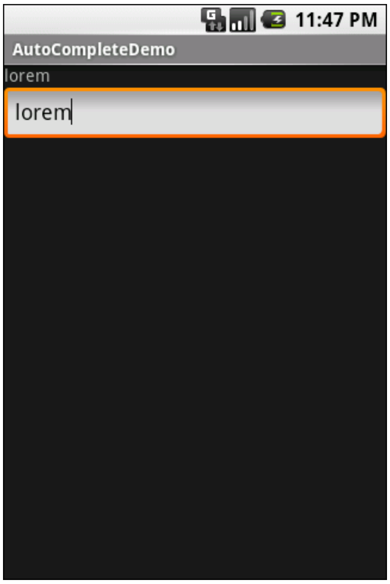


Figure 26. The same application, after the auto-complete value was selected

Galleries, Give Or Take The Art

The `Gallery` widget is not one ordinarily found in GUI toolkits. It is, in effect, a horizontally-laid-out listbox. One choice follows the next across the horizontal plane, with the currently-selected item highlighted. On an Android device, one rotates through the options through the left and right D-pad buttons.

Compared to the `ListView`, the `Gallery` takes up less screen space while still showing multiple choices at one time (assuming they are short enough). Compared to the `Spinner`, the `Gallery` always shows more than one choice at a time.

The quintessential example use for the `Gallery` is image preview – given a collection of photos or icons, the `Gallery` lets people preview the pictures in the process of choosing one.

Code-wise, the `Gallery` works much like a `Spinner` or `GridView`. In your XML layout, you have a few properties at your disposal:

- `android:spacing` controls the number of pixels between entries in the list
- `android:spinnerSelector` controls what is used to indicate a selection – this can either be a reference to a `Drawable` (see the resources chapter) or an RGB value in `#AARRGGBB` or similar notation
- `android:drawSelectorOnTop` indicates if the selection bar (or `Drawable`) should be drawn before (`false`) or after (`true`) drawing the selected child – if you choose `true`, be sure that your selector has sufficient transparency to show the child through the selector, otherwise users will not be able to read the selection

CHAPTER 9

Getting Fancy With Lists

The humble `ListView` is one of the most important widgets in all of Android, simply because it is used so frequently. Whether choosing a contact to call or an email message to forward or an ebook to read, `ListView` widgets are employed in a wide range of activities.

Of course, it would be nice if they were more than just plain text.

The good news is that they can be as fancy as you want, within the limitations of a mobile device's screen, of course. However, making them fancy takes some work and some features of Android that we will cover in this chapter.

The material in this chapter is based on the author's posts to the Building 'Droids column on AndroidGuys.com.

Getting To First Base

The classic Android `ListView` is a plain list of text — solid but uninspiring. This is because all we have handed to the `ListView` is a bunch of words in an array, and told Android to use a simple built-in layout for pouring those words into a list.

However, you can have a list whose rows are made up of icons, or icons and text, or checkboxes and text, or whatever you want. It is merely a matter of supplying enough data to the adapter and helping the adapter to create a richer set of `View` objects for each row.

For example, suppose you want a `ListView` whose entries are made up of an icon, followed by some text. You could construct a layout for the row that looks like this, found in the `Static` sample project:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="wrap_content"
  android:orientation="horizontal"
>
  <ImageView
    android:id="@+id/icon"
    android:layout_width="22px"
    android:paddingLeft="2px"
    android:paddingRight="2px"
    android:paddingTop="2px"
    android:layout_height="wrap_content"
    android:src="@drawable/ok"
  />
  <TextView
    android:id="@+id/label"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:textSize="44sp"
  />
</LinearLayout>
```

This layout uses a `LinearLayout` to set up a row, with the icon on the left and the text (in a nice big font) on the right.

By default, though, Android has no idea that you want to use this layout with your `ListView`. To make the connection, you need to supply your `Adapter` with the resource ID of the custom layout shown above:

```
public class StaticDemo extends ListActivity {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue",
        "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    setListAdapter(new ArrayAdapter<String>(this,
                       R.layout.row, R.id.label,
                       items));
    selection=(TextView)findViewById(R.id.selection);
  }

  public void onListItemClick(ListView parent, View v,
                             int position,  long id) {
   selection.setText(items[position]);
  }
}
```

This follows the general structure for the previous ListView sample.

The key in this example is that you have told `ArrayAdapter` that you want to use your custom layout (`R.layout.row`) and that the `TextView` where the word should go is known as `R.id.label` within that custom layout. Remember: to reference a layout (`row.xml`), use `R.layout` as a prefix on the base name of the layout XML file (`R.layout.row`).

The result is a `ListView` with icons down the left side. In particular, all the icons are the same:

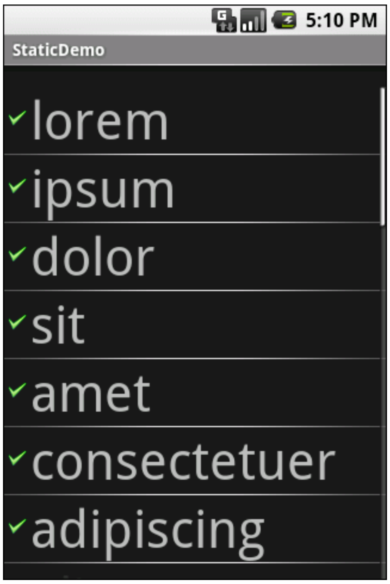


Figure 27. The StaticDemo application

A Dynamic Presentation

This technique – supplying an alternate layout to use for rows – handles simple cases very nicely. However, it falls down when you have more complicated scenarios for your rows, such as:

- Not every row uses the same layout (e.g., some have one line of text, others have two)
- You need to configure the widgets in the rows (e.g., different icons for different cases)

In those cases, the better option is to create your own subclass of your desired `Adapter`, override `getView()`, and construct your rows yourself. The `getView()` method is responsible for returning a `View`, representing the row for the supplied position in the adapter data.

For example, let's rework the above code to use `getView()`, so we can have different icons for different rows – in this case, one icon for short words and one for long words (from the `Dynamic` sample project):

```
public class DynamicDemo extends ListActivity {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue",
          "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    setListAdapter(new IconicAdapter(this));
    selection=(TextView)findViewById(R.id.selection);
  }

  public void onListItemClick(ListView parent, View v,
                              int position, long id) {
   selection.setText(items[position]);
  }

  class IconicAdapter extends ArrayAdapter {
    Activity context;

    IconicAdapter(Activity context) {
      super(context, R.layout.row, items);

      this.context=context;
    }

    public View getView(int position, View convertView,
                        ViewGroup parent) {
      LayoutInflater inflater=context.getLayoutInflater();
      View row=inflater.inflate(R.layout.row, null);
      TextView label=(TextView)row.findViewById(R.id.label);

      label.setText(items[position]);

      if (items[position].length()>4) {
        ImageView icon=(ImageView)row.findViewById(R.id.icon);

        icon.setImageResource(R.drawable.delete);
      }

      return(row);
    }
  }
}
```

The theory is that we override `getView()` and return rows based on which object is being displayed, where the object is indicated by a position index into the `Adapter`. However, if you look at the implementation shown above, you will see a reference to a `ViewInflate` class...and that concept takes a little bit of an explanation.

A Sidebar About Inflation

In this case, "inflation" means the act of converting an XML layout specification into the actual tree of `View` objects the XML represents. This is undoubtedly a tedious bit of code: take an element, create an instance of the specified `View` class, walk the attributes, convert those into property setter calls, iterate over all child elements, lather, rinse, repeat.

The good news is that the fine folk on the Android team wrapped all that up into a class called `LayoutInflater` that we can use ourselves. When it comes to fancy lists, for example, we will want to inflate `Views` for each row shown in the list, so we can use the convenient shorthand of the XML layout to describe what the rows are supposed to look like.

In the sample shown above, we inflate our `R.layout.row` layout we created in the previous section. This gives us a `View` object back which, in reality, is our `LinearLayout` with an `ImageView` and a `TextView`, just as `R.layout.row` specifies. However, rather than having to create all those objects ourselves and wire them together, the XML and `LayoutInflater` handle the "heavy lifting" for us.

And Now, Back To Our Story

So we have used `LayoutInflater` to give us a `View` representing the row. This row is "empty", since the static layout file has no idea what actual data goes into the row. It is our job to customize and populate the row as we see fit before returning it. So, we:

- Fill in the text label into our label widget, using the word at the supplied position
- See if the word is longer than four characters and, if so, we find our `ImageView` icon widget and replace the stock resource with a different one

Now, we have a ListView with different icons based upon context of that specific entry in the list:

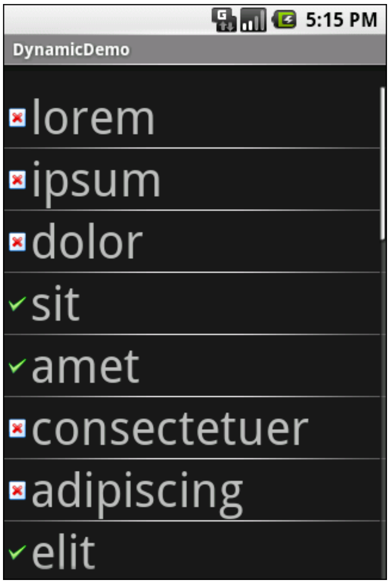


Figure 28. The DynamicDemo application

Obviously, this was a fairly contrived example, but you can see where this technique could be used to customize rows based on any sort of criteria, such as other columns in a returned Cursor.

Better. Stronger. Faster.

The getView() implementation shown above works, but is inefficient. Every time the user scrolls, we have to create a bunch of new View objects to accommodate the newly-shown rows. And, since the Android framework does not cache existing View objects itself, we wind up making new row View objects even for rows we just created a second or two ago.

This is bad.

It might be bad for the immediate user experience, if the list appears to be sluggish. More likely, though, it will be bad due to battery usage – every bit of CPU that is used eats up the battery. This is compounded by the extra work the garbage collector needs to do to get rid of all those extra objects you create. So the less efficient your code, the more quickly the phone's battery will be drained, and the less happy the user will be.

And you want happy users, right?

So, let us take a look at a few tricks to make your fancy `ListView` widgets more efficient.

Using convertView

The `getView()` method receives, as one of its parameters, a `View` named, by convention, `convertView`. Sometimes, `convertView` will be null. In those cases, you have to create a new row `View` from scratch (e.g., via inflation), just as we did before.

However, if `convertView` is not null, then it is actually one of your previously-created `Views`! This will happen primarily when the user scrolls the `ListView` – as new rows appear, Android will attempt to recycle the views of the rows that scrolled off the other end of the list, to save you having to rebuild them from scratch.

Assuming that each of your rows has the same basic structure, you can use `findViewById()` to get at the individual widgets that make up your row and change their contents, then return `contentView` from `getView()`, rather than create a whole new row.

For example, here is the `getView()` implementation from last time, now optimized via `contentView` (from the Recycling project):

```
public class RecyclingDemo extends ListActivity {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue",
        "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    setListAdapter(new IconicAdapter(this));
    selection=(TextView)findViewById(R.id.selection);
  }

  public void onListItemClick(ListView parent, View v,
                              int position, long id) {
   selection.setText(items[position]);
  }

  class IconicAdapter extends ArrayAdapter {
    Activity context;

    IconicAdapter(Activity context) {
      super(context, R.layout.row, items);

      this.context=context;
    }

    public View getView(int position, View convertView,
                        ViewGroup parent) {
      View row=convertView;

      if (row==null) {
        LayoutInflater inflater=context.getLayoutInflater();

        row=inflater.inflate(R.layout.row, null);
      }

      TextView label=(TextView)row.findViewById(R.id.label);

      label.setText(items[position]);

      if (items[position].length()>4) {
        ImageView icon=(ImageView)row.findViewById(R.id.icon);

        icon.setImageResource(R.drawable.delete);
      }

      return(row);
    }
  }
}
```

Here, we check to see if the `contentView` is null and, if so, we then inflate our row – but if it is not-null, we just reuse it. The work to fill in the contents (icon image, text) is the same in either case. The advantage is that we avoid the potentially-expensive inflation step.

This approach will not work in every case, though. For example, it may be that you have a ListView for which some rows will have one line of text and others have two. In this case, recycling existing rows becomes tricky, as the layouts may significantly differ. For example, if the row we need to create a View for requires two lines of text, we cannot just use a `View` with one line of text as-is. We either need to tinker with the innards of that `View`, or ignore it and inflate a new `View`.

Of course, there are ways to deal with this, such as making the second line of text visible or invisible depending on whether it is needed. And, on a phone, every millisecond of CPU time is precious, possibly for the user experience, but always for battery life – more CPU utilization means a more quickly-drained battery.

That being said, particularly if you are a rookie to Android, focus on getting the functionality right first, then looking to optimize performance on a second pass through your code, rather than get lost in a sea of `Views` trying to tackle it all in one shot.

Using the Holder Pattern

Another somewhat expensive operation we do a lot with fancy views is call `findViewById()`. This dives into our inflated row and pulls out widgets by their assigned identifiers, so we can customize the widget contents (e.g., change the text of a `TextView`, change the icon in an `ImageView`). Since `findViewById()` can find widgets anywhere in the tree of children of the row's root `View`, this could take a fair number of instructions to execute, particularly if we keep having to re-find widgets we had found once before.

In some GUI toolkits, this problem is avoided by having the composite `Views`, like our rows, be declared totally in program code (in this case, Java). Then, accessing individual widgets is merely the matter of calling a getter or accessing a field. And you can certainly do that with Android, but the code gets rather verbose. What would be nice is a way where we can still use the layout XML yet cache our row's key child widgets so we only have to find them once.

That's where the holder pattern comes into play, in a class we'll call `ViewWrapper`.

All `View` objects have `getTag()` and `setTag()` methods. These allow you to associate an arbitrary object with the widget. What the holder pattern does is use that "tag" to hold an object that, in turn, holds each of the child widgets of interest. By attaching that holder to the row View, every time we use the row, we already have access to the child widgets we care about, without having to call `findViewById()` again.

So, let's take a look at one of these holder classes (taken from the `ViewWrapper` sample project):

```
class ViewWrapper {
  View base;
  TextView label=null;
  ImageView icon=null;

  ViewWrapper(View base) {
    this.base=base;
  }

  TextView getLabel() {
    if (label==null) {
      label=(TextView)base.findViewById(R.id.label);
    }

    return(label);
  }

  ImageView getIcon() {
    if (icon==null) {
      icon=(ImageView)base.findViewById(R.id.icon);
    }

    return(icon);
  }
}
```

`ViewWrapper` not only holds onto the child widgets, it lazy-finds the child widgets. If you create a wrapper and never need a specific child, you never go through the `findViewById()` operation for it and never have to pay for those CPU cycles.

The holder pattern also:

- Allows us to consolidate all our per-widget type casting in one place, rather than having to cast it everywhere we call `findViewById()`
- Perhaps track other information about the row, such as state information we are not yet ready to "flush" to the underlying model

Using `ViewWrapper` is a matter of creating an instance whenever we inflate a row and attaching said instance to the row `View` via `setTag()`, as shown in this rewrite of `getView()`:

```java
public class ViewWrapperDemo extends ListActivity {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue",
          "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    setListAdapter(new IconicAdapter(this));
    selection=(TextView)findViewById(R.id.selection);
  }

  private String getModel(int position) {
    return(((IconicAdapter)getListAdapter()).getItem(position));
  }

  public void onListItemClick(ListView parent, View v,
                              int position, long id) {
   selection.setText(getModel(position));
  }

  class IconicAdapter extends ArrayAdapter<String> {
    Activity context;

    IconicAdapter(Activity context) {
      super(context, R.layout.row, items);

      this.context=context;
    }
    public View getView(int position, View convertView,
                        ViewGroup parent) {
      View row=convertView;
      ViewWrapper wrapper=null;

      if (row==null) {
        LayoutInflater inflater=context.getLayoutInflater();

        row=inflater.inflate(R.layout.row, null);
        wrapper=new ViewWrapper(row);
        row.setTag(wrapper);
      }
      else {
        wrapper=(ViewWrapper)row.getTag();
      }

      wrapper.getLabel().setText(getModel(position));

      if (getModel(position).length()>4) {
        wrapper.getIcon().setImageResource(R.drawable.delete);
      }

      return(row);
    }
  }
}
```

Just as we check `convertView` to see if it is null in order to create the row `View`s as needed, we also pull out (or create) the corresponding row's `ViewWrapper`. Then, accessing the child widgets is merely a matter of calling their associated methods on the wrapper.

Making a List...

Lists with pretty icons next to them are all fine and well. But, can we create `ListView` widgets whose rows contain interactive child widgets instead of just passive widgets like `TextView` and `ImageView`? For example, could we combine the `RatingBar` with text in order to allow people to scroll a list of, say, songs and rate them right inside the list?

There is good news and bad news.

The good news is that interactive widgets in rows work just fine. The bad news is that it is a little tricky, specifically when it comes to taking action when the interactive widget's state changes (e.g., a value is typed into a field). We need to store that state somewhere, since our `RatingBar` widget will be recycled when the `ListView` is scrolled. We need to be able to set the `RatingBar` state based upon the actual word we are viewing as the `RatingBar` is recycled, and we need to save the state when it changes so it can be restored when this particular row is scrolled back into view.

What makes this interesting is that, by default, the `RatingBar` has absolutely no idea what model in the `ArrayAdapter` it is looking at. After all, the `RatingBar` is just a widget, used in a row of a `ListView`. We need to teach the rows which model they are presently displaying, so when their checkbox is checked, they know which model's state to modify.

So, let's see how this is done, using the activity in the `RateList` sample project. We'll use the same basic classes as our previous demo – we're showing a list of nonsense words, which you can then rate. In addition, words given a top rating are put in all caps:

```
public class RateListDemo extends ListActivity {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue",
          "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    ArrayList<RowModel> list=new ArrayList<RowModel>();

    for (String s : items) {
      list.add(new RowModel(s));
    }

    setListAdapter(new CheckAdapter(this, list));
    selection=(TextView)findViewById(R.id.selection);
  }

  private RowModel getModel(int position) {
    return(((CheckAdapter)getListAdapter()).getItem(position));
  }
```

```
public void onListItemClick(ListView parent, View v,
                           int position, long id) {
 selection.setText(getModel(position).toString());
}

class CheckAdapter extends ArrayAdapter<RowModel> {
  Activity context;

  CheckAdapter(Activity context, ArrayList<RowModel> list) {
    super(context, R.layout.row, list);

    this.context=context;
  }

  public View getView(int position, View convertView,
                     ViewGroup parent) {
    View row=convertView;
    ViewWrapper wrapper;
    RatingBar rate;

    if (row==null) {
      LayoutInflater inflater=context.getLayoutInflater();

      row=inflater.inflate(R.layout.row, null);
      wrapper=new ViewWrapper(row);
      row.setTag(wrapper);
      rate=wrapper.getRatingBar();

      RatingBar.OnRatingBarChangeListener l=
                  new RatingBar.OnRatingBarChangeListener() {
        public void onRatingChanged(RatingBar ratingBar,
                                    float rating,
                                    boolean fromTouch)  {
          Integer myPosition=(Integer)ratingBar.getTag();
          RowModel model=getModel(myPosition);

          model.rating=rating;

          LinearLayout parent=(LinearLayout)ratingBar.getParent();
          TextView label=(TextView)parent.findViewById(R.id.label);

          label.setText(model.toString());
        }
      };

      rate.setOnRatingBarChangeListener(l);
    }
    else {
      wrapper=(ViewWrapper)row.getTag();
      rate=wrapper.getRatingBar();
    }

    RowModel model=getModel(position);
```

```
      wrapper.getLabel().setText(model.toString());
      rate.setTag(new Integer(position));
      rate.setRating(model.rating);

      return(row);
    }
  }

  class RowModel {
    String label;
    float rating=2.0f;

    RowModel(String label) {
      this.label=label;
    }

    public String toString() {
      if (rating>=3.0) {
        return(label.toUpperCase());
      }

      return(label);
    }
  }
}
```

Here is what is different in this activity and `getView()` implementation than before:

1. While we are still using `String`[] items as the list of nonsense words, rather than pour that `String` array straight into an `ArrayAdapter`, we turn it into a list of `RowModel` objects. `RowModel` is this demo's poor excuse for a mutable model: it holds the nonsense word plus the current checked state. In a real system, these might be objects populated from a `Cursor`, and the properties would have more business meaning.

2. Utility methods like `onListItemClick()` had to be updated to reflect the change from a pure-`String` model to use a `RowModel`.

3. The `ArrayAdapter` subclass (`CheckAdapter`), in `getView()`, looks to see if `convertView` is `null`. If so, we create a new row by inflating a simple layout (see below) and also attach a `ViewWrapper` (also below). For the row's `RatingBar`, we add an anonymous `onRatingChanged()` listener that looks at the row's tag (`getTag()`) and converts that into an `Integer`, representing the position within the `ArrayAdapter` that this row is displaying. Using that, the checkbox can get the actual

RowModel for the row and update the model based upon the new state of the rating bar. It also updates the text adjacent to the RatingBar when checked to match the rating bar state.

4. We always make sure that the RatingBar has the proper contents and has a tag (via setTag()) pointing to the position in the adapter the row is displaying.

The row layout is very simple: just a RatingBar and a TextView inside a LinearLayout:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="wrap_content"
  android:orientation="horizontal"
>
  <RatingBar
    android:id="@+id/rate"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:numStars="3"
    android:stepSize="1"
    android:rating="2" />
  <TextView
    android:id="@+id/label"
    android:paddingLeft="2px"
    android:paddingRight="2px"
    android:paddingTop="2px"
    android:textSize="40sp"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"/>
</LinearLayout>
```

The ViewWrapper is similarly simple, just extracting the RatingBar and the TextView out of the row View:

```
class ViewWrapper {
  View base;
  RatingBar rate=null;
  TextView label=null;

  ViewWrapper(View base) {
    this.base=base;
  }

  RatingBar getRatingBar() {
    if (rate==null) {
      rate=(RatingBar)base.findViewById(R.id.rate);
    }

    return(rate);
  }

  TextView getLabel() {
    if (label==null) {
      label=(TextView)base.findViewById(R.id.label);
    }

    return(label);
  }
}
```

And the result is what you would expect, visually:

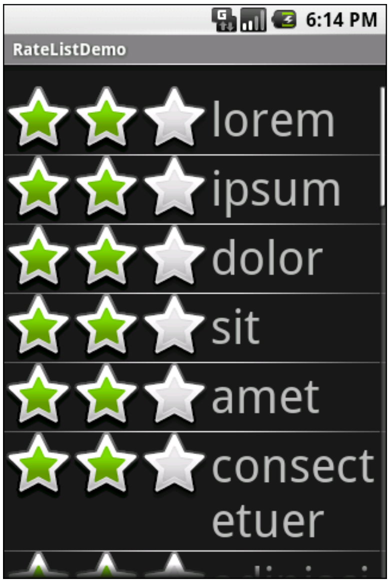


Figure 29. The RateListDemo application, as initially launched

This includes the toggled checkboxes turning their words into all caps:

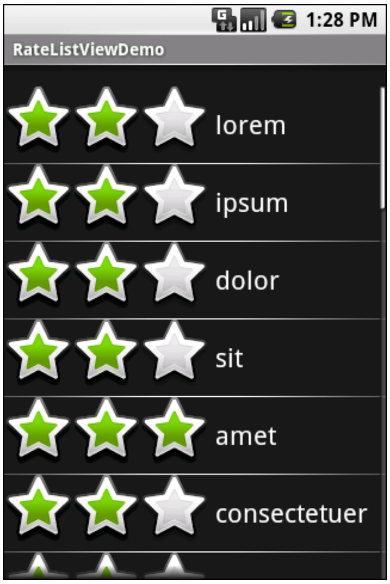


Figure 30. The same application, showing a top-rated word

...And Checking It Twice

The rating list in the previous section works, but implementing it was very tedious. Worse, much of that tedium would not be reusable except in very limited circumstances.

We can do better.

What we'd really like is to be able to create a layout like this:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent" >
  <TextView
    android:id="@+id/selection"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"/>
  <com.commonsware.android.fancylists.seven.RateListView
    android:id="@android:id/list"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:drawSelectorOnTop="false"
    />
</LinearLayout>
```

where, in our code, almost all of the logic that might have referred to a `ListView` before "just works" with the `RateListView` we put in the layout:

```
public class RateListViewDemo extends ListActivity {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue",
          "purus"};

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    setListAdapter(new ArrayAdapter<String>(this,
                       android.R.layout.simple_list_item_1,
                       items));
    selection=(TextView)findViewById(R.id.selection);
  }

  public void onListItemClick(ListView parent, View v,
                             int position, long id) {
   selection.setText(items[position]);
  }
}
```

Where things get a wee bit challenging is when you stop and realize that, in everything up to this point in this chapter, never were we actually changing the `ListView` itself. All our work was with the adapters, overriding `getView()` and inflating our own rows, and whatnot.

So if we want `RateListView` to take in any ordinary `ListAdapter` and "just work", putting checkboxes on the rows as needed, we are going to need to do some fancy footwork. Specifically, we are going to need to wrap the "raw" `ListAdapter` in some other `ListAdapter` that knows how to put the checkboxes on the rows and track the state of those checkboxes.

First, we need to establish the pattern of one ListAdapter augmenting another. Here is the code for AdapterWrapper, which takes a ListAdapter and delegates all of the interface's methods to the delegate (from the CheckListView sample project):

```
public class AdapterWrapper implements ListAdapter {
  ListAdapter delegate=null;

  public AdapterWrapper(ListAdapter delegate) {
    this.delegate=delegate;
  }

  public int getCount() {
    return(delegate.getCount());
  }

  public Object getItem(int position) {
    return(delegate.getItem(position));
  }

  public long getItemId(int position) {
    return(delegate.getItemId(position));
  }

  public View getView(int position, View convertView,
                      ViewGroup parent) {
    return(delegate.getView(position, convertView, parent));
  }

  public void registerDataSetObserver(DataSetObserver observer) {
    delegate.registerDataSetObserver(observer);
  }

  public boolean hasStableIds() {
    return(delegate.hasStableIds());
  }

  public boolean isEmpty() {
    return(delegate.isEmpty());
  }

  public int getViewTypeCount() {
    return(delegate.getViewTypeCount());
  }

  public int getItemViewType(int position) {
    return(delegate.getItemViewType(position));
  }

  public void unregisterDataSetObserver(DataSetObserver observer) {
    delegate.unregisterDataSetObserver(observer);
  }
  public boolean areAllItemsEnabled() {
    return(delegate.areAllItemsEnabled());
  }

  public boolean isEnabled(int position) {
    return(delegate.isEnabled(position));
  }
}
```

We can then subclass `AdapterWrapper` to create `RateableWrapper`, overriding the default `getView()` but otherwise allowing the delegated `ListAdapter` to do the "real work":

```
public class RateableWrapper extends AdapterWrapper {
  Context ctxt=null;
  float[] rates=null;

  public RateableWrapper(Context ctxt, ListAdapter delegate) {
    super(delegate);

    this.ctxt=ctxt;
    this.rates=new float[delegate.getCount()];

    for (int i=0;i<delegate.getCount();i++) {
      this.rates[i]=2.0f;
    }
  }

  public View getView(int position, View convertView,
                      ViewGroup parent) {
    ViewWrapper wrap=null;
    View row=convertView;

    if (convertView==null) {
      LinearLayout layout=new LinearLayout(ctxt);
      RatingBar rate=new RatingBar(ctxt);

      rate.setNumStars(3);
      rate.setStepSize(1.0f);

      View guts=delegate.getView(position, null, parent);

      layout.setOrientation(LinearLayout.HORIZONTAL);

      rate.setLayoutParams(new LinearLayout.LayoutParams(
            LinearLayout.LayoutParams.WRAP_CONTENT,
            LinearLayout.LayoutParams.FILL_PARENT));
      guts.setLayoutParams(new LinearLayout.LayoutParams(
            LinearLayout.LayoutParams.FILL_PARENT,
            LinearLayout.LayoutParams.FILL_PARENT));
      RatingBar.OnRatingBarChangeListener l=
                    new RatingBar.OnRatingBarChangeListener() {
        public void onRatingChanged(RatingBar ratingBar,
                                      float rating,
                                      boolean fromTouch)  {
          rates[(Integer)ratingBar.getTag()]=rating;
        }
      };

      rate.setOnRatingBarChangeListener(l);

      layout.addView(rate);
      layout.addView(guts);

      wrap=new ViewWrapper(layout);
      wrap.setGuts(guts);
      layout.setTag(wrap);

      rate.setTag(new Integer(position));
      rate.setRating(rates[position]);

      row=layout;
    }
    else {
      wrap=(ViewWrapper)convertView.getTag();
      wrap.setGuts(delegate.getView(position, wrap.getGuts(),
                                    parent));
      wrap.getRatingBar().setTag(new Integer(position));
      wrap.getRatingBar().setRating(rates[position]);
    }

    return(row);
  }
}
```

The idea is that `RateableWrapper` is where most of our rate-list logic resides. It puts the rating bars on the rows and it tracks the rating bars' states as they are adjusted by the user. For the states, it has a `float[]` sized to fit the number of rows that the delegate says are in the list.

`RateableWrapper`'s implementation of `getView()` is reminiscent of the one from RateListDemo, except that rather than use `LayoutInflater`, we need to manually construct a `LinearLayout` to hold our `RatingBar` and the "guts" (a.k.a., whatever view the delegate created that we are decorating with the checkbox). `LayoutInflater` is designed to construct a `View` from raw widgets; in our case, we don't know in advance what the rows will look like, other than that we need to add a checkbox to them. However, the rest is similar to the one from RateListDemo, including using a ViewWrapper (below), hooking onRatingBarChanged() to have the rating bar update the state, and so forth:

```
class ViewWrapper {
  ViewGroup base;
  View guts=null;
  RatingBar rate=null;

  ViewWrapper(ViewGroup base) {
    this.base=base;
  }

  RatingBar getRatingBar() {
    if (rate==null) {
      rate=(RatingBar)base.getChildAt(0);
    }

    return(rate);
  }

  void setRatingBar(RatingBar rate) {
    this.rate=rate;
  }

  View getGuts() {
    if (guts==null) {
      guts=base.getChildAt(1);
    }

    return(guts);
  }

  void setGuts(View guts) {
    this.guts=guts;
  }
}
```

With all that in place, RateListView is comparatively simple:

```
public class RateListView extends ListView {
  public RateListView(Context context) {
    super(context);
  }

  public RateListView(Context context, AttributeSet attrs) {
    super(context, attrs);
  }

  public RateListView(Context context, AttributeSet attrs,
                       int defStyle) {
    super(context, attrs, defStyle);
  }

  public void setAdapter(ListAdapter adapter) {
    super.setAdapter(new RateableWrapper(getContext(), adapter));
  }
}
```

We simply subclass `ListView` and override `setAdapter()` so we can wrap the supplied `ListAdapter` in our own `RateableWrapper`.

Visually, the results are similar to the `RateListDemo`, albeit without top-rated words appearing in all caps:

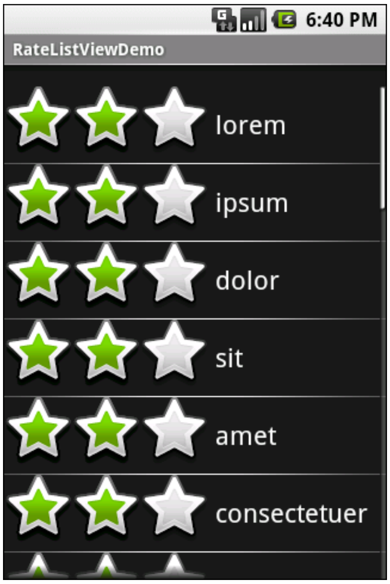


Figure 31. The RateListViewDemo sample application

The difference is in reusability. We could package `RateListView` in its own JAR and plop it into any Android project where we need it. So while `RateListView` is somewhat complicated to write, we only have to write it once, and the rest of the application code is blissfully simple.

Of course, this `RateListView` could use some more features, such as programmatically changing states (updating both the `float[]` and the actual `RatingBar` itself), allowing other application logic to be invoked when a

RatingBar state is toggled (via some sort of callback), etc. These are left as exercises for the reader.

CHAPTER 10

Employing Fancy Widgets and Containers

The widgets and containers covered to date are not only found in many GUI toolkits (in one form or fashion), but also are widely used in building GUI applications, whether Web-based, desktop, or mobile. The widgets and containers in this chapter are a little less widely used, though you will likely find many to be quite useful.

Pick and Choose

With limited-input devices like phones, having widgets and dialogs that are aware of the type of stuff somebody is supposed to be entering is very helpful. It minimizes keystrokes and screen taps, plus reduces the chance of making some sort of error (e.g., entering a letter someplace where only numbers are expected).

As shown previously, `EditText` has content-aware flavors for entering in numbers, phone numbers, etc. Android also supports widgets (`DatePicker`, `TimePicker`) and dialogs (`DatePickerDialog`, `TimePickerDialog`) for helping users enter dates and times.

The `DatePicker` and `DatePickerDialog` allow you to set the starting date for the selection, in the form of a year, month, and day of month value. Note that the month runs from `0` for January through `11` for December. Most importantly, each let you provide a callback object (`OnDateChangedListener` or `OnDateSetListener`) where you are informed of a new date selected by the user. It is up to you to store that date someplace, particularly if you are using the dialog, since there is no other way for you to get at the chosen date later on.

Similarly, `TimePicker` and `TimePickerDialog` let you:

- set the initial time the user can adjust, in the form of an hour (`0` through `23`) and a minute (`0` through `59`)
- indicate if the selection should be in 12-hour mode with an AM/PM toggle, or in 24-hour mode (what in the US is thought of as "military time" and in the rest of the world is thought of as "the way times are supposed to be")
- provide a callback object (`OnTimeChangedListener` or `OnTimeSetListener`) to be notified of when the user has chosen a new time, which is supplied to you in the form of an hour and minute

For example, from the `Chrono` sample project, here's a trivial layout containing a label and two buttons – the buttons will pop up the dialog flavors of the date and time pickers:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <TextView android:id="@+id/dateAndTime"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    />
  <Button android:id="@+id/dateBtn"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:text="Set the Date"
    />
  <Button android:id="@+id/timeBtn"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:text="Set the Time"
    />
</LinearLayout>
```

The more interesting stuff comes in the Java source:

```
public class ChronoDemo extends Activity {
  DateFormat fmtDateAndTime=DateFormat.getDateTimeInstance();
  TextView dateAndTimeLabel;
  Calendar dateAndTime=Calendar.getInstance();
  DatePickerDialog.OnDateSetListener d=new DatePickerDialog.OnDateSetListener()
{
    public void onDateSet(DatePicker view, int year, int monthOfYear,
                int dayOfMonth) {
      dateAndTime.set(Calendar.YEAR, year);
      dateAndTime.set(Calendar.MONTH, monthOfYear);
      dateAndTime.set(Calendar.DAY_OF_MONTH, dayOfMonth);
      updateLabel();
    }
  };
  TimePickerDialog.OnTimeSetListener t=new TimePickerDialog.OnTimeSetListener()
{
    public void onTimeSet(TimePicker view, int hourOfDay,
                         int minute) {
      dateAndTime.set(Calendar.HOUR_OF_DAY, hourOfDay);
      dateAndTime.set(Calendar.MINUTE, minute);
      updateLabel();
    }
  };

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    Button btn=(Button)findViewById(R.id.dateBtn);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View v) {
        new DatePickerDialog(ChronoDemo.this,
          d,
          dateAndTime.get(Calendar.YEAR),
          dateAndTime.get(Calendar.MONTH),
          dateAndTime.get(Calendar.DAY_OF_MONTH)).show();
      }
    });

    btn=(Button)findViewById(R.id.timeBtn);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View v) {
        new TimePickerDialog(ChronoDemo.this,
                  t,
                  dateAndTime.get(Calendar.HOUR_OF_DAY),
                  dateAndTime.get(Calendar.MINUTE),
                  true).show();
      }
    });
    dateAndTimeLabel=(TextView)findViewById(R.id.dateAndTime);

    updateLabel();
  }

  private void updateLabel() {
    dateAndTimeLabel.setText(fmtDateAndTime
                              .format(dateAndTime.getTime()));
  }
}
```

The "model" for this activity is just a `Calendar` instance, initially set to be the current date and time. We pour it into the view via a `DateFormat` formatter. In the `updateLabel()` method, we take the current `Calendar`, format it, and put it in the `TextView`.

Each button is given a `OnClickListener` callback object. When the button is clicked, either a `DatePickerDialog` or a `TimePickerDialog` is shown. In the case of the `DatePickerDialog`, we give it a `OnDateSetListener` callback that updates the `Calendar` with the new date (year, month, day of month). We also give the dialog the last-selected date, getting the values out of the `Calendar`. In the case of the `TimePickerDialog`, it gets a `OnTimeSetListener` callback to update the time portion of the `Calendar`, the last-selected time, and a true indicating we want 24-hour mode on the time selector.

With all this wired together, the resulting activity looks like this:

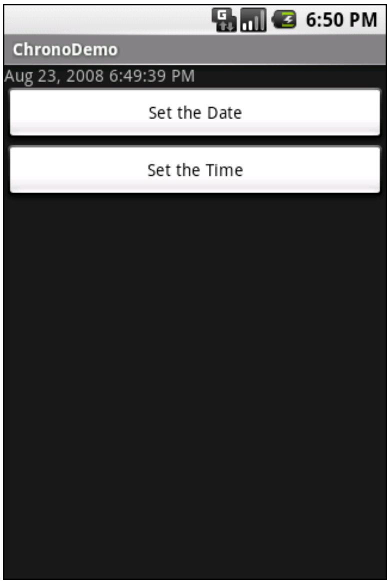


Figure 32. The ChronoDemo sample application, as initially launched

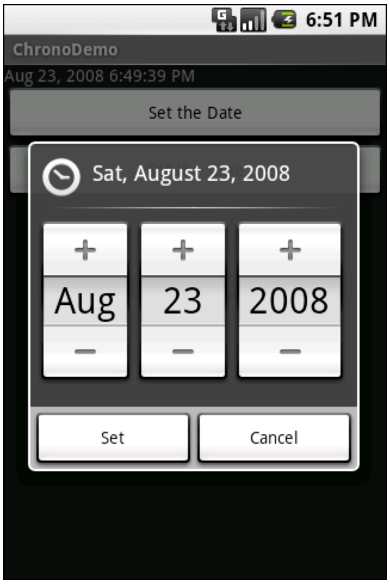


Figure 33. The same application, showing the date picker dialog

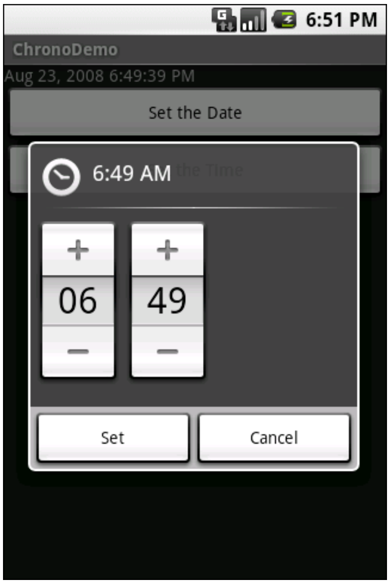


Figure 34. The same application, showing the time picker dialog

Time Keeps Flowing Like a River

If you want to display the time, rather than have users enter the time, you may wish to use the `DigitalClock` or `AnalogClock` widgets. These are extremely easy to use, as they automatically update with the passage of time. All you need to do it put them in your layout and let them do their thing.

For example, from the `Clocks` sample application, here is an XML layout containing both `DigitalClock` and `AnalogClock`:

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <AnalogClock android:id="@+id/analog"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:layout_centerHorizontal="true"
    android:layout_alignParentTop="true"
    />
  <DigitalClock android:id="@+id/digital"
```

```
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_centerHorizontal="true"
    android:layout_below="@id/analog"
    />
</RelativeLayout>
```

Without any Java code other than the generated stub, we can build this project and get the following activity:

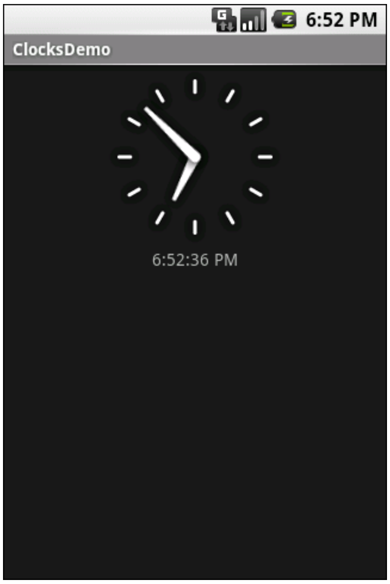


Figure 35. The ClocksDemo sample application

Making Progress

If you need to be doing something for a long period of time, you owe it to your users to do two things:

- Use a background thread, which will be covered in a later chapter
- Keep them apprised of your progress, lest they think your activity has wandered away and will never come back

The typical approach to keeping users informed of progress is some form of progress bar or "throbber" (think the animated graphic towards the upper-right corner of many Web browsers). Android supports this through the `ProgressBar` widget.

A `ProgressBar` keeps track of progress, defined as an integer, with 0 indicating no progress has been made. You can define the maximum end of the range – what value indicates progress is complete – via `setMax()`. By default, a `ProgressBar` starts with a progress of `0`, though you can start from some other position via `setProgress()`.

If you prefer your progress bar to be indeterminate, use `setIndeterminate()`, setting it to true.

In your Java code, you can either positively set the amount of progress that has been made (via `setProgress()`) or increment the progress from its current amount (via `incrementProgressBy()`). You can find out how much progress has been made via `getProgress()`.

Since the `ProgressBar` is tied closely to the use of threads – a background thread doing work, updating the UI thread with new progress information – we will hold off demonstrating the use of `ProgressBar` to a later chapter.

Putting It On My Tab

The general Android philosophy is to keep activities short and sweet. If there is more information than can reasonably fit on one screen, albeit perhaps with scrolling, then it perhaps belongs in another activity kicked off via an `Intent`, as will be described later in this book. However, that can be complicated to set up. Moreover, sometimes there legitimately is a lot of information that needs to be collected to be processed as an atomic operation.

In a traditional UI, you might use tabs to accomplish this end, such as a `JTabbedPane` in Java/Swing. In Android, you now have an option of using a `TabHost` container in much the same way – a portion of your activity's screen is taken up with tabs which, when clicked, swap out part of the view and replace it with something else. For example, you might have an activity with a tab for entering a location and a second tab for showing a map of that location.

Some GUI toolkits refer to "tabs" as being just the things a user clicks on to toggle from one view to another. Some toolkits refer to "tabs" as being the combination of the clickable button-ish element and the content that appears when that tab is chosen. Android treats the tab buttons and contents as discrete entities, so we will call them "tab buttons" and "tab contents" in this section.

The Pieces

There are a few widgets and containers you need to use in order to set up a tabbed portion of a view:

- `TabHost` is the overarching container for the tab buttons and tab contents
- `TabWidget` implements the row of tab buttons, which contain text labels and optionally contain icons
- `FrameLayout` is the container for the tab contents; each tab content is a child of the `FrameLayout`

This is similar to the approach that Mozilla's XUL takes. In XUL's case, the `tabbox` element corresponds to Android's `TabHost`, the `tabs` element corresponds to `TabWidget`, and `tabpanels` corresponds to the `FrameLayout`.

The Idiosyncrasies

There are a few rules to follow, at least in this milestone edition of the Android toolkit, in order to make these three work together:

- You must give the `TabWidget` an `android:id` of `@android:id/tabs`
- You must set aside some padding in the `FrameLayout` for the tab buttons (more on this below)

- If you wish to use the `TabActivity`, you must give the `TabHost` an `android:id` of `@android:id/tabhost`

`TabActivity`, like `ListActivity`, wraps a common UI pattern (activity made up entirely of tabs) into a pattern-aware activity subclass. You do not necessarily have to use `TabActivity` – a plain activity can use tabs as well.

With respect to the `FrameLayout` padding issue, for whatever reason, the `TabWidget` does not seem to allocate its own space inside the `TabHost` container. In other words, no matter what you specify for `android:layout_height` for the `TabWidget`, the `FrameLayout` ignores it and draws at the top of the overall `TabHost`. Your tab contents obscure your tab buttons. Hence, you need to leave enough padding (via `android:paddingTop`) in `FrameLayout` to "shove" the actual tab contents down beneath the tab buttons. This is likely a bug, so this behavior may well change in future versions of the toolkit.

In addition, the `TabWidget` seems to always draw itself with room for icons, even if you do not supply icons. Hence, for this version of the toolkit, you need to supply at least 62 pixels of padding, perhaps more depending on the icons you supply.

For example, here is a layout definition for a tabbed activity, from `Tab`:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent">
  <TabHost android:id="@+id/tabhost"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent">
    <TabWidget android:id="@android:id/tabs"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
    />
    <FrameLayout android:id="@android:id/tabcontent"
      android:layout_width="fill_parent"
      android:layout_height="fill_parent"
      android:paddingTop="62px">
      <AnalogClock android:id="@+id/tab1"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:layout_centerHorizontal="true"
      />
      <Button android:id="@+id/tab2"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:text="A semi-random button"
      />
    </FrameLayout>
  </TabHost>
</LinearLayout>
```

Note that the `TabWidget` and `FrameLayout` are immediate children of the `TabHost`, and the `FrameLayout` itself has children representing the various tabs. In this case, there are two tabs: a clock and a button. In a more complicated scenario, the tabs are probably some form of container (e.g., `LinearLayout`) with their own contents.

Wiring It Together

The Java code needs to tell the `TabHost` what views represent the tab contents and what the tab buttons should look like. This is all wrapped up in `TabSpec` objects. You get a `TabSpec` instance from the host via `newTabSpec()`, fill it out, then add it to the host in the proper sequence.

The two key methods on `TabSpec` are:

- `setContent()`, where you indicate what goes in the tab content for this tab, typically the `android:id` of the view you want shown when this tab is selected
- `setIndicator()`, where you provide the caption for the tab button and, in some flavors of this method, supply a `Drawable` to represent the icon for the tab

Note that tab "indicators" can actually be views in their own right, if you need more control than a simple label and optional icon.

Also note that you must call `setup()` on the `TabHost` before configuring any of these `TabSpec` objects. The call to `setup()` is not needed if you are using the `TabActivity` base class for your activity.

For example, here is the Java code to wire together the tabs from the preceding layout example:

```
package com.commonsware.android.fancy;

import android.app.Activity;
import android.os.Bundle;
import android.widget.TabHost;

public class TabDemo extends Activity {
  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    TabHost tabs=(TabHost)findViewById(R.id.tabhost);

    tabs.setup();

    TabHost.TabSpec spec=tabs.newTabSpec("tag1");

    spec.setContent(R.id.tab1);
    spec.setIndicator("Clock");
    tabs.addTab(spec);

    spec=tabs.newTabSpec("tag2");
    spec.setContent(R.id.tab2);
    spec.setIndicator("Button");
    tabs.addTab(spec);

    tabs.setCurrentTab(0);
  }
}
```

We find our `TabHost` via the familiar `findViewById()` method, then have it `setup()`. After that, we get a `TabSpec` via `newTabSpec()`, supplying a tag whose purpose is unknown at this time. Given the spec, you call `setContent()` and `setIndicator()`, then call `addTab()` back on the `TabHost` to register the tab as available for use. Finally, you can choose which tab is the one to show via `setCurrentTab()`, providing the `0`-based index of the tab.

The result?

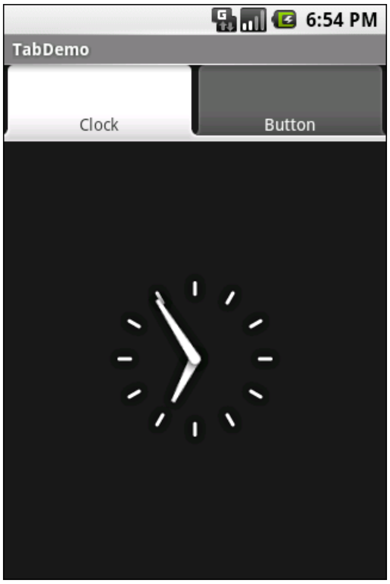


Figure 36. The TabDemo sample application, showing the first tab

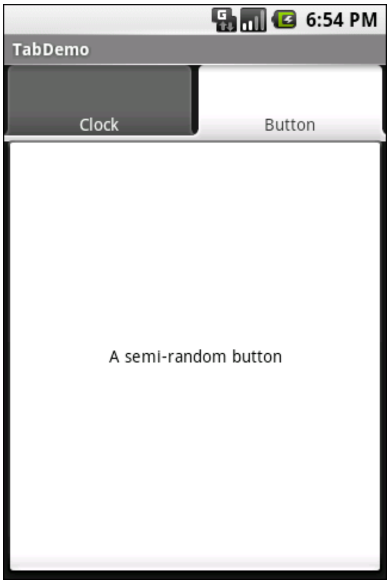


Figure 37. The same application, showing the second tab

Adding Them Up

TabWidget is set up to allow you to easily define tabs at compile time. However, sometimes, you want to add tabs to your activity during runtime. For example, imagine an email client where individual emails get opened in their own tab, for easy toggling between messages. In this case, you don't know how many tabs or what their contents will be until runtime, when the user chooses to open a message.

Fortunately, Android also supports adding tabs dynamically at runtime.

Adding tabs dynamically at runtime works much like the compile-time tabs shown above, except you use a different flavor of setContent(), one that takes a TabHost.TabContentFactory instance. This is just a callback that will be invoked – you provide an implementation of createTabContent() and use it to build and return the View that becomes the content of the tab.

Let's take a look at an example (DynamicTab).

First, here is some layout XML for an activity that sets up the tabs and defines one tab, containing a single button:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent">
  <TabHost android:id="@+id/tabhost"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent">
    <TabWidget android:id="@android:id/tabs"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
    />
    <FrameLayout android:id="@android:id/tabcontent"
      android:layout_width="fill_parent"
      android:layout_height="fill_parent"
      android:paddingTop="62px">
      <Button android:id="@+id/buttontab"
        android:layout_width="fill_parent"
        android:layout_height="fill_parent"
        android:text="A semi-random button"
      />
    </FrameLayout>
  </TabHost>
</LinearLayout>
```

What we want to do is add new tabs whenever the button is clicked. That can be accomplished in just a few lines of code:

```
public class DynamicTabDemo extends Activity {
  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    final TabHost tabs=(TabHost)findViewById(R.id.tabhost);

    tabs.setup();

    TabHost.TabSpec spec=tabs.newTabSpec("buttontab");
    spec.setContent(R.id.buttontab);
    spec.setIndicator("Button");
    tabs.addTab(spec);

    tabs.setCurrentTab(0);

    Button btn=(Button)tabs.getCurrentView().findViewById(R.id.buttontab);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View view) {
        TabHost.TabSpec spec=tabs.newTabSpec("tag1");

        spec.setContent(new TabHost.TabContentFactory() {
          public View createTabContent(String tag) {
            return(new AnalogClock(DynamicTabDemo.this));
          }
        });
        spec.setIndicator("Clock");
        tabs.addTab(spec);
      }
    });
  }
}
```

In our button's `setOnClickListener()` callback, we create a `TabHost.TabSpec` object and give it an anonymous `TabHost.TabContentFactory`. The factory, in turn, returns the `View` to be used for the tab – in this case, just an `AnalogClock`. The logic for constructing the tab's `View` could be much more elaborate, such as using `ViewInflate` to construct a view from layout XML.

Initially, when the activity is launched, we just have the one tab:

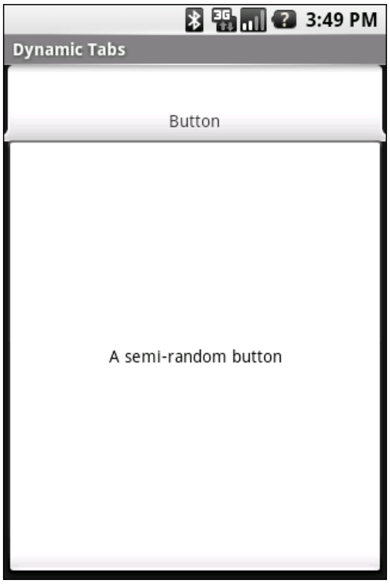


Figure 38. The DynamicTab application, with the single initial tab

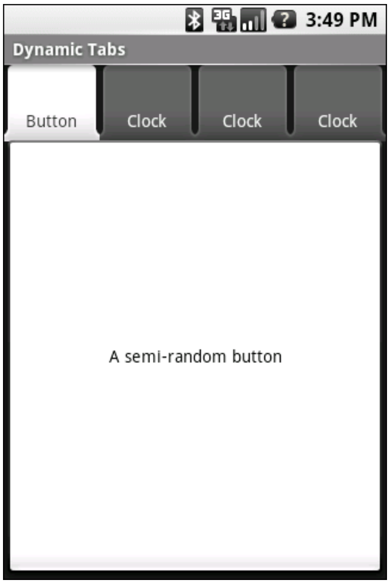


Figure 39. The DynamicTab application, with three dynamically-created tabs

Flipping Them Off

Sometimes, you want the overall effect of tabs (only some Views visible at a time), but you do not want the actual UI implementation of tabs. Maybe the tabs take up too much screen space. Maybe you want to switch between perspectives based on a gesture or a device shake. Or maybe you just like being different.

The good news is that the guts of the view-flipping logic from tabs can be found in the ViewFlipper container, which can be used in other ways than the traditional tab.

ViewFlipper inherits from FrameLayout, just like we used to describe the innards of a TabWidget. However, initially, it just shows the first child view. It is up to you to arrange for the views to flip, either manually by user interaction, or automatically via a timer.

For example, here is a layout for a simple activity (Flipper1) using a Button and a ViewFlipper:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
  <Button android:id="@+id/flip_me"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:text="Flip Me!"
      />
  <ViewFlipper android:id="@+id/details"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
    <TextView
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:textStyle="bold"
      android:textColor="#FF00FF00"
      android:text="This is the first panel"
    />
    <TextView
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:textStyle="bold"
      android:textColor="#FFFF0000"
      android:text="This is the second panel"
    />
    <TextView
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:textStyle="bold"
      android:textColor="#FFFFFF00"
      android:text="This is the third panel"
    />
  </ViewFlipper>
</LinearLayout>
```

Notice that the layout defines three child views for the ViewFlipper, each a TextView with a simple message. Of course, you could have very complicated child views, if you so chose.

To manually flip the views, we need to hook into the Button and flip them ourselves when the button is clicked:

```
public class FlipperDemo extends Activity {
  ViewFlipper flipper;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    flipper=(ViewFlipper)findViewById(R.id.details);

    Button btn=(Button)findViewById(R.id.flip_me);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View view) {
        flipper.showNext();
      }
    });
  }
}
```

This is just a matter of calling showNext() on the ViewFlipper, like you can on any ViewAnimator class.

The result is a trivial activity: click the button, and the next TextView in sequence is displayed, wrapping around to the first after viewing the last:

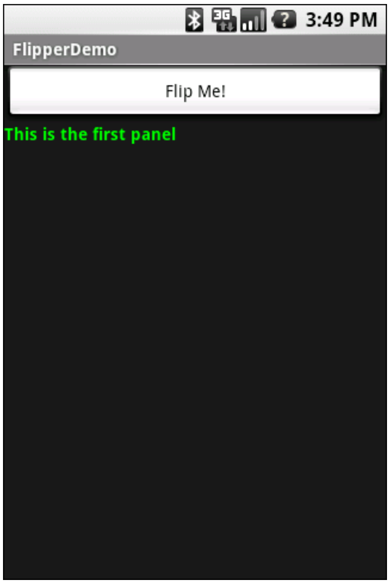


Figure 40. The Flipper1 application, showing the first panel

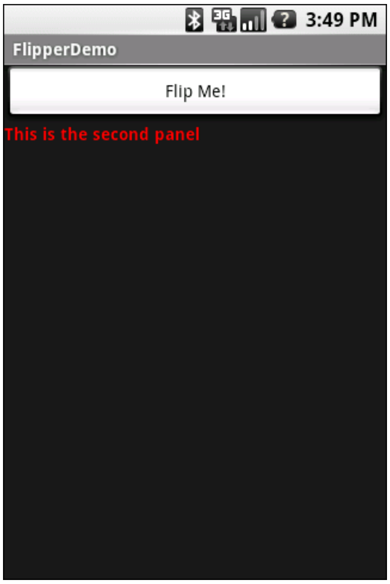


Figure 41. The same application, after switching to the second panel

This, of course, could be handled more simply by having a single `TextView` and changing the text and color on each click. However, you can imagine that the ViewFlipper contents could be much more complicated, like the contents you might put into a TabView.

As with the TabWidget, sometimes, your ViewFlipper contents may not be known at compile time. As with TabWidget, though, you can add new contents on the fly with ease.

For example, let's look at another sample activity (Flipper2), using this layout:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
  <ViewFlipper android:id="@+id/details"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
  </ViewFlipper>
</LinearLayout>
```

Notice that the ViewFlipper has no contents at compile time. Also note that there is no Button for flipping between the contents – more on this in a moment.

For the ViewFlipper contents, we will create large Button widgets, each containing one of the random words used in many chapters in this book. And, we will set up the ViewFlipper to automatically rotate between the Button widgets, using an animation for transition:

```
public class FlipperDemo2 extends Activity {
  static String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
                         "consectetuer", "adipiscing", "elit",
                         "morbi", "vel", "ligula", "vitae",
                         "arcu", "aliquet", "mollis", "etiam",
                         "vel", "erat", "placerat", "ante",
                         "porttitor", "sodales", "pellentesque",
                         "augue", "purus"};
  ViewFlipper flipper;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    flipper=(ViewFlipper)findViewById(R.id.details);

    flipper.setInAnimation(AnimationUtils.loadAnimation(this,
                                    R.anim.push_left_in));
    flipper.setOutAnimation(AnimationUtils.loadAnimation(this,
                                    R.anim.push_left_out));

    for (String item : items) {
      Button btn=new Button(this);

      btn.setText(item);

      flipper.addView(btn,
                  new ViewGroup.LayoutParams(
                          ViewGroup.LayoutParams.FILL_PARENT,
                          ViewGroup.LayoutParams.FILL_PARENT));
    }

    flipper.setFlipInterval(2000);
    flipper.startFlipping();
  }
}
```

After getting our `ViewFlipper` widget from the layout, we first set up the "in" and "out" animations. In Android terms, an animation is a description of how a widget leaves ("out") or enters ("in") the viewable area. Animations are a complex beast, eventually worthy of their own chapter. For now, realize that animations are resources, stored in `res/anim/` in your project. For this example, we are using a pair of animations supplied by the SDK samples, available under the Apache 2.0 license. As their names suggest, widgets are "pushed" to the left, either to enter or leave the viewable area.

After iterating over the funky words, turning each into a `Button`, and adding the `Button` as a child of the `ViewFlipper`, we set up the flipper to automatically flip between children (`flipper.setFlipInterval(2000);`) and to start flipping (`flipper.startFlipping();`).

The result is an endless series of buttons, each appearing, then sliding out to the left after 1.5 seconds, being replaced by the next button in sequence, wrapping around to the first after the last has been shown:

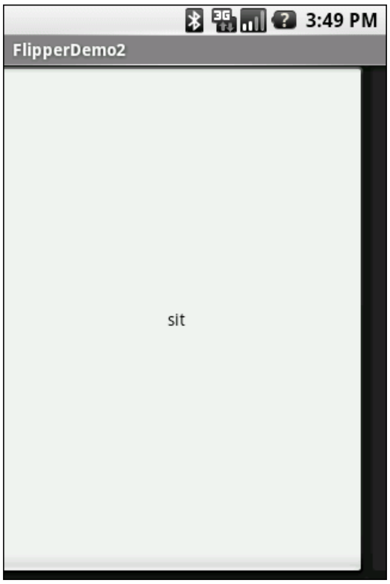


Figure 42. The Flipper2 application, showing an animated transition

The auto-flipping `ViewFlipper` is useful for status panels or other situations where you have a lot of information to display, but not much room. The key is that, since it automatically flips between views, expecting users to interact with individual views is dicey – the view might switch away part-way through their interaction.

Other Containers of Note

Android offers `AbsoluteLayout`, where the contents are laid out based on specific coordinate positions. You tell `AbsoluteLayout` where to place a child in precise X,Y coordinates, and Android puts it there, no questions asked. On the plus side, this gives you precise positioning. On the minus side, it means your views will only look "right" on screens of a certain dimension, or it requires you to write a bunch of code to adjust the coordinates based on screen size. Since Android screens might run the gamut of sizes, plus have new sizes crop up periodically, using `AbsoluteLayout` could get quite annoying.

Android also has a new flavor of list, the `ExpandableListView`. This provides a simplified tree representation, supporting two levels of depth: groups and children. Groups contain children; children are "leaves" of the tree. This requires a new set of adapters, since the `ListAdapter` family does not provide any sort of group information for the items in the list.\

CHAPTER 11

Applying Menus

Like applications for the desktop and some mobile operating systems, such as PalmOS and Windows Mobile, Android supports activities with "application" menus. Some Android phones will have a dedicated menu key for popping up the menu; others will offer alternate means for triggering the menu to appear.

Also, as with many GUI toolkits, you can create "context menus". On a traditional GUI, this might be triggered by the right-mouse button. On mobile devices, context menus typically appear when the user "taps-and-holds" over a particular widget. For example, if a `TextView` had a context menu, and the device was designed for finger-based touch input, you could push the `TextView` with your finger, hold it for a second or two, and a pop-up menu will appear for the user to choose from.

Where Android differs from most other GUI toolkits is in terms of menu construction. While you can add items to the menu, you do not have full control over the menu's contents, nor the timing of when the menu is built. Part of the menu is system-defined, and that portion is managed by the Android framework itself.

Flavors of Menu

Android considers the two types of menu described above as being the "options menu" and "context menu". The options menu is triggered by pressing the hardware "Menu" button on the device, while the context menu is raised by a tap-and-hold on the widget sporting the menu.

In addition, the options menu operates in one of two modes: icon and expanded. When the user first presses the "Menu" button, the icon mode will appear, showing up to the first six menu choices as large, finger-friendly buttons in a grid at the bottom of the screen. If the menu has more than six choices, the sixth button will become "More" – clicking that option will bring up the expanded mode, showing the remaining choices not visible in the regular menu. The menu is scrollable, so the user can get to any of the menu choices.

Menus of Options

Rather than building your activity's options menu during `onCreate()`, the way you wire up the rest of your UI, you instead need to implement `onCreateOptionsMenu()`. This callback receives an instance of `Menu`.

The first thing you should do is chain upward to the superclass (`super.onCreateOptionsMenu(menu)`), so the Android framework can add in any menu choices it feels are necessary. Then, you can go about adding your own options, described below.

If you will need to adjust the menu during your activity's use (e.g., disable a now-invalid menu choice), just hold onto the `Menu` instance you receive in `onCreateOptionsMenu()`. Note, however, that `onCreateOptionsMenu()` will be called each and every time the user presses the Menu button.

Given that you have received a `Menu` object via `onCreateOptionsMenu()`, you add menu choices by calling `add()`. There are many flavors of this method, which require some combination of the following parameters:

- A group identifier (`int`), which should be `NONE` unless you are creating a specific grouped set of menu choices for use with `setGroupCheckable()` (see below)

- A choice identifier (also an `int`), for use in identifying this choice in the `onOptionsItemSelected()` callback when a menu choice is chosen
- An order identifier (yet another int), for indicating where this menu choice should be slotted if the menu has Android-supplied choices alongside your own – for now, just use `NONE`
- The text of the menu choice, as a String or a resource ID

The `add()` family of methods all return an instance of `MenuItem`, where you can adjust any of the menu item settings you have already set (e.g., the text of the menu choice). You can also set the shortcuts for the menu choice – single-character mnemonics that choose that menu choice when the menu is visible. Android supports both an alphabetic (or "qwerty") set of shortcuts and a numeric set of shortcuts. These are set individually by calling `setAlphabeticShortcut()` and `setNumericShortcut()` respectively. The menu is placed into alphabetic shortcut mode by calling `setQwertyMode()` on the menu with a `true` parameter.

The choice and group identifiers are keys used to unlock additional menu features, such as:

- Calling `MenuItem#setCheckable()` with a choice identifier, to control if the menu choice has a two-state checkbox alongside the title, where the checkbox value gets toggled when the user chooses that menu choice
- Calling `Menu#setGroupCheckable()` with a group identifier, to turn a set of menu choices into ones with a mutual-exclusion radio button between them, so one out of the group can be in the "checked" state at any time

You can also call `addIntentOptions()` to populate the menu with menu choices corresponding to the available activities for an intent (see the chapter on launching activities)

Finally, you can create fly-out sub-menus by calling `addSubMenu()`, supplying the same parameters as `addMenu()`. Android will eventually call `onCreatePanelMenu()`, passing it the choice identifier of your sub-menu, along with another `Menu` instance representing the sub-menu itself. As with `onCreateOptionsMenu()`, you should chain upward to the superclass, then add menu choices to the sub-menu. One limitation is that you cannot indefinitely nest sub-menus – a menu can have a sub-menu, but a sub-menu cannot itself have a sub-sub-menu.

If the user makes a menu choice, your activity will be notified via the `onOptionsItemSelected()` callback that a menu choice was selected. You are given the `MenuItem` object corresponding to the selected menu choice. A typical pattern is to `switch()` on the menu ID (`item.getItemId()`) and take appropriate behavior. Note that `onOptionsItemSelected()` is used regardless of whether the chosen menu item was in the base menu or in a submenu.

Menus in Context

By and large, context menus use the same guts as option menus. The two main differences are how you populate the menu and how you are informed of menu choices.

First, you need to indicate which widget(s) on your activity have context menus. To do this, call `registerForContextMenu()` from your activity, supplying the `View` that is the widget needing a context menu.

Next, you need to implement `onCreateContextMenu()`, which, among other things, is passed the `View` you supplied in `registerForContextMenu()`. You can use that to determine which menu to build, assuming your activity has more than one.

The `onCreateContextMenu()` method gets the `ContextMenu` itself, the `View` the context menu is associated with, and a `ContextMenu.ContextMenuInfo`, which tells you which item in the list the user did the tap-and-hold over, in case you want to customize the context menu based on that information. For example, you could toggle a checkable menu choice based upon the current state of the item. Note that you only get this "extra information" when the menu is built, not when a choice is made.

It is also important to note that `onCreateContextMenu()` gets called for each time the context menu is requested. Unlike the options menu (which is only built once per activity), context menus are discarded once they are used or dismissed. Hence, you do not want to hold onto the supplied `ContextMenu` object; just rely on getting the chance to rebuild the menu to suit your activity's needs on an on-demand basis based on user actions.

To find out when a context menu choice was chosen, implement `onContextItemSelected()` on the activity. Note that you only get the `MenuItem` instance that was chosen in this callback. As a result, if your activity has two or more context menus, you may want to ensure they have unique menu item identifiers for all their choices, so you can tell them apart in this callback. Otherwise, this callback behaves the same as `onOptionsItemSelected()` as is described above.

Taking a Peek

In the sample project `Menus`, you will find an amended version of the `ListView` sample (`List`) with an associated menu. Since the menus are defined in Java code, the XML layout need not change and is not reprinted here.

However, the Java code has a few new behaviors:

```
public class MenuDemo extends ListActivity {
  TextView selection;
  String[] items={"lorem", "ipsum", "dolor", "sit", "amet",
          "consectetuer", "adipiscing", "elit", "morbi", "vel",
          "ligula", "vitae", "arcu", "aliquet", "mollis",
          "etiam", "vel", "erat", "placerat", "ante",
          "porttitor", "sodales", "pellentesque", "augue", "purus"};
  public static final int EIGHT_ID = Menu.FIRST+1;
  public static final int SIXTEEN_ID = Menu.FIRST+2;
  public static final int TWENTY_FOUR_ID = Menu.FIRST+3;
  public static final int TWO_ID = Menu.FIRST+4;
  public static final int THIRTY_TWO_ID = Menu.FIRST+5;
  public static final int FORTY_ID = Menu.FIRST+6;
  public static final int FORTY_EIGHT_ID = Menu.FIRST+7;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    setListAdapter(new ArrayAdapter<String>(this,
                android.R.layout.simple_list_item_1, items));
    selection=(TextView)findViewById(R.id.selection);

    registerForContextMenu(getListView());
  }

  public void onListItemClick(ListView parent, View v,
                              int position, long id) {
   selection.setText(items[position]);
  }

  @Override
  public void onCreateContextMenu(ContextMenu menu, View v,
                                  ContextMenu.ContextMenuInfo menuInfo) {
    populateMenu(menu);
  }

  @Override
  public boolean onCreateOptionsMenu(Menu menu) {
    populateMenu(menu);

    return(super.onCreateOptionsMenu(menu));
  }

  @Override
  public boolean onOptionsItemSelected(MenuItem item) {
    applyMenuChoice(item);

    return(applyMenuChoice(item) ||
            super.onOptionsItemSelected(item));
  }

  @Override
  public boolean onContextItemSelected(MenuItem item) {

    return(applyMenuChoice(item) ||
            super.onContextItemSelected(item));
  }

  private void populateMenu(Menu menu) {
    menu.add(Menu.NONE, TWO_ID, Menu.NONE, "2 Pixels");
    menu.add(Menu.NONE, EIGHT_ID, Menu.NONE, "8 Pixels");
    menu.add(Menu.NONE, SIXTEEN_ID, Menu.NONE, "16 Pixels");
    menu.add(Menu.NONE, TWENTY_FOUR_ID, Menu.NONE, "24 Pixels");
    menu.add(Menu.NONE, THIRTY_TWO_ID, Menu.NONE, "32 Pixels");
    menu.add(Menu.NONE, FORTY_ID, Menu.NONE, "40 Pixels");
    menu.add(Menu.NONE, FORTY_EIGHT_ID, Menu.NONE, "48 Pixels");
  }

  private boolean applyMenuChoice(MenuItem item) {
    switch (item.getItemId()) {
      case EIGHT_ID:
        getListView().setDividerHeight(8);
        return(true);

      case SIXTEEN_ID:
        getListView().setDividerHeight(16);
        return(true);

      case TWENTY_FOUR_ID:
        getListView().setDividerHeight(24);
        return(true);

      case TWO_ID:
        getListView().setDividerHeight(2);
        return(true);

      case THIRTY_TWO_ID:
        getListView().setDividerHeight(32);
        return(true);

      case FORTY_ID:
        getListView().setDividerHeight(40);
        return(true);

      case FORTY_EIGHT_ID:
        getListView().setDividerHeight(48);
        return(true);
    }

    return(false);
  }
}
```

In `onCreate()`, we register our list widget as having a context menu, which we fill in via our `populateMenu()` private method, by way of `onCreateContextMenu()`.

We also implement the `onCreateOptionsMenu()` callback, indicating that our activity also has an options menu. Once again, we delegate to `populateMenu()` to fill in the menu.

Our implementations of `onOptionsItemSelected()` (for options menu selections) and `onContextItemSelected()` (for context menu selections) both delegate to a private `applyMenuChoice()` method, plus chaining upwards to the superclass if none of our menu choices was the one selected by the user.

In populateMenu(), we add four menu choices, each with a unique identifier. Being lazy, we eschew the icons.

In applyMenuChoice(), we see if any of our menu choices were chosen; if so, we set the list's divider size to be the user-selected width.

Initially, the activity looks the same in the emulator as it did for ListDemo:

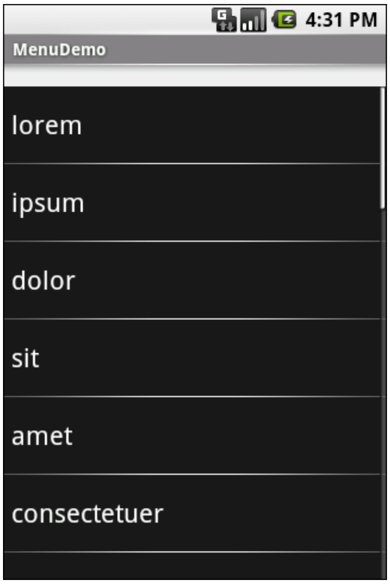


Figure 43. The MenuDemo sample application, as initially launched

But, if you press the Menu button, you will get our options menu:

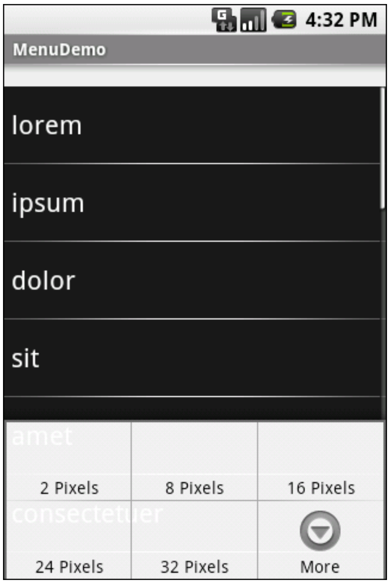


Figure 44. The same application, showing the options menu

Clicking the More button shows the remaining two menu choices:

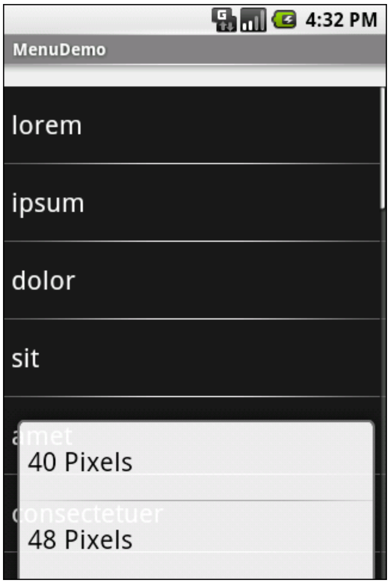


Figure 45. The same application, the remaining menu choices

Choosing a height (say, 16 pixels) then changes the divider height of the list to something garish:

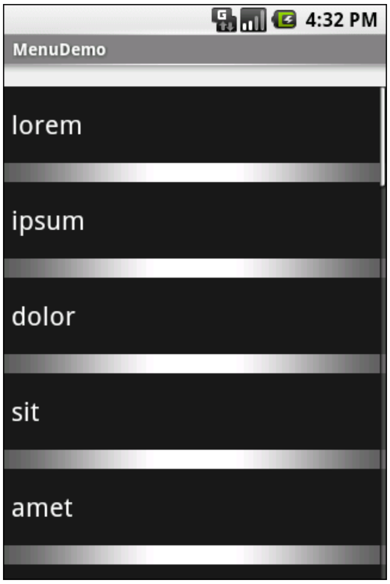


Figure 46. The same application, made ugly

You can trigger the context menu by doing a tap-and-hold on any item in the list:

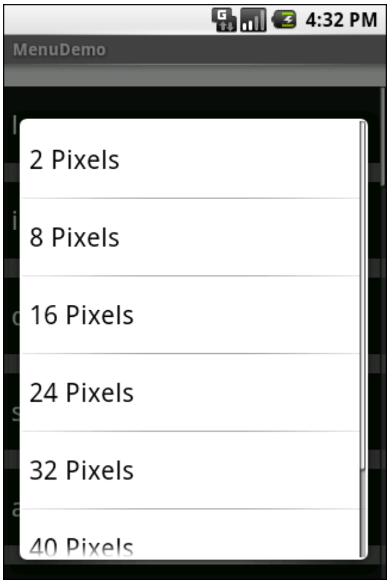


Figure 47. The same application, showing a context menu

Once again, choosing an option sets the divider height.

Yet More Inflation

We saw earlier in this book that you can describe `Views` via XML files and "inflate" them into actual `View` objects at runtime. Android also allows you to describe menus via XML files and "inflate" them when a menu is called for. This helps you keep your menu structure separate from the implementation of menu-handling logic, and it provides easier ways to develop menu-authoring tools.

Menu XML Structure

Menu XML goes in `res/menu/` in your project tree, alongside the other types of resources that your project might employ. As with layouts, you can have several menu XML files in your project, each with their own filename and the `.xml` extension.

For example, from the Inflation sample project, here is menu called `sample.xml`:

```
<?xml version="1.0" encoding="utf-8"?>
<menu xmlns:android="http://schemas.android.com/apk/res/android">
  <item android:id="@+id/close"
    android:title="Close"
    android:orderInCategory="3"
    android:icon="@drawable/eject" />
  <item android:id="@+id/no_icon"
    android:orderInCategory="2"
    android:title="Sans Icon" />
  <item android:id="@+id/disabled"
    android:orderInCategory="4"
    android:enabled="false"
    android:title="Disabled" />
  <group android:id="@+id/other_stuff"
    android:menuCategory="secondary"
    android:visible="false">
    <item android:id="@+id/later"
      android:orderInCategory="0"
      android:title="2nd-To-Last" />
    <item android:id="@+id/last"
      android:orderInCategory="1"
      android:title="Last" />
  </group>
  <item android:id="@+id/submenu"
    android:orderInCategory="3"
    android:title="A Submenu">
    <menu>
      <item android:id="@+id/non_ghost"
        android:title="Non-Ghost"
        android:visible="true"
        android:alphabeticShortcut="n" />
      <item android:id="@+id/ghost"
        android:title="A Ghost"
        android:visible="false"
        android:alphabeticShortcut="g" />
    </menu>
  </item>
</menu>
```

- You must start with a `menu` root element
- Inside a `menu` are `item` elements and `group` elements, the latter representing a collection of menu items that can be operated upon as a group
- Submenus are specified by adding a `menu` element as a child of an `item` element, using this new `menu` element to describe the contents of the submenu

- If you want to detect when an item is chosen, or to reference an item or group from your Java code, be sure to apply an `android:id`, just as you do with `View` layout XML

Menu Options and XML

Inside the item and group elements you can specify various options, matching up with corresponding methods on `Menu` or `MenuItem`.

Title

The title of a menu item is provided via the `android:title` attribute on an `item` element. This can be either a literal string or a reference to a string resource (e.g., `@string/foo`).

Icon

Menu items optionally have icons. To provide an icon – in the form of a reference to a drawable resource (e.g., `@drawable/eject`), use the `android:icon` attribute on the `item` element.

Order

By default, the order of the items in the menu is determined by the order they appear in the menu XML. If you want, you can change that, by specifying the `android:orderInCategory` attribute on `item` element. This is a `0`-based index of the order for the items associated with the current category. There is an implicit default category; groups can provide an `android:menuCategory` attribute to specify a different category to use for items in that group.

Generally, though, it is simplest just to put the items in the XML in the order you want them to appear.

Enabled

Items and groups can be enabled or disabled, controlled in the XML via the `android:enabled` attribute on the item or group element. By default, items and groups are enabled. Disabled items and groups appear in the menu but cannot be selected. You can change an item's status at runtime via the `setEnabled()` method on `MenuItem`, or change a group's status via `setGroupEnabled()` on `Menu`.

Visible

Similarly, items and groups can be visible or invisible, controlled in the XML via the `android:visible` attribute on the item or group element. By default, items and groups are visible. Invisible items and groups do not appear in the menu at all. You can change an item's status at runtime via the `setVisible()` method on `MenuItem`, or change a group's status via `setGroupVisible()` on `Menu`.

In the layout XML shown above, the `other_stuff` group is initially invisible. If we make it visible in our Java code, the two menu items in the group will "magically" appear.

Shortcut

Items can have shortcuts – single letters (`android:alphabeticShortcut`) or numbers (`android:numericShortcut`) that can be pressed to choose the item without having to use the touchscreen, D-pad, or trackball to navigate the full menu.

Inflating the Menu

Actually using the menu, once defined in XML, is easy. Just create a `MenuInflater` and tell it to inflate your menu:

```
@Override
public boolean onCreateOptionsMenu(Menu menu) {
  theMenu=menu;

  new MenuInflater(getApplication())
                              .inflate(R.menu.sample, menu);

  return(super.onCreateOptionsMenu(menu));
}
```

CHAPTER 12

Fonts

Inevitably, you'll get the question "hey, can we change this font?" when doing application development. The answer depends on what fonts come with the platform, whether you can add other fonts, and how to apply them to the widget or whatever needs the font change.

Android is no different. It comes with some fonts plus a means for adding new fonts. Though, as with any new environment, there are a few idiosyncrasies to deal with.

Love The One You're With

Android natively knows three fonts, by the shorthand names of "sans", "serif", and "monospace". These fonts are actually the Droid series of fonts, created for the Open Handset Alliance by Ascender.

For those fonts, you can just reference them in your layout XML, if you choose, such as the following layout from the FontSampler sample project:

```
<?xml version="1.0" encoding="utf-8"?>
<TableLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  android:stretchColumns="1">
  <TableRow>
    <TextView
```

```
      android:text="sans:"
      android:layout_marginRight="4px"
      android:textSize="20sp"
    />
    <TextView
      android:id="@+id/sans"
      android:text="Hello, world!"
      android:typeface="sans"
      android:textSize="20sp"
    />
  </TableRow>
  <TableRow>
    <TextView
      android:text="serif:"
      android:layout_marginRight="4px"
      android:textSize="20sp"
    />
    <TextView
      android:id="@+id/serif"
      android:text="Hello, world!"
      android:typeface="serif"
      android:textSize="20sp"
    />
  </TableRow>
  <TableRow>
    <TextView
      android:text="monospace:"
      android:layout_marginRight="4px"
      android:textSize="20sp"
    />
    <TextView
      android:id="@+id/monospace"
      android:text="Hello, world!"
      android:typeface="monospace"
      android:textSize="20sp"
    />
  </TableRow>
  <TableRow>
    <TextView
      android:text="Custom:"
      android:layout_marginRight="4px"
      android:textSize="20sp"
    />
    <TextView
      android:id="@+id/custom"
      android:text="Hello, world!"
      android:textSize="20sp"
    />
  </TableRow>
</TableLayout>
```

This layout builds a table showing short samples of four fonts. Notice how the first three have the `android:typeface` attribute, whose value is one of the three built-in font faces (e.g., "sans").

The three built-in fonts are very nice. However, it may be that a designer, or a manager, or a customer wants a different font than one of those three. Or perhaps you want to use a font for specialized purposes, such as a "dingbats" font instead of a series of PNG graphics.

The easiest way to accomplish this is to package the desired font(s) with your application. To do this, simply create an `assets/` folder in the project root, and put your fonts (in TrueType, or TTF, form) in the assets. You might, for example, create `assets/fonts/` and put your TTF files in there.

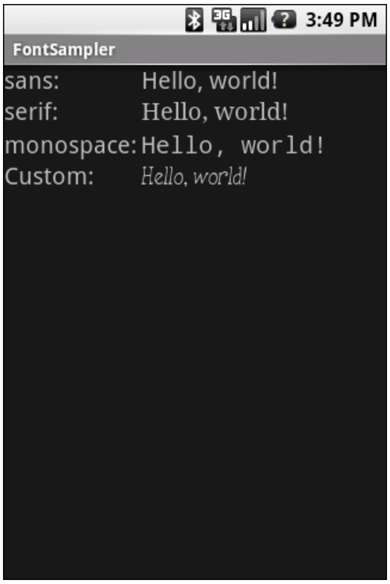
Then, you need to tell your widgets to use that font. Unfortunately, you can no longer use layout XML for this, since the XML does not know about any fonts you may have tucked away as an application asset. Instead, you need to make the change in Java code:

```
public class FontSampler extends Activity {
  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    TextView tv=(TextView)findViewById(R.id.custom);
    Typeface face=Typeface.createFromAsset(getAssets(),
                                          "fonts/HandmadeTypewriter.ttf");

    tv.setTypeface(face);
  }
}
```

Here we grab the `TextView` for our "custom" sample, then create a `Typeface` object via the static `createFromAsset()` builder method. This takes the application's `AssetManager` (from `getAssets()`) and a path within your `assets/` directory to the font you want.

Then, it is just a matter of telling the `TextView` to `setTypeface()`, providing the `Typeface` you just created. In this case, we are using the Handmade Typewriter font.

The results?



sans: Hello, world!
serif: Hello, world!
monospace: Hello, world!
Custom: Hello, world!

Figure 48. The FontSampler application

Note that Android does not seem to like all TrueType fonts. When Android dislikes a custom font, rather than raise an `Exception`, it seems to substitute Droid Sans ("sans") quietly. So, if you try to use a different font and it does not seem to be working, it may be that the font in question is incompatible with Android, for whatever reason.

Also, you are probably best served by changing the case of your font filenames to be all lowercase, to match the naming convention used in the rest of your resources.

Also note that TrueType fonts can be rather pudgy, particularly if they support an extensive subset of the available Unicode characters. The Handmade Typewriter font used here runs over 70KB; the DejaVu free fonts can run upwards of 500KB apiece. Even compressed, these add bulk to your application, so be careful not to go overboard with custom fonts, lest your application take up too much room on your users' phones.

CHAPTER 13

Embedding the WebKit Browser

Other GUI toolkits let you use HTML for presenting information, from limited HTML renderers (e.g., Java/Swing, wxWidgets) to embedding Internet Explorer into .NET applications. Android is much the same, in that you can embed the built-in Web browser as a widget in your own activities, for displaying HTML or full-fledged browsing. The Android browser is based on WebKit, the same engine that powers Apple's Safari Web browser.

The Android browser is sufficiently complex that it gets its own Java package (`android.webkit`), though using the `WebView` widget itself can be simple or powerful, based upon your requirements.

A Browser, Writ Small

For simple stuff, `WebView` is not significantly different than any other widget in Android – pop it into a layout, tell it what URL to navigate to via Java code, and you're done.

For example (`Browser1`), here is a simple layout with a `WebView`:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <WebView android:id="@+id/webkit"
```

```
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
  />
</LinearLayout>
```

As with any other widget, you need to tell it how it should fill up the space in the layout (in this case, it fills all remaining space).

The Java code is equally simple:

```
package com.commonsware.android.webkit;

import android.app.Activity;
import android.os.Bundle;
import android.webkit.WebView;

public class BrowserDemo1 extends Activity {
  WebView browser;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    browser=(WebView)findViewById(R.id.webkit);

    browser.loadUrl("http://commonsware.com");
  }
}
```

The only bit unusual with this edition of `onCreate()` is that we invoke `loadUrl()` on the `WebView` widget, to tell it to load a Web page (in this case, the home page of some random firm).

However, we also have to make one change to `AndroidManifest.xml`, requesting permission to access the Internet:

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.commonsware.android.webkit">
  <uses-permission android:name="android.permission.INTERNET" />
  <application>
    <activity android:name=".BrowserDemo1" android:label="BrowserDemo1">
      <intent-filter>
        <action android:name="android.intent.action.MAIN" />
        <category android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
    </activity>
  </application>
</manifest>
```

If we fail to add this permission, the browser will refuse to load pages.

The resulting activity looks like a Web browser, just with hidden scrollbars:

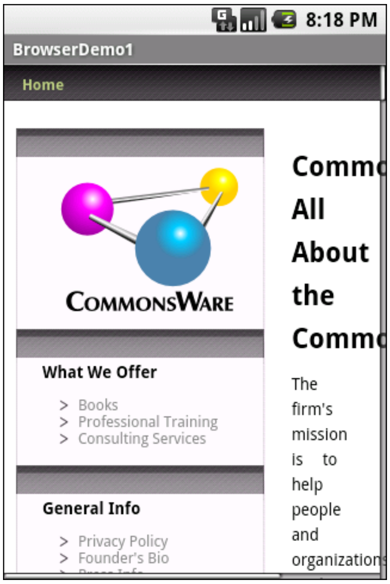


Figure 49. The Browser1 sample application

As with the regular Android browser, you can pan around the page by dragging it, while the directional pad moves you around all the focusable elements on the page.

What is missing is all the extra accouterments that make up a Web browser, such as a navigational toolbar.

Loading It Up

There are two main ways to get content into the `WebView`. One, shown above, is to provide the browser with a URL and have the browser display that page via `loadUrl()`. The browser will access the Internet through whatever means are available to that specific device at the present time (WiFi, cellular network, Bluetooth-tethered phone, well-trained tiny carrier pigeons, etc.).

The alternative is to use `loadData()`. Here, you supply the HTML for the browser to view. You might use this to:

- display a manual that was installed as a file with your application package
- display snippets of HTML you retrieved as part of other processing, such as the description of an entry in an Atom feed
- generate a whole user interface using HTML, instead of using the Android widget set

There are two flavors of `loadData()`. The simpler one allows you to provide the content, the MIME type, and the encoding, all as strings. Typically, your MIME type will be `text/html` and your encoding will be `UTF-8` for ordinary HTML.

For example, if you replace the `loadUrl()` invocation in the previous example with the following:

```
browser.loadData("<html><body>Hello, world!</body></html>",
                 "text/html", "UTF-8");
```

You get:

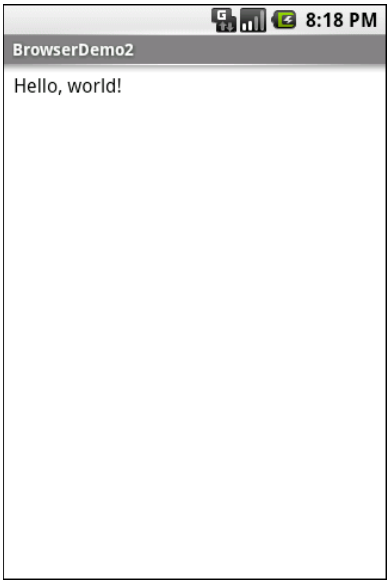


Figure 50. The Browser2 sample application

This is also available as a fully-buildable sample, as `Browser2`.

Navigating the Waters

As was mentioned above, there is no navigation toolbar with the `WebView` widget. This allows you to use it in places where such a toolbar would be pointless and a waste of screen real estate. That being said, if you want to offer navigational capabilities, you can, but you have to supply the UI.

`WebView` offers ways to perform garden-variety browser navigation, including:

- `reload()` to refresh the currently-viewed Web page
- `goBack()` to go back one step in the browser history, and `canGoBack()` to determine if there is any history to go back to
- `goForward()` to go forward one step in the browser history, and `canGoForward()` to determine if there is any history to go forward to
- `goBackOrForward()` to go backwards or forwards in the browser history, where negative numbers represent a count of steps to go

backwards, and positive numbers represent how many steps to go forwards

- `canGoBackOrForward()` to see if the browser can go backwards or forwards the stated number of steps (following the same positive/negative convention as `goBackOrForward()`)
- `clearCache()` to clear the browser resource cache and `clearHistory()` to clear the browsing history

Entertaining the Client

Particularly if you are going to use the `WebView` as a local user interface (vs. browsing the Web), you will want to be able to get control at key times, particularly when users click on links. You will want to make sure those links are handled properly, either by loading your own content back into the `WebView`, by submitting an `Intent` to Android to open the URL in a full browser, or by some other means (see the chapter on launching activities).

Your hook into `WebView` activity is via `setWebViewClient()`, which takes an instance of a `WebViewClient` implementation as a parameter. The supplied callback object will be notified of a wide range of activities, ranging from when parts of a page have been retrieved (`onPageStarted()`, etc.) to when you, as the host application, need to handle certain user- or circumstance-initiated events, such as:

- `onTooManyRedirects()`
- `onReceivedHttpAuthRequest()`
- etc.

A common hook will be `shouldOverrideUrlLoading()`, where your callback is passed a URL (plus the `WebView` itself) and you return `true` if you will handle the request or `false` if you want default handling (e.g., actually fetch the Web page referenced by the URL). In the case of a feed reader application, for example, you will probably not have a full browser with navigation built into your reader, so if the user clicks a URL, you probably want to use an `Intent` to ask Android to load that page in a full browser. But, if you have inserted a "fake" URL into the HTML, representing a link to some activity-provided content, you can update the `WebView` yourself.

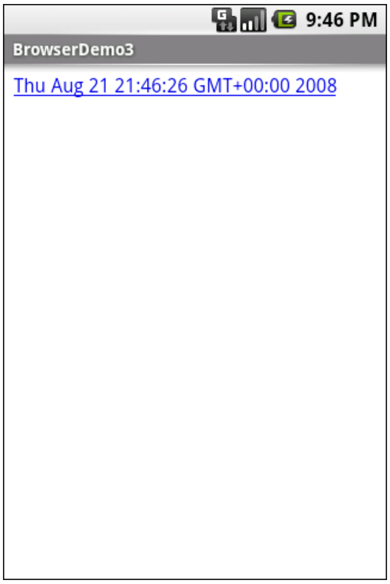
For example, let's amend the first browser example to be a browser-based equivalent of our original example: an application that, upon a click, shows the current time.

From `Browser3`, here is the revised Java:

```
package com.commonsware.android.webkit;

import android.app.Activity;
import android.os.Bundle;
import android.webkit.WebView;
import android.webkit.WebViewClient;
import java.util.Date;

public class BrowserDemo3 extends Activity {
  WebView browser;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    browser=(WebView)findViewById(R.id.webkit);
    browser.setWebViewClient(new Callback());

    loadTime();
  }

  void loadTime() {
    String page="<html><body><a href=\"clock\">"
            +new Date().toString()
            +"</a></body></html>";

            browser.loadDataWithBaseURL("x-data://base", page,
                                        "text/html", "UTF-8",
                                        null);
  }

  private class Callback extends WebViewClient {
    public boolean shouldOverrideUrlLoading(WebView view, String url) {
      loadTime();

      return(true);
    }
```

Here, we load a simple Web page into the browser (`loadTime()`) that consists of the current time, made into a hyperlink to the `/clock` URL. We also attach an instance of a `WebViewClient` subclass, providing our implementation of `shouldOverrideUrlLoading()`. In this case, no matter what the URL, we want to just reload the `WebView` via `loadTime()`.

Running this activity gives us:



Thu Aug 21 21:46:26 GMT+00:00 2008

Figure 51. The Browser3 sample application

Selecting the link and clicking the D-pad center button will "click" the link, causing us to rebuild the page with the new time.

Settings, Preferences, and Options (Oh, My!)

With your favorite desktop Web browser, you have some sort of "settings" or "preferences" or "options" window. Between that and the toolbar controls, you can tweak and twiddle the behavior of your browser, from preferred fonts to the behavior of Javascript.

Similarly, you can adjust the settings of your `WebView` widget as you see fit, via the `WebSettings` instance returned from calling the widget's `getSettings()` method.

There are lots of options on `WebSettings` to play with. Most appear fairly esoteric (e.g., `setFantasyFontFamily()`). However, here are some that you may find more useful:

- Control the font sizing via `setDefaultFontSize()` (to use a point size) or `setTextSize()` (to use constants indicating relative sizes like `LARGER` and `SMALLEST`)
- Control Javascript via `setJavaScriptEnabled()` (to disable it outright) and `setJavaScriptCanOpenWindowsAutomatically()` (to merely stop it from opening pop-up windows)
- Control Web site rendering via `setUserAgent()` – `0` means the `WebView` gives the Web site a user-agent string that indicates it is a mobile browser, while `1` results in a user-agent string that suggests it is a desktop browser

The settings you change are not persistent, so you should store them somewhere (such as via the Android preferences engine) if you are allowing your users to determine the settings, versus hard-wiring the settings in your application.

CHAPTER 14

Showing Pop-Up Messages

Sometimes, your activity (or other piece of Android code) will need to speak up.

Not every interaction with Android users will be neat, tidy, and containable in activities composed of views. Errors will crop up. Background tasks may take way longer than expected. Something asynchronous may occur, such as an incoming message. In these and other cases, you may need to communicate with the user outside the bounds of the traditional user interface.

Of course, this is nothing new. Error messages in the form of dialog boxes have been around for a very long time. More subtle indicators also exist, from task tray icons to bouncing dock icons to a vibrating cell phone.

Android has quite a few systems for letting you alert your users outside the bounds of an `Activity`-based UI. One, notifications, is tied heavily into intents and services and, as such, is covered in a later chapter. In this chapter, you will see two means of raising pop-up messages: toasts and alerts.

Raising Toasts

A `Toast` is a transient message, meaning that it displays and disappears on its own without user interaction. Moreover, it does not take focus away from the currently-active `Activity`, so if the user is busy writing the next Great American Programming Guide, they will not have keystrokes be "eaten" by the message.

Since a `Toast` is transient, you have no way of knowing if the user even notices it. You get no acknowledgment from them, nor does the message stick around for a long time to pester the user. Hence, the `Toast` is mostly for advisory messages, such as indicating a long-running background task is completed, the battery has dropped to a low-but-not-too-low level, etc.

Making a `Toast` is fairly easy. The `Toast` class offers a static `makeText()` that accepts a `String` (or string resource ID) and returns a `Toast` instance. The `makeText()` method also needs the `Activity` (or other `Context`) plus a duration. The duration is expressed in the form of the `LENGTH_SHORT` or `LENGTH_LONG` constants to indicate, on a relative basis, how long the message should remain visible.

If you would prefer your `Toast` be made out of some other `View`, rather that be a boring old piece of text, simply create a new `Toast` instance via the constructor (which takes a `Context`), then call `setView()` to supply it with the view to use and `setDuration()` to set the duration.

Once your `Toast` is configured, call its `show()` method, and the message will be displayed.

Alert! Alert!

If you would prefer something in the more classic dialog box style, what you want is an `AlertDialog`. As with any other modal dialog box, an `AlertDialog` pops up, grabs the focus, and stays there until closed by the user. You might use this for a critical error, a validation message that cannot be effectively displayed in the base activity UI, or something else where you are sure that the user needs to see the message and needs to see it now.

The simplest way to construct an `AlertDialog` is to use the `Builder` class. Following in true builder style, `Builder` offers a series of methods to configure an `AlertDialog`, each method returning the `Builder` for easy chaining. At the end, you call `show()` on the builder to display the dialog box.

Commonly-used configuration methods on `Builder` include:

- `setMessage()` if you want the "body" of the dialog to be a simple textual message, from either a supplied `String` or a supplied string resource ID
- `setTitle()` and `setIcon()`, to configure the text and/or icon to appear in the title bar of the dialog box
- `setPositiveButton()`, `setNeutralButton()`, and `setNegativeButton()`, to indicate which button(s) should appear across the bottom of the dialog, where they should be positioned (left, center, or right, respectively), what their captions should be, and what logic should be invoked when the button is clicked (besides dismissing the dialog).

If you need to configure the `AlertDialog` beyond what the builder allows, instead of calling `show()`, call `create()` to get the partially-built `AlertDialog` instance, configure it the rest of the way, then call one of the flavors of `show()` on the `AlertDialog` itself.

Once `show()` is called, the dialog box will appear and await user input.

Checking Them Out

To see how these work in practice, take a peek at `Message`, containing the following layout...:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent" >
  <Button
    android:id="@+id/alert"
    android:text="Raise an alert"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"/>
  <Button
    android:id="@+id/toast"
    android:text="Make a toast"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"/>
</LinearLayout>
```

...and Java code:

```
public class MessageDemo extends Activity implements View.OnClickListener {
  Button alert;
  Button toast;

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

    setContentView(R.layout.main);

    alert=(Button)findViewById(R.id.alert);
    alert.setOnClickListener(this);
    toast=(Button)findViewById(R.id.toast);
    toast.setOnClickListener(this);
  }

  public void onClick(View view) {
    if (view==alert) {
      new AlertDialog.Builder(this)
        .setTitle("MessageDemo")
        .setMessage("eek!")
        .setNeutralButton("Close", new DialogInterface.OnClickListener() {
          public void onClick(DialogInterface dlg, int sumthin) {
            // do nothing – it will close on its own
          }
        })
        .show();
    }
    else {
      Toast
        .makeText(this, "<clink, clink>", Toast.LENGTH_SHORT)
        .show();
    }
  }
}
```

The layout is unremarkable – just a pair of buttons to trigger the alert and the toast.

When you click the alert button, we use a builder (`new Builder(this)`) to set the title (`setTitle("MessageDemo")`), message (`setMessage("eek!")`), and "neutral button" (`setNeutralButton("Close", new OnClickListener() ...)`) before showing the dialog. When the button is clicked, the `OnClickListener` callback does nothing – the mere fact the button was pressed causes the dialog to be dismissed. However, you could update information in your activity based upon the user action, particularly if you have multiple buttons for the user to choose from. The result is a typical dialog box:

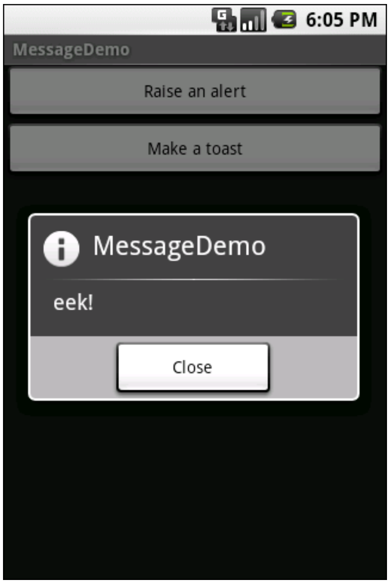


Figure 52. The MessageDemo sample application, after clicking the "Raise an alert" button

When you click the toast button, the `Toast` class makes us a text-based toast (`makeText(this, "<clink, clink>", LENGTH_SHORT)`), which we then `show()`. The result is a short-lived, non-interrupting message:

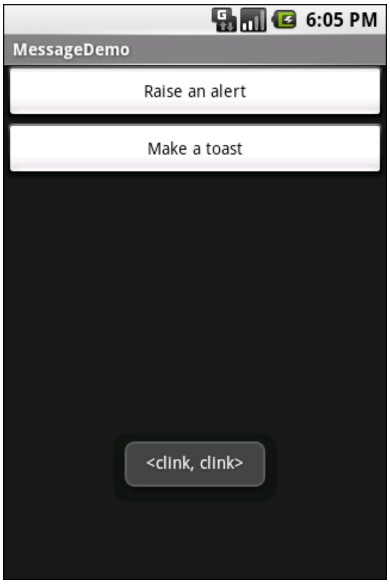


Figure 53. The same application, after clicking the "Make a toast" button

CHAPTER 15

Dealing with Threads

Ideally, you want your activities to be downright snappy, so your users don't feel that your application is sluggish. Responding to user input quickly (e.g., 200ms) is a fine goal. At minimum, though, you need to make sure you respond within 5 seconds, lest the `ActivityManager` decide to play the role of the Grim Reaper and kill off your activity as being non-responsive.

Of course, your activity might have real work to do, which takes non-negligible amounts of time. There are two ways of dealing with this:

1. Do expensive operations in a background service, relying on notifications to prompt users to go back to your activity
2. Do expensive work in a background thread

Android provides a veritable cornucopia of means to set up background threads yet allow them to safely interact with the UI on the UI thread. These include `Handler` objects, posting `Runnable` objects to the `View`, and using `UIThreadUtilities`.

Getting Through the Handlers

The most flexible means of making an Android-friendly background thread is to create an instance of a `Handler` subclass. You only need one `Handler` object per activity, and you do not need to manually register it or anything –

merely creating the instance is sufficient to register it with the Android threading subsystem.

Your background thread can communicate with the `Handler`, which will do all of its work on the activity UI thread. This is important, as UI changes, such as updating widgets, should only occur on the activity UI thread.

You have two options for communicating with the `Handler`: messages and `Runnable` objects.

Messages

To send a `Message` to a `Handler`, first invoke `obtainMessage()` to get the `Message` object out of the pool. There are a few flavors of `obtainMessage()`, allowing you to just create empty `Message` objects, or ones populated with message identifiers and arguments. The more complicated your `Handler` processing needs to be, the more likely it is you will need to put data into the `Message` to help the `Handler` distinguish different events.

Then, you send the `Message` to the `Handler` via its message queue, using one of the `sendMessage...()` family of methods, such as:

- `sendMessage()` puts the message on the queue immediately
- `sendMessageAtFrontOfQueue()` puts the message on the queue immediately, and moreover puts it at the front of the message queue (versus the back, as is the default), so your message takes priority over all others
- `sendMessageAtTime()` puts the message on the queue at the stated time, expressed in the form of milliseconds based on system uptime (`SystemClock.uptimeMillis()`)
- `sendMessageDelayed()` puts the message on the queue after a delay, expressed in milliseconds

To process these messages, your `Handler` needs to implement `handleMessage()`, which will be called with each message that appears on the message queue. There, the handler can update the UI as needed. However, it should still do that work quickly, as other UI work is suspended until the `Handler` is done.

For example, let's create a `ProgressBar` and update it via a `Handler`. Here is the layout from `Handler`:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <ProgressBar android:id="@+id/progress"
    style="?android:attr/progressBarStyleHorizontal"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content" />
</LinearLayout>
```

The `ProgressBar`, in addition to setting the width and height as normal, also employs two other properties of note:

- `style`, which will be covered in greater detail in some future edition of this book. For now, suffice it to say that it indicates this `ProgressBar` should be drawn as the traditional horizontal bar showing the amount of work that has been completed.
- `android:max`, which indicates the maximum value for the `ProgressBar` (i.e., at what value is the work "done" and the progress bar completed). A value of `100` means the `ProgressBar` works on a simple percentage system.

And here is the Java:

```
package com.commonsware.android.threads;

import android.app.Activity;
import android.os.Bundle;
import android.os.Handler;
import android.os.Message;
import android.widget.ProgressBar;

public class HandlerDemo extends Activity {
  ProgressBar bar;
  Handler handler=new Handler() {
    @Override
    public void handleMessage(Message msg) {
      bar.incrementProgressBy(5);
    }
  };
  boolean isRunning=false;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    bar=(ProgressBar)findViewById(R.id.progress);
  }

  public void onStart() {
    super.onStart();
    bar.setProgress(0);

    Thread background=new Thread(new Runnable() {
      public void run() {
        try {
          for (int i=0;i<20 && isRunning;i++) {
            Thread.sleep(1000);
            handler.sendMessage(handler.obtainMessage());
          }
        }
        catch (Throwable t) {
          // just end the background thread
        }
      }
    });

    isRunning=true;
    background.start();
  }

  public void onStop() {
    super.onStop();
    isRunning=false;
  }
}
```

As part of constructing the `Activity`, we create an instance of `Handler`, with our implementation of `handleMessage()`. Basically, for any message received, we update the `ProgressBar` by `5` points, then exit the message handler.

In `onStart()`, we set up a background thread. In a real system, this thread would do something meaningful. Here, we just sleep one second, post a `Message` to the `Handler`, and repeat for a total of `20` passes.

Note that we then *leave* `onStart()`. This is crucial. The `onStart()` method is invoked on the activity UI thread, so it can update widgets and such. However, that means we need to get out of `onStart()`, both to let the `Handler` get its work done, and also so Android does not think our activity is stuck.

The resulting activity is simply a horizontal progress bar:

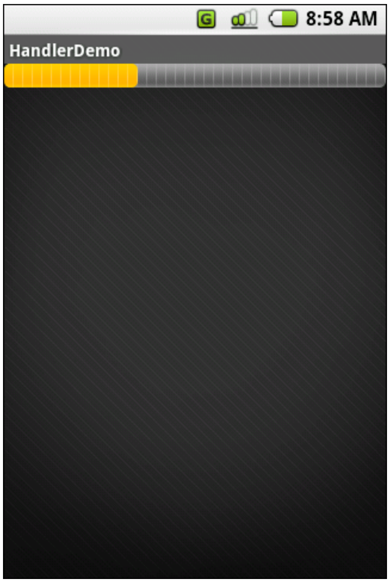


Figure 54. The HandlerDemo sample application

Runnables

If you would rather not fuss with `Message` objects, you can also pass `Runnable` objects to the `Handler`, which will run those `Runnable` objects on the activity UI thread. `Handler` offers a set of `post...()` methods for passing `Runnable` objects in for eventual processing.

Running In Place

Just as `Handler` supports `post()` and `postDelayed()` to add `Runnable` objects to the event queue, you can use those same methods on `View`. This lightly simplifies your code, in that you can then skip the `Handler` object. However, you lose a bit of flexibility, and the `Handler` has been around longer in the Android toolkit and may be more tested.

Where, Oh Where Has My UI Thread Gone?

Sometimes, you may not know if you are presently executing on the UI thread of your application. For example, if you package some of your code in a JAR for others to reuse, you might not know whether your code is being executed on the UI thread or from a background thread.

To help combat this problem, `Activity` offers `runOnUIThread()`. This works similar to the `post()` methods on `Handler` and `View`, in that it queues up a `Runnable` to run on the UI thread...if you are not on the UI thread right now. If you already are on the UI thread, it invokes the `Runnable` immediately. This gives you the best of both worlds: no delay if you are on the UI thread, yet safety in case you are not.

And Now, The Caveats

Background threads, while eminently possible using the Android `Handler` system, are not all happiness and warm puppies. Background threads not only add complexity, but they have real-world costs in terms of available memory, CPU, and battery life.

To that end, there are a wide range of scenarios you need to account for with your background thread, including:

- The possibility that users will interact with your activity's UI while the background thread is chugging along. If the work that the background thread is doing is altered or invalidated by the user input, you will need to communicate this to the background thread. Android includes many classes in the `java.util.concurrent` package that will help you communicate safely with your background thread.
- The possibility that the activity will be killed off while background work is going on. For example, after starting your activity, the user

might have a call come in, followed by a text message, followed by a need to look up a contact…all of which might be sufficient to kick your activity out of memory. The next chapter will cover the various events Android will take your activity through; hook the proper ones and be sure to shut down your background thread cleanly when you have the chance.

- The possibility that your user will get irritated if you chew up a lot of CPU time and battery life without giving any payback. Tactically, this means using `ProgressBar` or other means of letting the user know that something is happening. Strategically, this means you still need to be efficient at what you do – background threads are no panacea for sluggish or pointless code.
- The possibility that you will encounter an error during background processing. For example, if you are gathering information off the Internet, the device might lose connectivity. Alerting the user of the problem via a Notification and shutting down the background thread may be your best option.

CHAPTER 16

Handling Activity Lifecycle Events

While this may sound like a broken record...please remember that Android devices, by and large, are phones. As such, some activities are more important that others – taking a call is probably more important to users than is playing Sudoku. And, since it is a phone, it probably has less RAM than does your current desktop or notebook.

As a result, your activity may find itself being killed off because other activities are going on and the system needs your activity's memory. Think of it as the Android equivalent of the "circle of life" – your activity dies so others may live, and so on. You cannot assume that your activity will run until you think it is complete, or even until the user thinks it is complete.

This is one example – perhaps the most important example – of how an activity's lifecycle will affect your own application logic. This chapter covers the various states and callbacks that make up an activity's lifecycle and how you can hook into them appropriately.

Schroedinger's Activity

An activity, generally speaking, is in one of four states at any point in time:

- **Active**: the activity was started by the user, is running, and is in the foreground. This is what you're used to thinking of in terms of your activity's operation.
- **Paused**: the activity was started by the user, is running, and is visible, but a notification or something is overlaying part of the screen. During this time, the user can see your activity but may not be able to interact with it. For example, if a call comes in, the user will get the opportunity to take the call or ignore it.
- **Stopped**: the activity was started by the user, is running, but it is hidden by other activities that have been launched or switched to. Your application will not be able to present anything meaningful to the user directly, only by way of a Notification .
- **Dead**: either the activity was never started (e.g., just after a phone reset) or the activity was terminated, perhaps due to lack of available memory.

Life, Death, and Your Activity

Android will call into your activity as the activity transitions between the four states listed above. Some transitions may result in multiple calls to your activity, and sometimes Android will kill your application without calling it. This whole area is rather murky and probably subject to change, so pay close attention to the official Android documentation as well as this section when deciding which events to pay attention to and which you can safely ignore.

Note that for all of these, you should chain upward and invoke the superclass' edition of the method, or Android may raise an exception.

onCreate() and onDestroy()

We have been implementing `onCreate()` in all of our `Activity` subclasses in all the examples. This will get called in three situations:

1. When the activity is first started (e.g., since a system restart), `onCreate()` will be invoked with a null parameter.

2. If the activity had been running, then sometime later was killed off, `onCreate()` will be invoked with the `Bundle` from `onSaveInstanceState()` as a parameter (see below).
3. If the activity had been running and you have set up your activity to have different resources based on different device states (e.g., landscape versus portrait), your activity will be re-created and `onCreate()` will be called.

Here is where you initialize your user interface and set up anything that needs to be done once, regardless of how the activity gets used.

On the other end of the lifecycle, `onDestroy()` may be called when the activity is shutting down, either because the activity called `finish()` (which "finishes" the activity) or because Android needs RAM and is closing the activity prematurely. Note that `onDestroy()` may not get called if the need for RAM is urgent (e.g., incoming phone call) and that the activity will just get shut down regardless. Hence, `onDestroy()` is mostly for cleanly releasing resources you obtained in `onCreate()` (if any).

onStart(), onRestart(), and onStop()

An activity can come to the foreground either because it is first being launched, or because it is being brought back to the foreground after having been hidden (e.g., by another activity, by an incoming phone call).

The `onStart()` method is called in either of those cases. The `onRestart()` method is called in the case where the activity had been stopped and is now restarting.

Conversely, `onStop()` is called when the activity is about to be stopped.

onPause() and onResume()

The `onResume()` method is called just before your activity comes to the foreground, either after being initially launched, being restarted from a stopped state, or after a pop-up dialog (e.g., incoming call) is cleared. This is a great place to refresh the UI based on things that may have occurred since the user last was looking at your activity. For example, if you are polling a service for changes to some information (e.g., new entries for a feed), `onResume()` is a fine time to both refresh the current view and, if applicable, kick off a background thread to update the view (e.g., via a `Handler`).

Conversely, anything that steals your user away from your activity – mostly, the activation of another activity – will result in your `onPause()` being called. Here, you should undo anything you did in `onResume()`, such as stopping background threads, releasing any exclusive-access resources you may have acquired (e.g., camera), and the like.

Once `onPause()` is called, Android reserves the right to kill off your activity's process at any point. Hence, you should not be relying upon receiving any further events.

The Grace of State

Mostly, the aforementioned methods are for dealing with things at the application-general level (e.g., wiring together the last pieces of your UI in `onCreate()`, closing down background threads in `onPause()`).

However, a large part of the goal of Android is to have a patina of seamlessness. Activities may come and go as dictated by memory requirements, but users are, ideally, unaware that this is going on. If, for example, they were using a calculator, and come back to that calculator after an absence, they should see whatever number(s) they were working on originally – unless they themselves took some action to close down the calculator.

To make all this work, activities need to be able to save their application-instance state, and to do so quickly and cheaply. Since activities could get killed off at any time, activities may need to save their state more frequently than one might expect. Then, when the activity restarts, the activity should get its former state back, so it can restore the activity to the way it appeared previously.

Saving instance state is handled by `onSaveInstanceState()`. This supplies a `Bundle`, into which activities can pour whatever data they need (e.g., the number showing on the calculator's display). This method implementation needs to be speedy, so do not try to do too much fancy – just put your data in the `Bundle` and exit the method.

That instance state is provided to you again in two places:

1. In `onCreate()`
2. In `onRestoreInstanceState()`

It is your choice when you wish to re-apply the state data to your activity – either callback is a reasonable option.

PART III – Data Stores, Network Services, and APIs

CHAPTER 17

Using Preferences

Android has many different ways for you to store data for long-term use by your activity. The simplest to use is the preferences system.

Android allows activities and applications to keep preferences, in the form of key/value pairs (akin to a `Map`), that will hang around between invocations of an activity. As the name suggests, the primary purpose is for you to store user-specified configuration details, such as the last feed the user looked at in your feed reader, or what sort order to use by default on a list, or whatever. Of course, you can store in the preferences whatever you like, so long as it is keyed by a `String` and has a primitive value (`boolean`, `String`, etc.)

Preferences can either be for a single activity or shared among all activities in an application. Eventually, preferences might be shareable across applications, but that is not supported as of the time of this writing.

Getting What You Want

To get access to the preferences, you have three APIs to choose from:

1. `getPreferences()` from within your `Activity`, to access activity-specific preferences
2. `getSharedPreferences()` from within your `Activity` (or other application `Context`), to access application-level preferences

3. getDefaultSharedPreferences(), on PreferencesManager, to get the shared preferences that work in concert with Android's overall preference framework

The first two take a security mode parameter – for now, pass in 0. The getSharedPreferences() method also takes a name of a set of preferences – getPreferences() effectively calls getSharedPreferences() with the activity's class name as the preference set name. The getDefaultSharedPreferences() method takes the Context for the preferences (e.g., your Activity).

All of those methods return an instance of SharedPreferences, which offers a series of getters to access named preferences, returning a suitably-typed result (e.g., getBoolean() to return a boolean preference). The getters also take a default value, which is returned if there is no preference set under the specified key.

Stating Your Preference

Given the appropriate SharedPreferences object, you can use edit() to get an "editor" for the preferences. This object has a set of setters that mirror the getters on the parent SharedPreferences object. It also has:

- remove() to get rid of a single named preference
- clear() to get rid of all preferences
- commit() to persist your changes made via the editor

The last one is important – if you modify preferences via the editor and fail to commit() the changes, those changes will evaporate once the editor goes out of scope.

Conversely, since the preferences object supports live changes, if one part of your application (say, an activity) modifies shared preferences, another part of your application (say, a service) will have access to the changed value immediately.

And Now, a Word From Our Framework

Beginning with the 0.9 SDK, Android has introduced a framework for managing preferences. Ironically, this framework does not change anything shown above. Instead, the framework is more for presenting a consistent set of preference-setting options for users, so different applications do not have to "reinvent the wheel".

The linchpin to the preferences framework is yet another XML data structure. You can describe your application's preferences in an XML file stored in your project's `res/xml/` directory. Given that, Android can present a pleasant user UI for manipulating those preferences, which are then stored in the `SharedPreferences` you get back from `getDefaultSharedPreferences()`.

Below, you will find the preference XML for the Simple preferences sample project:

```
<PreferenceScreen
  xmlns:android="http://schemas.android.com/apk/res/android">
  <CheckBoxPreference
    android:key="@string/checkbox"
    android:title="Checkbox Preference"
    android:summary="Check it on, check it off" />
  <RingtonePreference
    android:key="@string/ringtone"
    android:title="Ringtone Preference"
    android:showDefault="true"
    android:showSilent="true"
    android:summary="Ping a tone, any tone, even silence" />
</PreferenceScreen>
```

The root of the preference XML is a `PreferenceScreen` element. We will explain why it is named that later in this chapter; for now, take it on faith that it is a sensible name.

One of the things you can have inside a `PreferenceScreen` element, not surprisingly, are preference definitions. These are subclasses of `Preference`, such as `CheckBoxPreference` or `RingtonePreference`, as shown above. As one might expect, these allow you to check a checkbox or choose a ringtone, respectively. In the case of `RingtonePreference`, you have your option of allowing users to choose the system default ringtone, or to choose "silence" as a ringtone.

Letting Users Have Their Say

Given that you have set up the preference XML, you can use a nearly-built-in activity for allowing your users to set their preferences. The activity is "nearly-built-in" because you need to subclass it to point it to your preference XML, plus hook it into the rest of your application.

So, for example, here is the `EditPreferences` activity of the Simple project:

```java
package com.commonsware.android.prefs;

import android.app.Activity;
import android.os.Bundle;
import android.preference.PreferenceActivity;


public class EditPreferences extends PreferenceActivity {
  @Override
  public void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);

    addPreferencesFromResource(R.xml.preferences);
  }
}
```

As you can see, there is not much *to* see. All you need to do is call `addPreferencesFromResource()` and specify the XML resource containing your preferences.

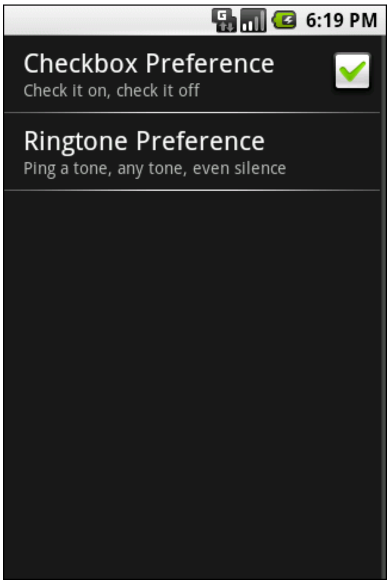
You will also need to add this as an activity to your `AndroidManifest.xml` file:

```xml
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonsware.android.prefs">
    <application android:label="@string/app_name">
        <activity
            android:name=".SimplePrefsDemo"
            android:label="@string/app_name">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
        <activity
            android:name=".EditPreferences"
            android:label="@string/app_name">
        </activity>
    </application>
</manifest>
```

And you will need to arrange to invoke the activity, such as from a menu option, here pulled from SimplePrefsDemo:

```
@Override
public boolean onCreateOptionsMenu(Menu menu) {
  menu.add(Menu.NONE, EDIT_ID, Menu.NONE, "Edit Prefs")
      .setIcon(R.drawable.misc)
      .setAlphabeticShortcut('e');
  menu.add(Menu.NONE, CLOSE_ID, Menu.NONE, "Close")
      .setIcon(R.drawable.eject)
      .setAlphabeticShortcut('c');

  return(super.onCreateOptionsMenu(menu));
}

@Override
public boolean onOptionsItemSelected(MenuItem item) {
  switch (item.getItemId()) {
    case EDIT_ID:
      startActivity(new Intent(this, EditPreferences.class));
      return(true);

    case CLOSE_ID:
      finish();
      return(true);
  }

  return(super.onOptionsItemSelected(item));
}
```

However, that is all that is needed, and it really is not that much code outside of the preferences XML. When you get for your effort is an Android-supplied preference UI:


6:19 PM

Checkbox Preference
Check it on, check it off ✓

Ringtone Preference
Ping a tone, any tone, even silence

Figure 55. The Simple project's preferences UI

The checkbox can be directly checked or unchecked. To change the ringtone preference, just click on the entry in the preference list to bring up a selection dialog:

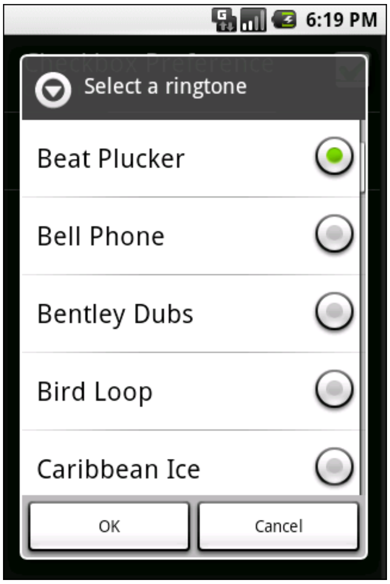


Figure 56. Choosing a ringtone preference

Note that there is no explicit "save" or "commit" button or menu – changes are persisted as soon as they are made.

The `SimplePrefsDemo` activity, beyond having the aforementioned menu, also displays the current preferences via a `TableLayout`:

```
<?xml version="1.0" encoding="utf-8"?>
<TableLayout
  xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
>
  <TableRow>
    <TextView
        android:text="Checkbox:"
        android:paddingRight="5px"
    />
    <TextView android:id="@+id/checkbox"
    />
  </TableRow>
  <TableRow>
    <TextView
        android:text="Ringtone:"
        android:paddingRight="5px"
    />
    <TextView android:id="@+id/ringtone"
    />
  </TableRow>
</TableLayout>
```

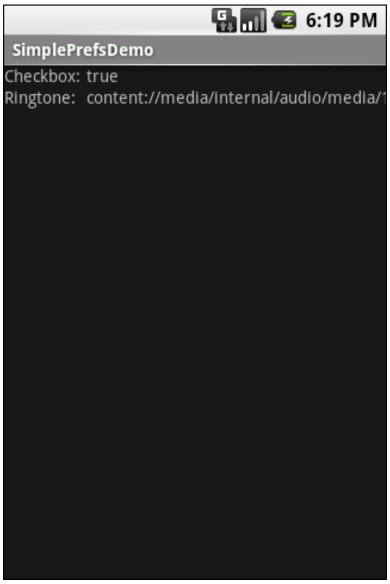
The fields for the table are found in `onCreate()`:

```
@Override
public void onCreate(Bundle savedInstanceState) {
  super.onCreate(savedInstanceState);
  setContentView(R.layout.main);

  checkbox=(TextView)findViewById(R.id.checkbox);
  ringtone=(TextView)findViewById(R.id.ringtone);
}
```

The fields are updated on each `onResume()`:

```
@Override
public void onResume() {
  super.onResume();

  SharedPreferences prefs=PreferenceManager
                          .getDefaultSharedPreferences(this);

  checkbox.setText(new Boolean(prefs
                              .getBoolean("checkbox", false))
                    .toString());
  ringtone.setText(prefs.getString("ringtone", "<unset>"));
}
```

This means the fields will be updated when the activity is opened and after the preferences activity is left (e.g., via the back button):



```
Checkbox: true
Ringtone:  content://media/internal/audio/media/1
```

Figure 57. The Simple project's list of saved preferences

Adding a Wee Bit O' Structure

If you have a lot of preferences for users to set, having them all in one big list may become troublesome. Android's preference framework gives you a few ways to impose a bit of structure on your bag of preferences, including categories and screens.

Categories are added via a `PreferenceCategory` element in your preference XML and are used to group together related preferences. Rather than have your preferences all as children of the root `PreferenceScreen`, you can put a few `PreferenceCategory` elements in the `PreferenceScreen`, and then put your preferences in their appropriate categories. Visually, this adds a divider with the category title between groups of preferences.

If you have lots and lots of preferences – more than is convenient for users to scroll through – you can also put them on separate "screens" by introducing the `PreferenceScreen` element.

Yes, *that* `PreferenceScreen` element.

Any children of `PreferenceScreen` go on their own screen. If you nest `PreferenceScreens`, the parent screen displays the screen as a placeholder entry – tapping that entry brings up the child screen.

For example, from the Structured sample project, here is a preference XML file that contains both `PreferenceCategory` and nested `PreferenceScreen` elements:

```
<PreferenceScreen
  xmlns:android="http://schemas.android.com/apk/res/android">
  <PreferenceCategory android:title="Simple Preferences">
    <CheckBoxPreference
      android:key="@string/checkbox"
      android:title="Checkbox Preference"
      android:summary="Check it on, check it off"
    />
    <RingtonePreference
      android:key="@string/ringtone"
      android:title="Ringtone Preference"
      android:showDefault="true"
      android:showSilent="true"
      android:summary="Ping a tone, any tone, even silence"
    />
  </PreferenceCategory>
  <PreferenceCategory android:title="Detail Screens">
    <PreferenceScreen
      android:key="detail"
      android:title="Detail Screen"
      android:summary="Additional preferences held in another page">
      <CheckBoxPreference
        android:key="@string/checkbox2"
        android:title="Another Checkbox"
        android:summary="On. Off. It really doesn't matter."
      />
    </PreferenceScreen>
  </PreferenceCategory>
</PreferenceScreen>
```

The result, when you use this preference XML with your `PreferenceActivity` implementation, is a categorized list of elements:

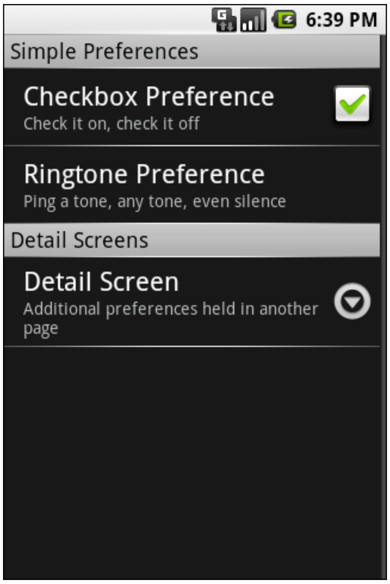

6:39 PM
Simple Preferences
Checkbox Preference
Check it on, check it off
Ringtone Preference
Ping a tone, any tone, even silence
Detail Screens
Detail Screen
Additional preferences held in another page

Figure 58. The Structured project's preference UI, showing categories and a screen placeholder

And, if you tap on the Detail Screen entry, you are taken to the child preference screen:

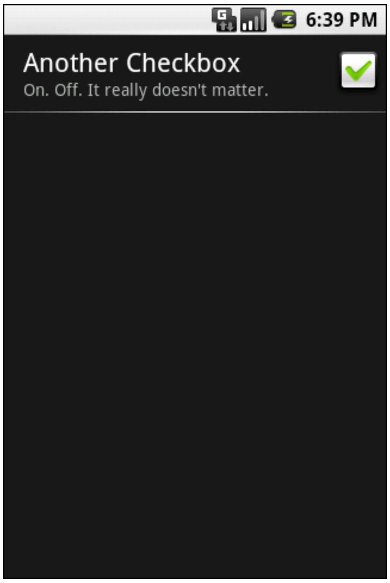


Figure 59. The child preference screen of the Structured project's preference UI

The Kind Of Pop-Ups You Like

Of course, not all preferences are checkboxes and ringtones.

For others, like entry fields and lists, Android uses pop-up dialogs. Users do not enter their preference directly in the preference UI activity, but rather tap on a preference, fill in a value, and click OK to commit the change.

Structurally, in the preference XML, fields and lists are not significantly different from other preference types, as seen in this preference XML from the Dialogs sample project:

```
<PreferenceScreen
  xmlns:android="http://schemas.android.com/apk/res/android">
  <PreferenceCategory android:title="Simple Preferences">
    <CheckBoxPreference
      android:key="@string/checkbox"
      android:title="Checkbox Preference"
      android:summary="Check it on, check it off"
    />
    <RingtonePreference
      android:key="@string/ringtone"
      android:title="Ringtone Preference"
      android:showDefault="true"
      android:showSilent="true"
      android:summary="Ping a tone, any tone, even silence"
    />
  </PreferenceCategory>
  <PreferenceCategory android:title="Detail Screens">
    <PreferenceScreen
      android:key="detail"
      android:title="Detail Screen"
      android:summary="Additional preferences held in another page">
      <CheckBoxPreference
        android:key="@string/checkbox2"
        android:title="Another Checkbox"
        android:summary="On. Off. It really doesn't matter."
      />
    </PreferenceScreen>
  </PreferenceCategory>
  <PreferenceCategory android:title="Simple Preferences">
    <EditTextPreference
      android:key="@string/text"
      android:title="Text Entry Dialog"
      android:summary="Click to pop up a field for entry"
      android:dialogTitle="Enter something useful"
    />
    <ListPreference
```

```
      android:key="@string/list"
      android:title="Selection Dialog"
      android:summary="Click to pop up a list to choose from"
      android:entries="@array/cities"
      android:entryValues="@array/airport_codes"
      android:dialogTitle="Choose a Pennsylvania city" />
  </PreferenceCategory>
</PreferenceScreen>
```

With the field (`EditTextPreference`), in addition to the title and summary you put on the preference itself, you can also supply the title to use for the dialog.

With the list (`ListPreference`), you supply both a dialog title and two string-array resources: one for the display names, one for the values. These need to be in the same order – the index of the chosen display name determines which value is stored as the preference in the `SharedPreferences`. For example, here are the arrays for use by the `ListPreference` shown above:

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
  <string-array name="cities">
    <item>Philadelphia</item>
    <item>Pittsburgh</item>
    <item>Allentown/Bethlehem</item>
    <item>Erie</item>
    <item>Reading</item>
    <item>Scranton</item>
    <item>Lancaster</item>
    <item>Altoona</item>
    <item>Harrisburg</item>
  </string-array>
  <string-array name="airport_codes">
    <item>PHL</item>
    <item>PIT</item>
    <item>ABE</item>
    <item>ERI</item>
    <item>RDG</item>
    <item>AVP</item>
    <item>LNS</item>
    <item>AOO</item>
    <item>MDT</item>
  </string-array>
</resources>
```

When you bring up the preference UI, you start with another category with another pair of preference entries:

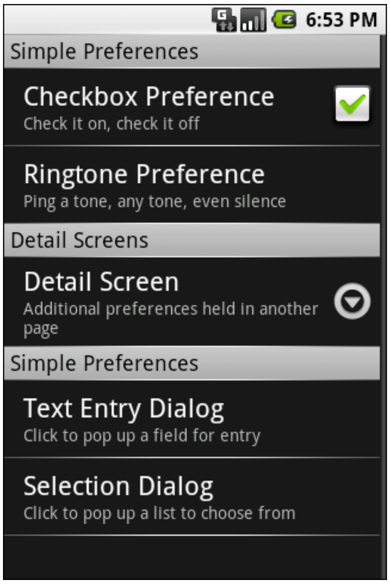

6:53 PM
Simple Preferences
Checkbox Preference
Check it on, check it off
Ringtone Preference
Ping a tone, any tone, even silence
Detail Screens
Detail Screen
Additional preferences held in another page
Simple Preferences
Text Entry Dialog
Click to pop up a field for entry
Selection Dialog
Click to pop up a list to choose from

Figure 60. The preference screen of the Dialogs project's preference UI

Tapping the Text Entry Dialog one brings up…a text entry dialog – in this case, with the prior preference entry pre-filled-in:

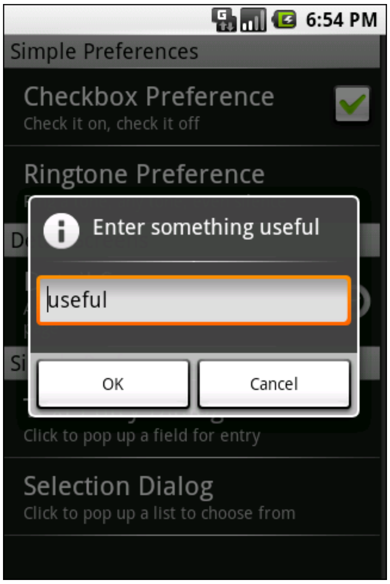


Figure 61. Editing a text preference

Tapping the Selection Dialog one brings up…a selection dialog, showing the display names from the one array:

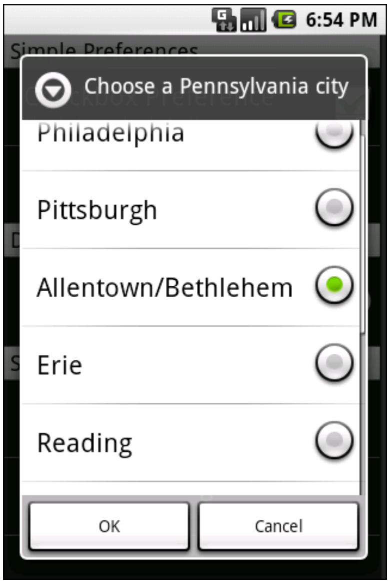


Figure 62. Editing a list preference

CHAPTER 18

Accessing Files

While Android offers structured storage, via preferences and databases, sometimes a simple file will suffice. Android offers two models for accessing files: one for files pre-packaged with your application, and one for files created on-device by your application.

You And The Horse You Rode In On

Let's suppose you have some static data you want to ship with the application, such as a list of words for a spell-checker. The easiest way to deploy that is to put the file in the `res/raw` directory, so it gets put in the Android application `.apk` file as part of the packaging process.

To access this file, you need to get yourself a `Resources` object. From an activity, that is as simple as calling `getResources()`. A `Resources` object offers `openRawResource()` to get an `InputStream` on the file you specify. Rather than a path, `openRawResource()` expects an integer identifier for the file as packaged. This works just like accessing widgets via `findViewById()` – if you put a file named `words.xml` in `res/raw`, the identifier is accessible in Java as `R.raw.words`.

Since you can only get an `InputStream`, you have no means of modifying this file. Hence, it is really only useful for static reference data. Moreover, since it is unchanging until the user installs an updated version of your application package, either the reference data has to be valid for the foreseeable future, or you will need to provide some means of updating the data. The simplest way to handle that is to use the reference data to bootstrap some other modifiable form of storage (e.g., a database), but this makes for two copies of the data in storage. An alternative is to keep the reference data as-is but keep modifications in a file or database, and merge them together when you need a complete picture of the information. For example, if your application ships a file of URLs, you could have a second file that tracks URLs added by the user or reference URLs that were deleted by the user.

In the `Static` sample project, you will find a reworking of the listbox example from earlier, this time using a static XML file instead of a hardwired array in Java. The layout is the same:

```xml
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent" >
  <TextView
    android:id="@+id/selection"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
  />
  <ListView
    android:id="@android:id/list"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:drawSelectorOnTop="false"
  />
</LinearLayout>
```

In addition to that XML file, you also need an XML file with the words to show in the list:

```xml
<words>
  <word value="lorem" />
  <word value="ipsum" />
  <word value="dolor" />
  <word value="sit" />
  <word value="amet" />
  <word value="consectetuer" />
  <word value="adipiscing" />
  <word value="elit" />
  <word value="morbi" />
  <word value="vel" />
  <word value="ligula" />
  <word value="vitae" />
  <word value="arcu" />
  <word value="aliquet" />
  <word value="mollis" />
  <word value="etiam" />
  <word value="vel" />
  <word value="erat" />
  <word value="placerat" />
  <word value="ante" />
  <word value="porttitor" />
  <word value="sodales" />
  <word value="pellentesque" />
  <word value="augue" />
  <word value="purus" />
</words>
```

While this XML structure is not exactly a model of space efficiency, it will suffice for a demo.

The Java code now must read in that XML file, parse out the words, and put them someplace for the list to pick up:

```
public class StaticFileDemo extends ListActivity {
  TextView selection;
  ArrayList items=new ArrayList();

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    selection=(TextView)findViewById(R.id.selection);

    try {
      InputStream in=getResources().openRawResource(R.raw.words);
      DocumentBuilder builder=DocumentBuilderFactory
                               .newInstance()
                               .newDocumentBuilder();
      Document doc=builder.parse(in, null);
      NodeList words=doc.getElementsByTagName("word");

      for (int i=0;i<words.getLength();i++) {
        items.add(((Element)words.item(i)).getAttribute("value"));
      }

      in.close();
    }
    catch (Throwable t) {
      Toast
        .makeText(this, "Exception: "+t.toString(), 2000)
        .show();
    }
    setListAdapter(new ArrayAdapter<String>(this,
                                 android.R.layout.simple_list_item_1,
                                 items));
  }

  public void onListItemClick(ListView parent, View v, int position,
                 long id) {
    selection.setText(items.get(position).toString());
  }
}
```

The differences mostly lie within `onCreate()`. We get an `InputStream` for the XML file (`getResources().openRawResource(R.raw.words)`), then use the built-in XML parsing logic to parse the file into a DOM `Document`, pick out the word elements, then pour the value attributes into an `ArrayList` for use by the `ArrayAdapter`.

The resulting activity looks the same as before, since the list of words is the same, just relocated:

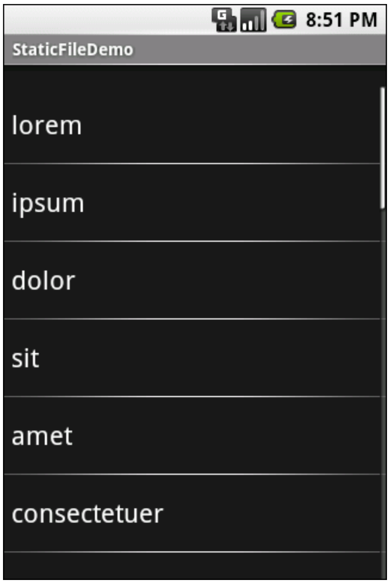


Figure 63. The StaticFileDemo sample application

Of course, there are even easier ways to have XML files available to you as pre-packaged files – using an XML resource. That is covered in the next chapter. However, while this example used XML, the file could just as easily have been a simple one-word-per-line list, or in some other format not handled natively by the Android resource system.

Readin' 'n Writin'

Reading and writing your own, application-specific data files is nearly identical to what you might do in a desktop Java application. The key is to use `openFileInput()` and `openFileOutput()` on your `Activity` or other `Context` to get an `InputStream` and `OutputStream`, respectively. From that point forward, it is not much different than regular Java I/O logic:

- Wrap those streams as needed, such as using an `InputStreamReader` or `OutputStreamWriter` for text-based I/O
- Read or write the data
- Use `close()` to release the stream when done

Relative paths (i.e., those without leading slashes) are local to the application. If two applications both try reading a `notes.txt` file via `openFileInput()`, they will each access their own edition of the file. If you need to have one file accessible from many places, you probably want to create a content provider, as will be described an upcoming chapter.

Below you will see the layout for the world's most trivial text editor, pulled from the `ReadWrite` sample application:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  android:orientation="vertical">
  <Button android:id="@+id/close"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="Close" />
  <EditText
    android:id="@+id/editor"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:singleLine="false"
    />
</LinearLayout>
```

All we have here is a large text-editing widget, with a "Close" button above it.

The Java is only slightly more complicated:

```
package com.commonsware.android.files;

import android.app.Activity;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;
import android.widget.Toast;
import java.io.BufferedReader;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.io.InputStream;
import java.io.OutputStream;
import java.io.OutputStreamWriter;

public class ReadWriteFileDemo extends Activity {
  EditText editor;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    editor=(EditText)findViewById(R.id.editor);

    Button btn=(Button)findViewById(R.id.close);

    btn.setOnClickListener(new Button.OnClickListener() {
      public void onClick(View v) {
        finish();
      }
    });
  }

  public void onResume() {
    super.onResume();

    try {
      InputStream in=openFileInput("notes.txt");

      if (in!=null) {
        BufferedReader reader=new BufferedReader(new InputStreamReader(in));
        String str;
        StringBuffer buf=new StringBuffer();
        while ((str = reader.readLine()) != null) {
          buf.append(str+"\n");
        }

        in.close();
        editor.setText(buf.toString());
      }
    }
    catch (java.io.FileNotFoundException e) {
      // that's OK, we probably haven't created it yet
    }
    catch (Throwable t) {
      Toast
        .makeText(this, "Exception: "+t.toString(), 2000)
        .show();
    }
  }

  public void onPause() {
    super.onPause();

    try {
      OutputStreamWriter out=
          new OutputStreamWriter(openFileOutput("notes.txt", 0));

      out.write(editor.getText().toString());
      out.close();
    }
    catch (Throwable t) {
```

First, we wire up the button to close out our activity when clicked by using `setOnClickListener()` to invoke `finish()` on the activity.

Next, we hook into `onResume()`, so we get control when our editor is coming back to life, from a fresh launch or after having been frozen. We use `openFileInput()` to read in `notes.txt` and pour the contents into the text editor. If the file is not found, we assume this is the first time the activity was run (or the file was deleted by other means), and we just leave the editor empty.

Finally, we hook into `onPause()`, so we get control as our activity gets hidden by other user activity or is closed, such as via our "Close" button. Here, we use `openFileOutput()` to open `notes.txt`, into which we pour the contents of the text editor.

The net result is that we have a persistent notepad: whatever is typed in will remain until deleted, surviving our activity being closed, the phone being turned off, or similar situations. Of course, it doesn't look like much:

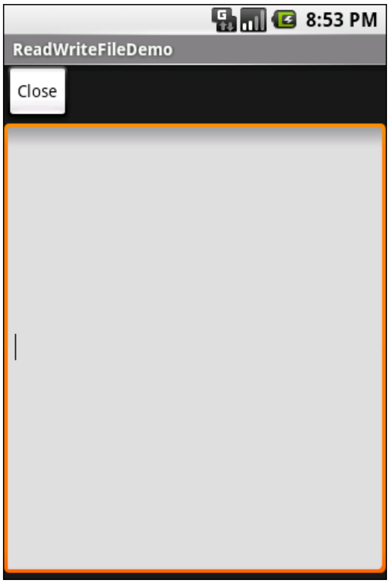
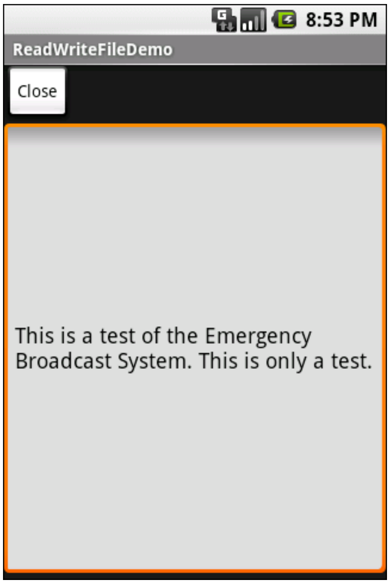


Figure 64. The ReadWriteFileDemo sample application, as initially launched



This is a test of the Emergency Broadcast System. This is only a test.

Figure 65. The same application, after entering some text

CHAPTER 19

Working with Resources

Resources are static bits of information held outside the Java source code. You have seen one type of resource – the layout – frequently in the examples in this book. There are many other types of resource, such as images and strings, that you can take advantage of in your Android applications.

The Resource Lineup

Resources are stored as files under the `res/` directory in your Android project layout. With the exception of raw resources (`res/raw/`), all the other types of resources are parsed for you, either by the Android packaging system or by the Android system on the device or emulator. So, for example, when you lay out an activity's UI via a layout resource (`res/layout/`), you do not have to parse the layout XML yourself – Android handles that for you.

In addition to layout resources (first seen in an earlier chapter) and raw resources (introduced in another earlier chapter), there are several other types of resource available to you, including:

- Animations (`res/anim/`), designed for short clips as part of a user interface, such as an animation suggesting the turning of a page when a button is clicked
- Images (`res/drawable`), for putting static icons or other pictures in a user interface

- Strings, colors, arrays, and dimensions (`res/values/`), to both give these sorts of constants symbolic names and to keep them separate from the rest of the code (e.g., for internationalization and localization)
- XML (`res/xml/`), for static XML files containing your own data and structure

String Theory

Keeping your labels and other bits of text outside the main source code of your application is generally considered to be a very good idea. In particular, it helps with internationalization (I18N) and localization (L10N), covered later in this chapter. Even if you are not going to translate your strings to other languages, it is easier to make corrections if all the strings are in one spot instead of scattered throughout your source code.

Android supports regular externalized strings, along with "string formats", where the string has placeholders for dynamically-inserted information. On top of that, Android supports simple text formatting, called "styled text", so you can make your words be bold or italic intermingled with normal text.

Plain Strings

Generally speaking, all you need to do is have an XML file in the `res/values` directory (typically named `res/values/strings.xml`), with a `resources` root element, and one child `string` element for each string you wish to encode as a resource. The `string` element takes a `name` attribute, which is the unique name for this string, and a single text element containing the text of the string:

```
<resources>
  <string name="quick">The quick brown fox...</string>
  <string name="laughs">He who laughs last...</string>
</resources>
```

The only tricky part is if the string value contains a quote (`"`) or an apostrophe (`'`). In those cases, you will want to escape those values, by preceding them with a backslash (e.g., `These are the times that try men\'s souls`). Or, if it is just an apostrophe, you could enclose the value in quotes (e.g., `"These are the times that try men's souls."`).

You can then reference this string from a layout file (as `@string/...`, where the ellipsis is the unique name – e.g., `@string/laughs`). Or you can get the string from your Java code by calling `getString()` with the resource ID of the string resource, that being the unique name prefixed with `R.string.` (e.g., `getString(R.string.quick)`).

String Formats

As with other implementations of the Java language, Android's Dalvik VM supports string formats. Here, the string contains placeholders representing data to be replaced at runtime by variable information (e.g., `My name is %1$s`). Plain strings stored as resources can be used as string formats:

```
String strFormat=getString(R.string.my_name);
String strResult=String.format(strFormat, "Tim");
((TextView)findViewById(R.layout.some_label))
  .setText(strResult);
```

Styled Text

If you want really rich text, you should have raw resources containing HTML, then pour those into a WebKit widget. However, for light HTML formatting, using `<b>`, `<i>`, and `<u>`, you can just use a string resource:

```
<resources>
  <string name="b">This has <b>bold</b> in it.</string>
  <string name="i">Whereas this has <i>italics</i>!</string>
</resources>
```

You can access these the same as with plain strings, with the exception that the result of the `getString()` call is really a `Spanned`:

```
((TextView)findViewById(R.layout.another_label))
            .setText(getString(R.string.laughs));
```

Styled Formats

Where styled text gets tricky is with styled string formats, as `String.format()` works on `String` objects, not `Spanned` objects with formatting instructions. If you really want to have styled string formats, here is the workaround:

1. Entity-escape the angle brackets in the string resource (e.g., `this is &lt;b&gt;%1$s&lt;/b&gt;`)
2. Retrieve the string resource as normal, though it will not be styled at this point (e.g., `getString(R.string.funky_format)`)
3. Generate the format results, being sure to escape any string values you substitute in, in case they contain angle brackets or ampersands

```
String.format(getString(R.string.funky_format),
              TextUtils.htmlEncode(strName));
```

4. Convert the entity-escaped HTML into a `Spanned` object via `Html.fromHtml()`

```
someTextView.setText(Html
                     .fromHtml(resultFromStringFormat));
```

To see this in action, let's look at the `Strings` demo. Here is the layout file:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    >
    <Button android:id="@+id/format"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:text="@string/btn_name"
      />
    <EditText android:id="@+id/name"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      />
  </LinearLayout>
  <TextView android:id="@+id/result"
```

```
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    />
</LinearLayout>
```

As you can see, it is just a button, a field, and a label. The intent is for somebody to enter their name in the field, then click the button to cause the label to be updated with a formatted message containing their name.

The `Button` in the layout file references a string resource (`@string/btn_name`), so we need a string resource file (`res/values/strings.xml`):

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
  <string name="app_name">StringsDemo</string>
  <string name="btn_name">Name:</string>
  <string name="funky_format">My name is &lt;b&gt;%1$s&lt;/b&gt;</string>
</resources>
```

The `app_name` resource is automatically created by the `activityCreator` script. The `btn_name` string is the caption of the `Button`, while our styled string format is in `funky_format`.

Finally, to hook all this together, we need a pinch of Java:

```
package com.commonsware.android.resources;

import android.app.Activity;
import android.os.Bundle;
import android.text.TextUtils;
import android.text.Html;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;
import android.widget.TextView;

public class StringsDemo extends Activity {
  EditText name;
  TextView result;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    name=(EditText)findViewById(R.id.name);
    result=(TextView)findViewById(R.id.result);

    Button btn=(Button)findViewById(R.id.format);

    btn.setOnClickListener(new Button.OnClickListener() {
      public void onClick(View v) {
        applyFormat();
      }
    });
  }

  private void applyFormat() {
    String format=getString(R.string.funky_format);
    String simpleResult=String.format(format,
                     TextUtils.htmlEncode(name.getText().toString()));
    result.setText(Html.fromHtml(simpleResult));
  }
}
```

The string resource manipulation can be found in `applyFormat()`, which is called when the button is clicked. First, we get our format via `getString()` – something we could have done at `onCreate()` time for efficiency. Next, we format the value in the field using this format, getting a `String` back, since the string resource is in entity-encoded HTML. Note the use of `TextUtils.htmlEncode()` to entity-encode the entered name, in case somebody decides to use an ampersand or something. Finally, we convert the simple HTML into a styled text object via `Html.fromHtml()` and update our label.

When the activity is first launched, we have an empty label:

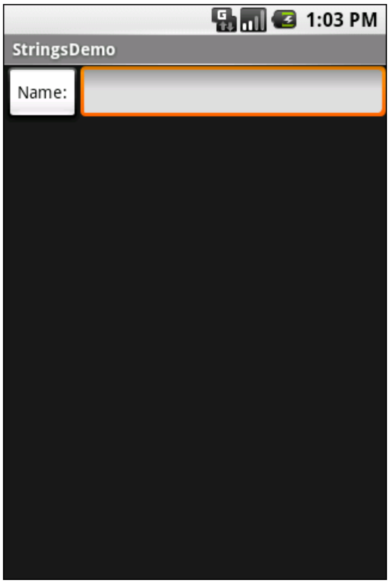
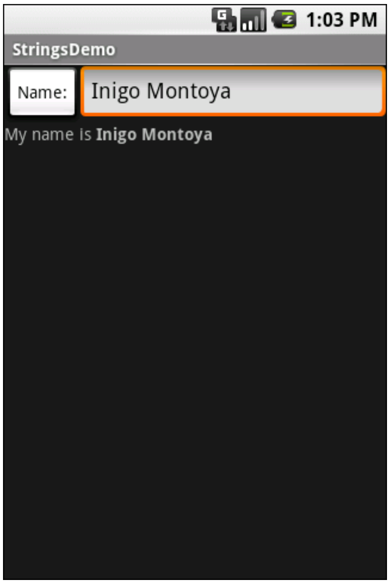


Figure 66. The StringsDemo sample application, as initially launched

but if we fill in a name and click the button, we get:



My name is **Inigo Montoya**

Figure 67. The same application, after filling in some heroic figure's name

Got the Picture?

Android supports images in the PNG, JPEG, and GIF formats. GIF is officially discouraged, however; PNG is the overall preferred format. Images can be used anywhere that requires a `Drawable`, such as the image and background of an `ImageView`.

Using images is simply a matter of putting your image files in `res/drawable/` and then referencing them as a resource. Within layout files, images are referenced as `@drawable/...` where the ellipsis is the base name of the file (e.g., for `res/drawable/foo.png`, the resource name is `@drawable/foo`). In Java, where you need an image resource ID, use `R.drawable.` plus the base name (e.g., `R.drawable.foo`).

If you need a `Uri` to an image resource, you can use one of two different string formats for the path:

1. `android.resource://com.example.app/...`, where `com.example.app` is the name of the Java package used by your application in `AndroidManifest.xml` and `...` is the numeric resource ID for the resource in question (e.g., the value of `R.drawable.foo`)
2. `android.resource://com.example.app/raw/...`, where `com.example.app` is the name of the Java package used by your application in `AndroidManifest.xml` and `...` is the textual name of the raw resource (e.g., `foo` for `res/drawable/foo.png`)

Note that Android ships with some image resources built in. Those are addressed in Java with an `android.R.drawable` prefix to distinguish them from application-specific resources (e.g., `android.R.drawable.picture_frame`).

So, let's update the previous example to use an icon for the button instead of the string resource. This can be found as `Images`. First, we slightly adjust the layout file, using an `ImageButton` and referencing a drawable named `@drawable/icon`:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
```

```
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    >
    <ImageButton android:id="@+id/format"
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:src="@drawable/icon"
      />
    <EditText android:id="@+id/name"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      />
  </LinearLayout>
  <TextView android:id="@+id/result"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    />
</LinearLayout>
```

Next, we need to put an image file in `res/drawable` with a base name of icon. In this case, we use a 32x32 PNG file from the Nuvola icon set. Finally, we twiddle the Java source, replacing our `Button` with an `ImageButton`:

```
package com.commonsware.android.resources;

import android.app.Activity;
import android.os.Bundle;
import android.text.TextUtils;
import android.text.Html;
import android.view.View;
import android.widget.Button;
import android.widget.ImageButton;
import android.widget.EditText;
import android.widget.TextView;

public class ImagesDemo extends Activity {
  EditText name;
  TextView result;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    name=(EditText)findViewById(R.id.name);
    result=(TextView)findViewById(R.id.result);
    ImageButton btn=(ImageButton)findViewById(R.id.format);

    btn.setOnClickListener(new Button.OnClickListener() {
      public void onClick(View v) {
        applyFormat();
      }
    });
  }

  private void applyFormat() {
    String format=getString(R.string.funky_format);
    String simpleResult=String.format(format,
                        TextUtils.htmlEncode(name.getText().toString()));
    result.setText(Html.fromHtml(simpleResult));
  }
}
```

Now, our button has the desired icon:

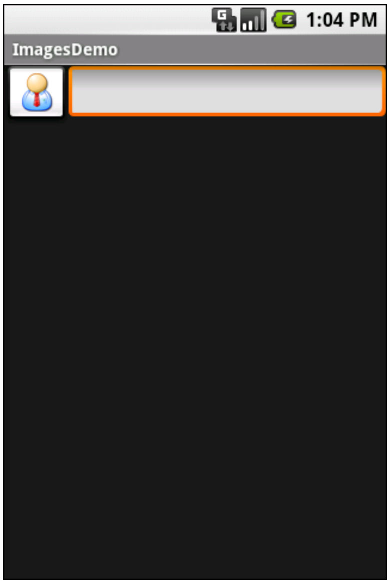


Figure 68. The ImagesDemo sample application

XML: The Resource Way

In a previous chapter, we showed how you can package XML files as raw resources and get access to them for parsing and usage. There is another way of packaging static XML with your application: the XML resource.

Simply put the XML file in `res/xml/`, and you can access it by `getXml()` on a `Resources` object, supplying it a resource ID of `R.xml.` plus the base name of your XML file. So, in an activity, with an XML file of `words.xml`, you could call `getResources().getXml(R.xml.words)`.

This returns an instance of the presently-undocumented `XmlPullParser`, found in the `org.xmlpull.v1` Java namespace. Documentation for this library can be found at the parser's site as of this writing.

An XML pull parser is event-driven: you keep calling `next()` on the parser to get the next event, which could be `START_TAG`, `END_TAG`, `END_DOCUMENT`, etc. On a `START_TAG` event, you can access the tag's name and attributes; a single `TEXT` event represents the concatenation of all text nodes that are direct children of this element. By looping, testing, and invoking per-element logic, you parse the file.

To see this in action, let's rewrite the Java code for the `Static` sample project to use an XML resource. This new project, `XML`, requires that you place the `words.xml` file from `Static` not in `res/raw/`, but in `res/xml/`. The layout stays the same, so all that needs replacing is the Java source:

```java
package com.commonsware.android.resources;

import android.app.Activity;
import android.os.Bundle;
import android.app.ListActivity;
import android.view.View;
import android.widget.AdapterView;
import android.widget.ArrayAdapter;
import android.widget.ListView;
import android.widget.TextView;
import android.widget.Toast;
import java.io.InputStream;
import java.util.ArrayList;
import org.xmlpull.v1.XmlPullParser;
import org.xmlpull.v1.XmlPullParserException;

public class XMLResourceDemo extends ListActivity {
  TextView selection;
  ArrayList items=new ArrayList();

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    selection=(TextView)findViewById(R.id.selection);

    try {
      XmlPullParser xpp=getResources().getXml(R.xml.words);

      while (xpp.getEventType()!=XmlPullParser.END_DOCUMENT) {
        if (xpp.getEventType()==XmlPullParser.START_TAG) {
          if (xpp.getName().equals("word")) {
            items.add(xpp.getAttributeValue(0));
          }
        }

        xpp.next();
      }
    }
    catch (Throwable t) {
      Toast
        .makeText(this, "Request failed: "+t.toString(), 4000)
        .show();
    }

    setListAdapter(new ArrayAdapter<String>(this,
                              android.R.layout.simple_list_item_1,
                              items));
  }

  public void onListItemClick(ListView parent, View v, int position,
                              long id) {
    selection.setText(items.get(position).toString());
  }
}
```

Now, inside our `try...catch` block, we get our `XmlPullParser` and loop until the end of the document. If the current event is `START_TAG` and the name of the element is `word` (`xpp.getName().equals("word")`), then we get the one-and-only attribute and pop that into our list of items for the selection widget. Since we're in complete control over the XML file, it is safe enough to assume there is exactly one attribute. But, if you were not as comfortable that the XML is properly defined, you might consider checking the attribute count (`getAttributeCount()`) and the name of the attribute (`getAttributeName()`) before blindly assuming the `0`-index attribute is what you think it is.

The result looks the same as before, albeit with a different name in the title bar:

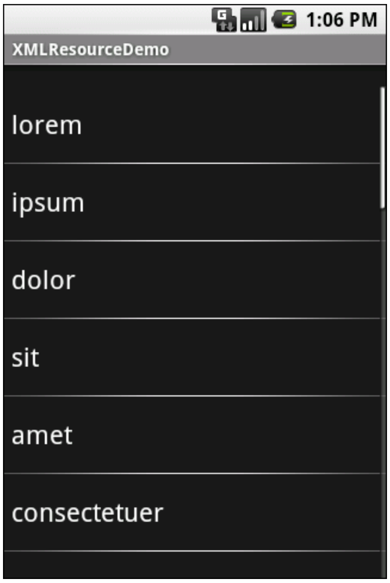


Figure 69. The XMLResourceDemo sample application

Miscellaneous Values

In the `res/values/` directory, you can place one (or more) XML files describing simple resources: dimensions, colors, and arrays. We have already seen uses of dimensions and colors in previous examples, where they were passed as simple strings (e.g., `"10px"`) as parameters to calls. You can, of course, set these up as Java static final objects and use their symbolic names...but this only works inside Java source, not in layout XML files. By putting these values in resource XML files, you can reference them from both Java and layouts, plus have them centrally located for easy editing.

Resource XML files have a root element of `resources`; everything else is a child of that root.

Dimensions

Dimensions are used in several places in Android to describe distances, such a widget's padding. While this book usually uses pixels (e.g., `10px` for ten pixels), there are several different units of measurement available to you:

- `in` and `mm` for inches and millimeters, respectively, based on the actual size of the screen
- `pt` for points, which in publishing terms is 1/72nd of an inch (again, based on the actual physical size of the screen)
- `dp` and `sp` for device-independent pixels and scale-independent pixels – one pixel equals one dp for a 160dpi resolution screen, with the ratio scaling based on the actual screen pixel density (scale-independent pixels also take into account the user's preferred font size)

To encode a dimension as a resource, add a `dimen` element, with a `name` attribute for your unique name for this resource, and a single child text element representing the value:

```
<resources>
  <dimen name="thin">10px</dimen>
  <dimen name="fat">1in</dimen>
</resources>
```

In a layout, you can reference dimensions as `@dimen/...`, where the ellipsis is a placeholder for your unique name for the resource (e.g., `thin` and `fat` from the sample above). In Java, you reference dimension resources by the unique name prefixed with `R.dimen.` (e.g., `Resources.getDimen(R.dimen.thin)`).

Colors

Colors in Android are hexadecimal RGB values, also optionally specifying an alpha channel. You have your choice of single-character hex values or double-character hex values, leaving you with four styles:

- `#RGB`

- `#ARGB`
- `#RRGGBB`
- `#AARRGGBB`

These work similarly to their counterparts in Cascading Style Sheets (CSS).

You can, of course, put these RGB values as string literals in Java source or layout resources. If you wish to turn them into resources, though, all you need to do is add `color` elements to the resources file, with a `name` attribute for your unique name for this color, and a single text element containing the RGB value itself:

```
<resources>
  <color name="yellow_orange">#FFD555</color>
  <color name="forest_green">#005500</color>
  <color name="burnt_umber">#8A3324</color>
</resources>
```

In a layout, you can reference colors as `@color/...`, replacing the ellipsis with your unique name for the color (e.g., `burnt_umber`). In Java, you reference color resources by the unique name prefixed with `R.color.` (e.g., `Resources.getColor(R.dimen.forest_green)`).

Arrays

Array resources are designed to hold lists of simple strings, such as a list of honorifics (Mr., Mrs., Ms., Dr., etc.).

In the resource file, you need one `string-array` element per array, with a `name` attribute for the unique name you are giving the array. Then, add one or more child `item` elements, each of which having a single text element with the value for that entry in the array:

```
<resources>
  <array name="honorifics">
    <item>Dr.</item>
    <item>Mr.</item>
    <item>Mrs.</item>
    <item>Ms.</item>
  </array>
</resources>
```

From your Java code, you can then use `Resources.getStringArray()` to get a `String[]` of the items in the list. The parameter to `getStringArray()` is your unique name for the array, prefixed with `R.array.` (e.g., `Resources.getStringArray(R.array.honorifics)`).

Different Strokes for Different Folks

One set of resources may not fit all situations where your application may be used. One obvious area comes with string resources and dealing with internationalization (I18N) and localization (L10N). Putting strings all in one language works fine – probably at least for the developer – but only covers one language.

That is not the only scenario where resources might need to differ, though. Here are others:

- **Screen orientation**: is the screen in a portrait orientation? Landscape? Is the screen square and, therefore, does not really have an orientation?
- **Screen size**: how many pixels does the screen have, so you can size your resources accordingly (e.g., large versus small icons)?
- **Touchscreen**: does the device have a touchscreen? If so, is the touchscreen set up to be used with a stylus or a finger?
- **Keyboard**: what keyboard does the user have (QWERTY, numeric, neither), either now or as an option?
- **Other input**: does the device have some other form of input, like a directional pad or click-wheel?

The way Android presently handles this is by having multiple resource directories, with the criteria for each embedded in their names.

Suppose, for example, you want to support strings in both English and Spanish. Normally, for a single-language setup, you would put your strings in a file named `res/values/strings.xml`. To support both English and Spanish, you would create two folders, `res/values-en` and `res/values-es`, where the value after the hyphen is the ISO 639-1 two-letter code for the language you want. Your English-language strings would go in `res/values-en/strings.xml` and the Spanish ones in `res/values-es/strings.xml`. Android will choose the proper file based on the user's device settings.

Seems easy, right?

Where things start to get complicated is when you need to use multiple disparate criteria for your resources. This may come most frequently with layouts, as you might want one layout for portrait and small screens, one layout for larger screens in landscape mode, and variations of each for finger-input versus other types of input (keyboard, stylus). This will allow you to make the best use of the available screen "real estate", without any coding changes to your activity using the layout.

Once you get into these sorts of situations, though, all sorts of rules come into play, such as:

- The configuration options (e.g., `-en`) have a particular order of precedence, and they must appear in the directory name in that order. The Android documentation outlines the specific order in which these options can appear. For the purposes of this example, screen orientation must precede touchscreen type, which must precede screen size.
- There can only be one value of each configuration option category per directory. You cannot, for example, consider portrait and square screens to be the same – each will require its own named `res/layout...` folder.
- Options are case sensitive

So, for the scenario described above, in theory, we would need the following directories:

- `res/layout-finger`
- `res/layout-square-finger`
- `res/layout-land-finger-640x480`
- `res/layout-notouch`
- `res/layout-square-notouch`
- `res/layout-land-notouch-640x480`
- `res/layout-stylus`
- `res/layout-square-stylus`
- `res/layout-land-stylus-640x480`

Note that for some of these, the actual layout files will be identical. For example, we only care about finger layouts being different than the other two, but since we cannot combine those two, we would theoretically have to have separate directories with identical contents for `notouch` and `stylus`.

Also note that there is nothing preventing you from also having a directory with the unadorned base name (`res/layout`). In fact, this is probably a good idea, in case future editions of the Android runtime introduce other configuration options you did not consider – having a default layout might make the difference between your application working or failing on that new device.

Now, we can "cheat" a bit, by decoding the rules Android uses for determining which, among a set of candidates, is the "right" resource directory to use:

1. First up, Android tosses out ones that are specifically invalid. So, for example, if the screen size of the device is 320x240, the `640x480` directories would be dropped as candidates, since they specifically call for some other size.
2. Next, Android counts the number of matches for each folder, and only pays attention to those with the most matches.

3. Finally, Android goes in the order of precedence of the options – in other words, it goes from left to right in the directory name.

So we could skate by with only the following configurations:

- `res/layout-land-finger-640x480`
- `res/layout-land-640x480`
- `res/layout-finger`
- `res/layout`

If the device is in portrait or square mode, or does not have a 640x480 screen size, the first two candidates will be skipped, and the layout will be chosen based on whether the device supports finger input or not. Otherwise, one of the two landscape 640x480 layouts will be chosen, as they would be a "stronger" match than the others, with the final determination being on whether the device supports finger input or not.

CHAPTER 20

Managing and Accessing Local Databases

SQLite is a very popular embedded database, as it combines a clean SQL interface with a very small memory footprint and decent speed. Moreover, it is public domain, so everyone can use it. Lots of firms (Adobe, Apple, Google, Sun, Symbian) and open source projects (Mozilla, PHP, Python) all ship products with SQLite.

For Android, SQLite is "baked into" the Android runtime, so every Android application can create SQLite databases. Since SQLite uses a SQL interface, it is fairly straightforward to use for people with experience in other SQL-based databases. However, its native API is not JDBC, and JDBC might be too much overhead for a memory-limited device like a phone, anyway. Hence, Android programmers have a different API to learn – the good news being is that it is not that difficult.

This chapter will cover the basics of SQLite use in the context of working on Android. It by no means is a thorough coverage of SQLite as a whole. If you want to learn more about SQLite and how to use it in other environment than Android, a fine book is The Definitive Guide to SQLite by Michael Owens.

Activities will typically access a database via a content provider or service. As such, this chapter does not have a full example. You will find a full example of a content provider that accesses a database in the Building a Content Provider chapter.

A Quick SQLite Primer

SQLite, as the name suggests, uses a dialect of SQL for queries (`SELECT`), data manipulation (`INSERT`, et. al.), and data definition (`CREATE TABLE`, et. al.). SQLite has a few places where it deviates from the SQL-92 standard, no different than most SQL databases. The good news is that SQLite is so space-efficient that the Android runtime can include all of SQLite, not some arbitrary subset to trim it down to size.

The biggest difference from other SQL databases you will encounter is probably the data typing. While you can specify the data types for columns in a `CREATE TABLE` statement, and while SQLite will use those as a hint, that is as far as it goes. You can put whatever data you want in whatever column you want. Put a string in an `INTEGER` column? Sure! No problem! Vice versa? Works too! SQLite refers to this as "manifest typing", as described in the documentation:

> *In manifest typing, the datatype is a property of the value itself, not of the column in which the value is stored. SQLite thus allows the user to store any value of any datatype into any column regardless of the declared type of that column.*

In addition, there are a handful of standard SQL features not supported in SQLite, notably `FOREIGN KEY` constraints, nested transactions, `RIGHT OUTER JOIN` and `FULL OUTER JOIN`, and some flavors of `ALTER TABLE`.

Beyond that, though, you get a full SQL system, complete with triggers, transactions, and the like. Stock SQL statements, like `SELECT`, work pretty much as you might expect.

If you are used to working with a major database, like Oracle, you may look upon SQLite as being a "toy" database. Please bear in mind that Oracle and

SQLite are meant to solve different problems, and that you will not be seeing a full copy of Oracle on a phone any time real soon, in all likelihood.

Start at the Beginning

No databases are automatically supplied to you by Android. If you want to use SQLite, you have to create your own database, then populate it with your own tables, indexes, and data.

To create and open a database, your best option is to craft a subclass of `SQLiteOpenHelper`. This class wraps up the logic to create and upgrade a database, per your specifications, as needed by your application. Your subclass of `SQLiteOpenHelper` will need three methods:

- The constructor, chaining upward to the `SQLiteOpenHelper` constructor. This takes the `Context` (e.g., an `Activity`), the name of the database, an optional cursor factory (typically, just pass null), and an integer representing the version of the database schema you are using.
- `onCreate()`, which passes you a `SQLiteDatabase` object that you need to populate with tables and initial data, as appropriate.
- `onUpgrade()`, which passes you a `SQLiteDatabase` object and the old and new version numbers, so you can figure out how best to convert the database from the old schema to the new one. The simplest, albeit least friendly, approach is to simply drop the old tables and create new ones. This is covered in greater detail in the chapter on creating a content provider.

The rest of this chapter will discuss how you actually create tables, insert data, drop tables, etc., and will show sample code from a `SQLiteOpenHelper` subclass.

To use your `SQLiteOpenHelper` subclass, create an instance and ask it to `getReadableDatabase()` or `getWriteableDatabase()`, depending upon whether or not you will be changing its contents:

```
db=(new DatabaseHelper(getContext())).getWritableDatabase();

return (db == null) ? false : true;
```

This will return a `SQLiteDatabase` instance, which you can then use to query the database or modify its data.

When you are done with the database (e.g., your activity is being closed), simply call `close()` on the `SQLiteDatabase` to release your connection.

Setting the Table

For creating your tables and indexes, you will need to call `execSQL()` on your `SQLiteDatabase`, providing the DDL statement you wish to apply against the database. Barring a database error, this method returns nothing.

So, for example, you can:

```
db.execSQL("CREATE TABLE constants (_id INTEGER PRIMARY KEY AUTOINCREMENT, title
TEXT, value REAL);");
```

This will create a table, named `constants`, with a primary key column named `_id` that is an auto-incremented integer (i.e., SQLite will assign the value for you when you insert rows), plus two data columns: `title` (text) and `value` (a float, or "real" in SQLite terms). SQLite will automatically create an index for you on your primary key column, so the second statement adds another index on the table, by name.

Most likely, you will create tables and indexes when you first create the database, or possibly when the database needs upgrading to accommodate a new release of your application. If you do not change your table schemas, you might never drop your tables or indexes, but if you do, just use `execSQL()` to invoke `DROP INDEX` and `DROP TABLE` statements as needed.

Makin' Data

Given that you have a database and one or more tables, you probably want to put some data in them and such. You have two major approaches for doing this.

You can always use `execSQL()`, just like you did for creating the tables. The `execSQL()` method works for any SQL that does not return results, so it can handle `INSERT`, `UPDATE`, `DELETE`, etc. just fine. So, for example:

```
db.execSQL("INSERT INTO widgets (name, inventory)"+
           "VALUES ('Sprocket', 5)");
```

Your alternative is to use the `insert()`, `update()`, and `delete()` methods on the `SQLiteDatabase` object. These are "builder" sorts of methods, in that the break down the SQL statements into discrete chunks, then take those chunks as parameters.

These methods make use of `ContentValues` objects, which implement a `Map`-esque interface, albeit one that has additional methods for working with SQLite types. For example, in addition to `get()` to retrieve a value by its key, you have `getAsInteger()`, `getAsString()`, and so forth.

The `insert()` method takes the name of the table, the name of one column as the "null column hack", and a `ContentValues` with the initial values you want put into this row. The "null column hack" is for the case where the `ContentValues` instance is empty – the column named as the "null column hack" will be explicitly assigned the value `NULL` in the SQL `INSERT` statement generated by `insert()`.

```
ContentValues cv=new ContentValues();

cv.put(Constants.TITLE, "Gravity, Death Star I");
cv.put(Constants.VALUE, SensorManager.GRAVITY_DEATH_STAR_I);
db.insert("constants", getNullColumnHack(), cv);
```

The `update()` method takes the name of the table, a `ContentValues` representing the columns and replacement values to use, an optional `WHERE` clause, and an optional list of parameters to fill into the WHERE clause, to replace any embedded question marks (?). Since update() only replaces columns with fixed values, versus ones computed based on other information, you may need to use execSQL() to accomplish some ends.

The WHERE clause and parameter list works akin to the positional SQL parameters you may be used to from other SQL APIs. For example:

```
// replacements is a ContentValues instance
String[] parms=new String[] {"snicklefritz"};
db.update("widgets", replacements, "name=?", parms);
```

The delete() method works akin to update(), taking the name of the table, the optional WHERE clause, and the corresponding parameters to fill into the WHERE clause.

What Goes Around, Comes Around

As with INSERT, UPDATE, and DELETE, you have two main options for retrieving data from a SQLite database using SELECT:

1. You can use rawQuery() to invoke a SELECT statement directly, or
2. You can use query() to build up a query from its component parts

Confounding matters further is the SQLiteQueryBuilder class and the issue of cursors and cursor factories. Let's take all of this one piece at a time.

Raw Queries

The simplest solution, at least in terms of the API, is rawQuery(). Simply call it with your SQL SELECT statement. The SELECT statement can include positional parameters; the array of these forms your second parameter to rawQuery(). So, we wind up with:

```
Cursor c=db.rawQuery("SELECT name FROM sqlite_master WHERE type='table' AND
name='constants'", null);
```

In this example, we actually query a SQLite system table (`sqlite_master`) to see if our constants table already exists. The return value is a `Cursor`, which contains methods for iterating over results (see below).

If your queries are pretty much "baked into" your application, this is a very straightforward way to use them. However, it gets complicated if parts of the query are dynamic, beyond what positional parameters can really handle. For example, if the set of columns you need to retrieve is not known at compile time, puttering around concatenating column names into a comma-delimited list can be annoying...which is where `query()` comes in.

Regular Queries

The `query()` method takes the discrete pieces of a SELECT statement and builds the query from them. The pieces, in order that they appear as parameters to `query()`, are:

- The name of the table to query against
- The list of columns to retrieve
- The `WHERE` clause, optionally including positional parameters
- The list of values to substitute in for those positional parameters
- The `GROUP BY` clause, if any
- The `ORDER BY` clause, if any
- The `HAVING` clause, if any

These can be `null` when they are not needed (except the table name, of course). So, our previous snippet converts into:

```
String[] columns={"ID", "inventory"};
String[] parms={"snicklefritz"};
Cursor result=db.query("widgets", columns, "name=?",
                       parms, null, null, null);
```

Building with Builders

Yet another option is to use `SQLiteQueryBuilder`, which offers much richer query-building options, particularly for nasty queries involving things like the union of multiple sub-query results. More importantly, the `SQLiteQueryBuilder` interface dovetails nicely with the `ContentProvider` interface for executing queries. Hence, a common pattern for your content provider's `query()` implementation is to create a `SQLiteQueryBuilder`, fill in some defaults, then allow it to build up (and optionally execute) the full query combining the defaults with what is provided to the content provider on the query request.

For example, here is a snippet of code from a content provider using `SQLiteQueryBuilder`:

```
@Override
public Cursor query(Uri url, String[] projection, String selection,
                     String[] selectionArgs, String sort) {
  SQLiteQueryBuilder qb=new SQLiteQueryBuilder();

  qb.setTables(getTableName());

  if (isCollectionUri(url)) {
    qb.setProjectionMap(getDefaultProjection());
  }
  else {
    qb.appendWhere(getIdColumnName()+"="+url.getPathSegments().get(1));
  }

  String orderBy;

  if (TextUtils.isEmpty(sort)) {
    orderBy=getDefaultSortOrder();
  } else {
    orderBy=sort;
  }

  Cursor c=qb.query(db, projection, selection, selectionArgs,
                  null, null, orderBy);
  c.setNotificationUri(getContext().getContentResolver(), url);
  return c;
}
```

Content providers are explained in greater detail later in the book, so some of this you will have to take on faith until then. Here, we see:

- A `SQLiteQueryBuilder` is constructed
- It is told the table to use for the query (`setTables(getTableName())`)
- It is either told the default set of columns to return (`setProjectionMap()`), or is given a piece of a `WHERE` clause to identify a particular row in the table by an identifier extracted from the `Uri` supplied to the `query()` call (`appendWhere()`)
- Finally, it is told to execute the query, blending the preset values with those supplied on the call to `query()` (`qb.query(db, projection, selection, selectionArgs, null, null, orderBy)`)

Instead of having the `SQLiteQueryBuilder` execute the query directly, we could have called `buildQuery()` to have it generate and return the SQL `SELECT` statement we needed, which we could then execute ourselves.

Using Cursors

No matter how you execute the query, you get a `Cursor` back. This is the Android/SQLite edition of the database cursor, a concept used in many database systems. With the cursor, you can:

- Find out how many rows are in the result set via `getCount()`
- Iterate over the rows via `moveToFirst()`, `moveToNext()`, and `isAfterLast()`
- Find out the names of the columns via `getColumnNames()`, convert those into column numbers via `getColumnIndex()`, and get values for the current row for a given column via methods like `getString()`, `getInt()`, etc.
- Re-execute the query that created the cursor via `requery()`
- Release the cursor's resources via `close()`

For example, here we iterate over the widgets table entries from the previous snippets:

```
Cursor result=
  db.rawQuery("SELECT ID, name, inventory FROM widgets");
```

```
result.moveToFirst();

while (!result.isAfterLast()) {
 int id=result.getInt(0);
 String name=result.getString(1);
 int inventory=result.getInt(2);

 // do something useful with these

 result.moveToNext();
}

result.close();
```

Making Your Own Cursors

There may be circumstances in which you want to use your own `Cursor` subclass, rather than the stock implementation provided by Android. In those cases, you can use `queryWithFactory()` and `rawQueryWithFactory()` that take a `SQLiteDatabase.CursorFactory` instance as a parameter. The factory, as one might expect, is responsible for creating new cursors via its `newCursor()` implementation.

Finding and implementing a valid use for this facility is left as an exercise for the reader. Suffice it to say that you should not need to create your own cursor classes much, if at all, in ordinary Android development.

Data, Data, Everywhere

If you are used to developing for other databases, you are also probably used to having tools to inspect and manipulate the contents of the database, beyond merely the database's API. With Android's emulator, you have two main options for this.

First, the emulator is supposed to bundle in the `sqlite3` console program and makes it available from the `adb shell` command. Once you are in the emulator's shell, just execute `sqlite3`, providing it the path to your database file. Your database file can be found at:

```
/data/data/your.app.package/databases/your-db-name.db
```

Here `your.app.package` is the Java package for your application (e.g., `com.commonsware.android`) and `your-db-name` is the name of your database, as supplied to `createDatabase()`.

Note, however, that the Android 0.9 SDK appears to be missing the `sqlite3` command, though it has returned in Android 1.0.

The `sqlite3` program works, and if you are used to poking around your tables using a console interface, you are welcome to use it. If you prefer something a little bit friendlier, you can always copy the SQLite database off the device onto your development machine, then use a SQLite-aware client program to putter around. Note, though, that you are working off a copy of the database; if you want your changes to go back to the device, you will need to transfer the database back over.

To get the database off the device, you can use the `adb pull` command (or the equivalent in your IDE), which takes the path to the on-device database and the local destination as parameters. To store a modified database on the device, use `adb push`, which takes the local path to the database and the on-device destination as parameters.

One of the most-accessible SQLite clients is the SQLite Manager extension for Firefox, as it works across all platforms.

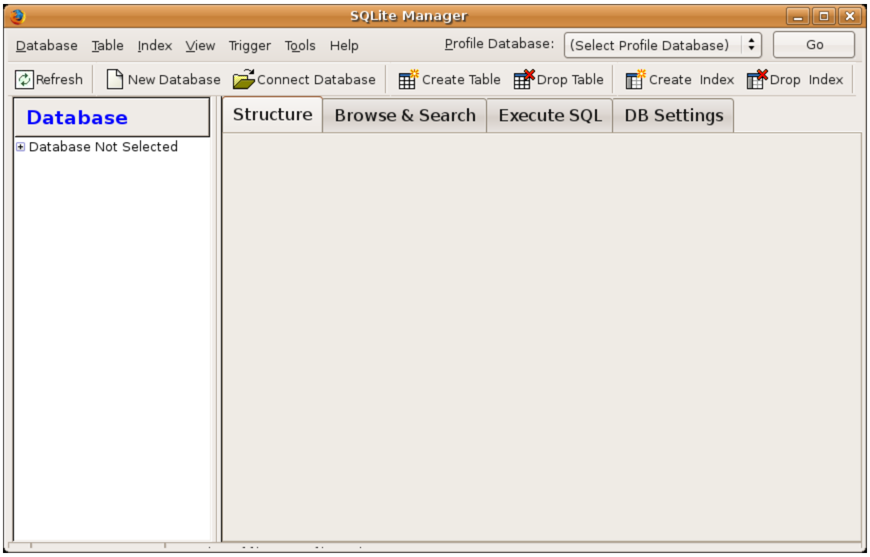

SQLite Manager
Database Table Index View Trigger Tools Help
Profile Database: (Select Profile Database) Go
Refresh New Database Connect Database Create Table Drop Table Create Index Drop Index
Database
Database Not Selected
Structure Browse & Search Execute SQL DB Settings

Figure 70. the SQLite Manager Firefox extension

You can find dozens of others on the SQLite Web site.

CHAPTER 21

Leveraging Java Libraries

Java has as many, if not more, third-party libraries than any other modern programming language. Here, "third-party libraries" refer to the innumerable JARs that you can include in a server or desktop Java application – the things that the Java SDKs themselves do not provide.

In the case of Android, the Dalvik VM at its heart is not precisely Java, and what it provides in its SDK is not precisely the same as any traditional Java SDK. That being said, many Java third-party libraries still provide capabilities that Android lacks natively and therefore may be of use to you in your project, for the ones you can get working with Android's flavor of Java.

This chapter explains what it will take for you to leverage such libraries and the limitations on Android's support for arbitrary third-party code.

The Outer Limits

Not all available Java code, of course, will work well with Android. There are a number of factors to consider, including:

- **Expected Platform APIs**: Does the code assume a newer JVM than the one Android is based on? Or, does the code assume the existence of Java APIs that ship with J2SE but not with Android, such as Swing?

- **Size**: Existing Java code designed for use on desktops or servers need not worry too much about on-disk size, or, to some extent, even in-RAM size. Android, of course, is short on both. Using third-party Java code, particularly when pre-packaged as JARs, may balloon the size of your application.
- **Performance**: Does the Java code effectively assume a much more powerful CPU than what you may find on many Android devices? Just because a desktop can run it without issue doesn't mean your average mobile phone will handle it well.
- **Interface**: Does the Java code assume a console interface? Or is it a pure API that you can wrap your own interface around?

One trick for addressing some of these concerns is to use open source Java code, and actually work with the code to make it more Android-friendly. For example, if you're only using 10% of the third-party library, maybe it's worthwhile to recompile the subset of the project to be only what you need, or at least removing the unnecessary classes from the JAR. The former approach is safer, in that you get compiler help to make sure you're not discarding some essential piece of code, though it may be more tedious to do.

Ants and Jars

You have two choices for integrating third-party code into your project: use source code, or use pre-packaged JARs.

If you choose to use their source code, all you need to do is copy it into your own source tree (under `src/` in your project), so it can sit alongside your existing code, then let the compiler perform its magic.

If you choose to use an existing JAR, perhaps one for which you do not have the source code, you will need to teach your build chain how to use the JAR. If you are using an IDE, that's a matter of telling it to reference the JAR. If, on the other hand, you are not using an IDE and are relying upon the `build.xml` Ant script, put the JAR in the `libs/` directory created for you by `activityCreator`, and the Ant build process will pick it up.

For example, in a previous edition of this book, we had a MailBuzz project. MailBuzz, as the name suggests, dealt with email. To accomplish that end, MailBuzz leveraged the JavaMail APIs and needs two JavaMail JARs: `mail-1.4.jar` and `activation-1.1.jar`. With both of those in the `libs/` directory, the `classpath` tells `javac` to link against those JARs, so any JavaMail references in the MailBuzz code can be correctly resolved. Then, those JARs are listed, along with the MailBuzz compiled classes, in the task that invokes the `dex` tool to convert the Java code into Dalvik VM instructions. Without this step, even though your code may compile, it won't find the JavaMail classes at runtime and will fail with an exception.

As it turned out, though, the Dalvik VM and compiler supplied with the Android 0.9 and newer SDKs no longer supported some Java language features used by JavaMail. And, while the JavaMail source code is available, it is under an open source license (CDDL) that...has issues.

Following the Script

The material in this section is based on the author's posts to the Building 'Droids column on AndroidGuys.com.

Unlike other mobile device operating systems, Android has no restrictions on what you can run on it, so long as you can do it in Java using the Dalvik VM. This includes incorporating your own scripting language into your application, something that is expressly prohibited on some other devices.

One possible Java scripting language is Beanshell. Beanshell gives you Java-compatible syntax with implicit typing and no compilation required.

So, to add Beanshell scripting, you need to put the Beanshell interpreter's JAR file in your `libs/` directory. The 2.0b4 JAR available for download from the Beanshell site, unfortunately, does not work out of the box with the Android 0.9 SDK, perhaps due to the compiler that was used to build it. Instead, you should probably check out the source code from Subversion and execute `ant jarcore` to build it, then copy the resulting JAR (in Beanshell's `dist/` directory) to your own project's `libs/`. Or, just use the

Beanshell JAR that accompanies the source code for this book, up on the CommonsWare site.

From there, using Beanshell on Android is no different than using Beanshell in any other Java environment:

1. Create an instance of the Beanshell `Interpreter` class
2. Set any "globals" for the script's use via `Interpreter#set()`
3. Call `Interpreter#eval()` to run the script and, optionally, get the result of the last statement

For example, here is the XML layout for the world's smallest Beanshell IDE:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
<Button
    android:id="@+id/eval"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:text="Go!"
    />
<EditText
    android:id="@+id/script"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:singleLine="false"
    android:gravity="top"
    />
</LinearLayout>
```

Couple that with the following activity implementation:

```
package com.commonsware.android.andshell;

import android.app.Activity;
import android.app.AlertDialog;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;
import android.widget.Toast;
import bsh.Interpreter;
```

```
public class MainActivity extends Activity {
  private Interpreter i=new Interpreter();

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    Button btn=(Button)findViewById(R.id.eval);
    final EditText script=(EditText)findViewById(R.id.script);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View view) {
        String src=script.getText().toString();

        try {
          i.set("context", MainActivity.this);
          i.eval(src);
        }
        catch (bsh.EvalError e) {
          AlertDialog.Builder builder=
                    new AlertDialog.Builder(MainActivity.this);

          builder
            .setTitle("Exception!")
            .setMessage(e.toString())
            .setPositiveButton("OK", null)
            .show();
        }
      }
    });
  }
}
```

Compile and run it (including incorporating the Beanshell JAR as mentioned above), and install it on the emulator. Fire it up, and you get a trivial IDE, with a large text area for your script and a big "Go!" button to execute it:

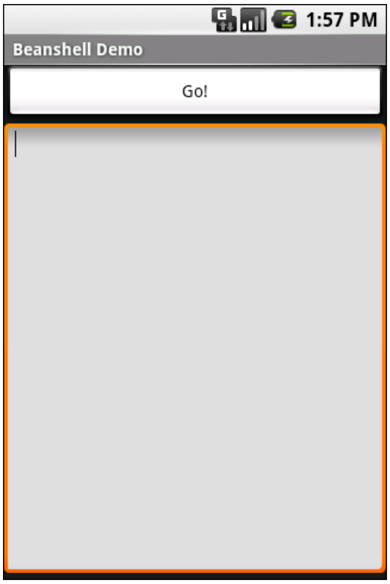
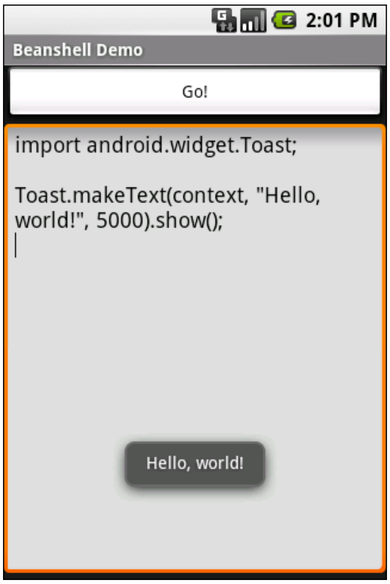


Figure 71. The AndShell Beanshell IDE

```
import android.widget.Toast;

Toast.makeText(context, "Hello, world!", 5000).show();
```

Note the use of `context` to refer to the activity when making the `Toast`. That is the global set by the activity to reference back to itself. You could call this global variable anything you want, so long as the `set()` call and the script code use the same name.

Then, click the Go! button, and you get:



```
import android.widget.Toast;

Toast.makeText(context, "Hello,
world!", 5000).show();
```

Figure 72. The AndShell Beanshell IDE, executing some code

And now, some caveats...

First, not all scripting languages will work. For example, those that implement their own form of just-in-time (JIT) compilation, generating Java bytecodes on the fly, would probably have to be augmented to generate Dalvik VM bytecodes instead of those for stock Java implementations. Simpler languages that execute off of parsed scripts, calling Java reflection APIs to call back into compiled classes, will likely work better. Even there, though, not every feature of the language may work, if it relies upon some facility in a traditional Java API that does not exist in Dalvik – for example, there could be stuff hidden inside Beanshell or the add-on JARs that does not work on today's Android.

Second, scripting languages without JIT will inevitably be slower than compiled Dalvik applications. Slower may mean users experience sluggishness. Slower definitely means more battery life is consumed for the same amount of work. So, building a whole Android application in Beanshell, simply because you feel it is easier to program in, may cause your users to be unhappy.

Third, scripting languages that expose the whole Java API, like Beanshell, can pretty much do anything the underlying Android security model allows. So, if your application has the `READ_CONTACTS` permission, expect any Beanshell scripts your application runs to have the same permission.

Last, but certainly not least, is that language interpreter JARs tend to be...portly. The Beanshell JAR used in this example is 200KB. That is not ridiculous, considering what it does, but it will make applications that use Beanshell that much bigger to download, take up that much more space on the device, etc.

CHAPTER 22

Communicating via the Internet

The expectation is that most, if not all, Android devices will have built-in Internet access. That could be WiFi, cellular data services (EDGE, 3G, etc.), or possibly something else entirely. Regardless, most people – or at least those with a data plan or WiFi access – will be able to get to the Internet from their Android phone.

Not surprisingly, the Android platform gives developers a wide range of ways to make use of this Internet access. Some offer high-level access, such as the integrated WebKit browser component we saw in an earlier chapter. If you want, you can drop all the way down to using raw sockets. Or, in between, you can leverage APIs – both on-device and from 3rd-party JARs – that give you access to specific protocols: HTTP, XMPP, SMTP, and so on.

The emphasis of this book is on the higher-level forms of access: the WebKit component and Internet-access APIs, as busy coders should be trying to reuse existing components versus rolling one's own on-the-wire protocol wherever possible.

REST and Relaxation

Android does not have built-in SOAP or XML-RPC client APIs. However, it does have the Apache HttpComponents library baked in. You can either layer a SOAP/XML-RPC layer atop this library, or use it "straight" for accessing REST-style Web services. For the purposes of this book, "REST-style Web services" is defined as "simple HTTP requests for ordinary URLs over the full range of HTTP verbs, with formatted payloads (XML, JSON, etc.) as responses".

More expansive tutorials, FAQs, and HOWTOs can be found at the HttpComponents Web site. Here, we'll cover the basics, while checking the weather.

HTTP Operations via Apache HttpComponents

The first step to using HttpClient is, not surprisingly, to create an `HttpClient` object. The client object handles all HTTP requests upon your behalf. Since `HttpClient` is an interface, you will need to actually instantiate some implementation of that interface, such as `DefaultHttpClient`.

Those requests are bundled up into `HttpRequest` instances, with different `HttpRequest` implementations for each different HTTP verb (e.g., `HttpGet` for HTTP `GET` requests). You create an `HttpRequest` implementation instance, fill in the URL to retrieve and other configuration data (e.g., form values if you are doing an HTTP `POST` via `HttpPost`), then pass the method to the client to actually make the HTTP request via execute().

What happens at this point can be as simple or as complicated as you want. You can get an `HttpResponse` object back, with response code (e.g,. `200` for OK), HTTP headers, and the like. Or, you can use a flavor of `execute()` that takes a `ResponseHandler<String>` as a parameter – the net result there being that `execute()` returns just the `String` representation of the request body. In practice, this is not a recommended approach, because you really should be checking your HTTP response codes for errors. However, for trivial applications, like book examples, the `ResponseHandler<String>` approach works just fine.

For example, let's take a look at the `Weather` sample project. This implements an activity that retrieves weather data for your current location from the National Weather Service (**NOTE**: this probably only works in the US). That data is converted into an HTML page, which is poured into a `WebKit` widget for display. Rebuilding this demo using a ListView is left as an exercise for the reader. Also, since this sample is relatively long, we will only show relevant pieces of the Java code here in this chapter, though you can always download the full source from the CommonsWare Web site.

To make this a bit more interesting, we use the Android location services to figure out where we are...sort of. The full details of how that works is described in the chapter on location services.

In the onResume() method, we toggle on location updates, so we will be informed where we are now and when we move a significant distance (10km). When a location is available – either at the start or based on movement – we retrieve the National Weather Service data via our updateForecast() method:

```
private void updateForecast(Location loc) {
  String url=String.format(format, loc.getLatitude(), loc.getLongitude());
  HttpGet getMethod=new HttpGet(url);

  try {
    ResponseHandler<String> responseHandler = new BasicResponseHandler();
    String responseBody=client.execute(getMethod, responseHandler);

    buildForecasts(responseBody);

    String page=generatePage();

    browser.loadDataWithBaseURL(null, page, "text/html",
                                "UTF-8", null);
  }
  catch (Throwable t) {
    Toast
      .makeText(this, "Request failed: "+t.toString(), 4000)
      .show();
  }
}
```

The updateForecast() method takes a Location as a parameter, obtained from the location update process. For now, all you need to know is that Location sports getLatitude() and getLongitude() methods that return the latitude and longitude of the device's position, respectively.

We hold the URL to the National Weather Service XML in a string resource, and pour in the latitude and longitude at runtime. Given our `HttpClient` object created in `onCreate()`, we populate an `HttpGet` with that customized URL, then execute that method. Given the resulting XML from the REST service, we build the forecast HTML page (see below) and pour that into the `WebKit` widget. If the `HttpClient` blows up with an exception, we provide that error as a `Toast`.

Parsing Responses

The response you get will be formatted using some system – HTML, XML, JSON, whatever. It is up to you, of course, to pick out what information you need and do something useful with it. In the case of the `WeatherDemo`, we need to extract the forecast time, temperature, and icon (indicating sky conditions and precipitation) and generate an HTML page from it.

Android includes:

- Three XML parsers: the traditional W3C DOM (`org.w3c.dom`), a SAX parser (`org.xml.sax`), and the XML pull parser discussed in the chapter on resources
- A JSON parser (`org.json`)

You are also welcome to use third-party Java code, where possible, to handle other formats, such as a dedicated RSS/Atom parser for a feed reader. The use of third-party Java code is discussed in a separate chapter.

For `WeatherDemo`, we use the W3C DOM parser in our `buildForecasts()` method:

```java
void buildForecasts(String raw) throws Exception {
  DocumentBuilder builder=DocumentBuilderFactory
                            .newInstance()
                            .newDocumentBuilder();
  Document doc=builder.parse(new InputSource(new StringReader(raw)));
  NodeList times=doc.getElementsByTagName("start-valid-time");

  for (int i=0;i<times.getLength();i++) {
    Element time=(Element)times.item(i);
    Forecast forecast=new Forecast();

    forecasts.add(forecast);
    forecast.setTime(time.getFirstChild().getNodeValue());
  }

  NodeList temps=doc.getElementsByTagName("value");

  for (int i=0;i<temps.getLength();i++) {
    Element temp=(Element)temps.item(i);
    Forecast forecast=forecasts.get(i);

    forecast.setTemp(new Integer(temp.getFirstChild().getNodeValue()));
  }

  NodeList icons=doc.getElementsByTagName("icon-link");

  for (int i=0;i<icons.getLength();i++) {
    Element icon=(Element)icons.item(i);
    Forecast forecast=forecasts.get(i);

    forecast.setIcon(icon.getFirstChild().getNodeValue());
  }
}
```

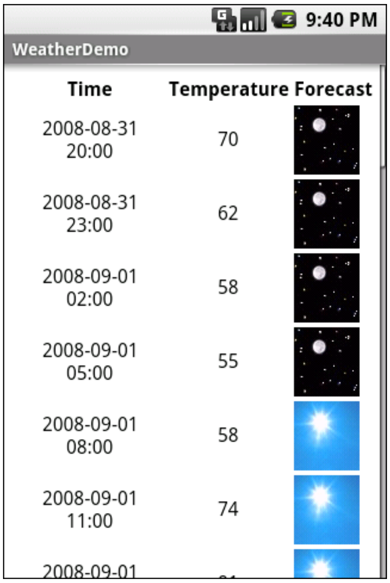
The National Weather Service XML format is...curiously structured, relying heavily on sequential position in lists versus the more object-oriented style you find in formats like RSS or Atom. That being said, we can take a few liberties and simplify the parsing somewhat, taking advantage of the fact that the elements we want (`start-valid-time` for the forecast time, `value` for the temperature, and `icon-link` for the icon URL) are all unique within the document.

The HTML comes in as an `InputStream` and is fed into the DOM parser. From there, we scan for the `start-valid-time` elements and populate a set of `Forecast` models using those start times. Then, we find the temperature `value` elements and `icon-link` URLs and fill those in to the `Forecast` objects.

In turn, the `generatePage()` method creates a rudimentary HTML table with the forecasts:

```
String generatePage() {
  StringBuffer bufResult=new StringBuffer("<html><body><table>");

  bufResult.append("<tr><th width=\"50%\">Time</th>"+
                   "<th>Temperature</th><th>Forecast</th></tr>");
  for (Forecast forecast : forecasts) {
    bufResult.append("<tr><td align=\"center\">");
    bufResult.append(forecast.getTime());
    bufResult.append("</td><td align=\"center\">");
    bufResult.append(forecast.getTemp());
    bufResult.append("</td><td><img src=\"");
    bufResult.append(forecast.getIcon());
    bufResult.append("\"></td></tr>");
  }

  bufResult.append("</table></body></html>");

  return(bufResult.toString());
}
```

The result looks like this:



Time	Temperature	Forecast
2008-08-31 20:00	70	
2008-08-31 23:00	62	
2008-09-01 02:00	58	
2008-09-01 05:00	55	
2008-09-01 08:00	58	
2008-09-01 11:00	74	
2008-09-01		

Figure 73. The WeatherDemo sample application

Stuff To Consider

If you need to use SSL, bear in mind that the default `HttpClient` setup does not include SSL support. Mostly, this is because you need to decide how to handle SSL certificate presentation – do you blindly accept all certificates, even self-signed or expired ones? Or do you want to ask the user if they really want to use some strange certificates?

Similarly, `HttpClient`, by default, is designed for single-threaded use. If you will be using `HttpClient` from a service or some other place where multiple threads might be an issue, you can readily set up `HttpClient` to support multiple threads.

For these sorts of topics, you are best served by checking out the HttpComponents Web site for documentation and support.

PART IV – Intents

CHAPTER 23

Creating Intent Filters

Up to now, the focus of this book has been on activities opened directly by the user from the device's launcher. This, of course, is the most obvious case for getting your activity up and visible to the user. And, in many cases it is the primary way the user will start using your application.

However, remember that the Android system is based upon lots of loosely-coupled components. What you might accomplish in a desktop GUI via dialog boxes, child windows, and the like are mostly supposed to be independent activities. While one activity will be "special", in that it shows up in the launcher, the other activities all need to be reached...somehow.

The "how" is via intents.

An intent is basically a message that you pass to Android saying, "Yo! I want to do...er...something! Yeah!" How specific the "something" is depends on the situation – sometimes you know exactly what you want to do (e.g., open up one of your other activities), and sometimes you don't.

In the abstract, Android is all about intents and receivers of those intents. So, now that we are well-versed in creating activities, let's dive into intents, so we can create more complex applications while simultaneously being "good Android citizens".

Some of the material in this chapter is based on the author's posts to the Building 'Droids column on AndroidGuys.com.

What's Your Intent?

When Sir Tim Berners-Lee cooked up the Hypertext Transfer Protocol – HTTP – he set up a system of verbs plus addresses in the form of URLs. The address indicated a resource, such as a Web page, graphic, or server-side program. The verb indicated what should be done: GET to retrieve it, POST to send form data to it for processing, etc.

Intents are similar, in that they represent an action plus context. There are more actions and more components to the context with Android intents than there are with HTTP verbs and resources, but the concept is still the same.

Just as a Web browser knows how to process a verb+URL pair, Android knows how to find activities or other application logic that will handle a given intent.

Pieces of Intents

The two most important pieces of an intent are the action and what Android refers to as the "data". These are almost exactly analogous to HTTP verbs and URLs – the action is the verb, and the "data" is a `Uri`, such as `content://contacts/people/1` representing a contact in the contacts database. Actions are constants, such as `ACTION_VIEW` (to bring up a viewer for the resource), `ACTION_EDIT` (to edit the resource), or `ACTION_PICK` (to choose an available item given a `Uri` representing a collection, such as `content://contacts/people`).

If you were to create an intent combining `ACTION_VIEW` with a content Uri of `content://contacts/people/1`, and pass that intent to Android, Android would know to find and open an activity capable of viewing that resource.

There are other criteria you can place inside an intent (represented as an Intent object), besides the action and "data" `Uri`, such as:

- A category. Your "main" activity will be in the `LAUNCHER` category, indicating it should show up on the launcher menu. Other activities will probably be in the `DEFAULT` or `ALTERNATIVE` categories.
- A MIME type, indicating the type of resource you want to operate on, if you don't know a collection `Uri`.
- A component, which is to say, the class of the activity that is supposed to receive this intent. Using components this way obviates the need for the other properties of the intent. However, it does make the intent more fragile, as it assumes specific implementations.
- "Extras", which is a `Bundle` of other information you want to pass along to the receiver with the intent, that the receiver might want to take advantage of. What pieces of information a given receiver can use is up to the receiver and (hopefully) is well-documented.

You will find rosters of the standard actions and categories in the Android SDK documentation for the `Intent` class.

Intent Routing

As noted above, if you specify the target component in your intent, Android has no doubt where the intent is supposed to be routed to – it will launch the named activity. This might be OK if the target intent is in your application. It definitely is not recommended for sending intents to other applications. Component names, by and large, are considered private to the application and are subject to change. Content `Uri` templates and MIME types are the preferred ways of identifying services you wish third-party code to supply.

If you do not specify the target component, then Android has to figure out what activities (or other intent receivers) are eligible to receive the intent. Note the use of the plural "activities", as a broadly-written intent might well resolve to several activities. That is the...ummm...intent (pardon the pun), as you will see later in this chapter. This routing approach is referred to as implicit routing.

Basically, there are three rules, all of which must be true for a given activity to be eligible for a given intent:

1. The activity must support the specified action
2. The activity must support the stated MIME type (if supplied)
3. The activity must support all of the categories named in the intent

The upshot is that you want to make your intents specific enough to find the right receiver(s), and no more specific than that.

This will become clearer as we work through some examples later in this chapter.

Stating Your Intent(ions)

All Android components that wish to be notified via intents must declare intent filters, so Android knows which intents should go to that component. To do this, you need to add `intent-filter` elements to your `AndroidManifest.xml` file.

All of the example projects have intent filters defined, courtesy of the Android application-building script (`activityCreator` or the IDE equivalent). They look something like this:

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonsware.android.skeleton">
    <application>
        <activity android:name=".Now" android:label="Now">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>
</manifest>
```

Note the intent-filter element under the activity element. Here, we declare that this activity:

- Is the main activity for this application
- It is in the LAUNCHER category, meaning it gets an icon in the Android main menu

Because this activity is the main one for the application, Android knows this is the component it should launch when somebody chooses the application from the main menu.

The intent filter also has a label (android:label = "ConsActivity"). In this case, this controls the name associated with the application's icon in the main menu.

You are welcome to have more than one action or more than one category in your intent filters. That indicates that the associated component (e.g., activity) handles multiple different sorts of intents.

More than likely, you will also want to have your secondary (non-MAIN) activities specify the MIME type of data they work on. Then, if an intent is targeted for that MIME type – either directly, or indirectly by the Uri referencing something of that type – Android will know that the component handles such data.

For example, you could have an activity declared like this:

```
<activity android:name=".TourViewActivity">
  <intent-filter>
    <action android:name="android.intent.action.VIEW" />
    <category android:name="android.intent.category.DEFAULT" />
    <data android:mimeType="vnd.android.cursor.item/vnd.commonsware.tour" />
  </intent-filter>
</activity>
```

This activity will get launched by an intent requesting to view a Uri representing a vnd.android.cursor.item/vnd.commonsware.tour piece of content. That intent could come from another activity in the same application (e.g., the MAIN activity for this application) or from another activity in another Android application that happens to know a `Uri` that this activity handles.

Narrow Receivers

In the examples shown above, the intent filters were set up on activities. Sometimes, tying intents to activities is not exactly what we want:

- Some system events might cause us to want to trigger something in a service rather than an activity
- Some events might need to launch different activities in different circumstances, where the criteria are not solely based on the intent itself, but some other state (e.g., if we get intent X and the database has a Y, then launch activity M; if the database does not have a Y, then launch activity N)

For these cases, Android offers the intent receiver, defined as a class implementing the `BroadcastReceiver` interface. Intent receivers are disposable objects designed to receive intents – particularly broadcast intents – and take action, typically involving launching other intents to trigger logic in an activity, service, or other component.

The `BroadcastReceiver` interface has only one method: `onReceive()`. Intent receivers implement that method, where they do whatever it is they wish to do upon an incoming intent. To declare an intent receiver, add an receiver element to your `AndroidManifest.xml` file:

```
<receiver android:name=".MyIntentReceiverClassName" />
```

An intent receiver is only alive for as long as it takes to process `onReceive()` – as soon as that method returns, the receiver instance is subject to garbage collection and will not be reused. This means intent receivers are somewhat limited in what they can do, mostly to avoid anything that involves any sort of callback. For example, they cannot bind to a service, and they cannot open a dialog box.

The exception is if the `BroadcastReceiver` is implemented on some longer-lived component, such as an activity or service – in that case, the intent receiver lives as long as its "host" does (e.g., until the activity is frozen). However, in this case, you cannot declare the intent receiver via `AndroidManifest.xml`. Instead, you need to call `registerReceiver()` on your `Activity`'s `onResume()` callback to declare interest in an intent, then call `unregisterReceiver()` from your `Activity`'s `onPause()` when you no longer need those intents.

The Pause Caveat

There is one hiccup with using Intent objects to pass arbitrary messages around: it only works when the receiver is active. To quote from the documentation for `BroadcastReceiver`:

> *If registering a receiver in your Activity.onResume() implementation, you should unregister it in Activity.onPause(). (You won't receive intents when paused, and this will cut down on unnecessary system overhead). Do not unregister in Activity.onSaveInstanceState(), because this won't be called if the user moves back in the history stack.*

Hence, you can only really use the Intent framework as an arbitrary message bus if:

- Your receiver does not care if it misses messages because it was not active, or
- You provide some means of getting the receiver "caught up" on messages it missed while it was inactive

In the chapters on creating and using services, you will see an example of the former condition, where the receiver (service client) will use `Intent`-based messages when they are available but does not need them if the client is not active.

CHAPTER 24

Launching Activities and Sub-Activities

As discussed previously, the theory behind the Android UI architecture is that developers should decompose their application into distinct activities, each implemented as an `Activity`, each reachable via intents, with one "main" activity being the one launched by the Android launcher. For example, a calendar application could have activities for viewing the calendar, viewing a single event, editing an event (including adding a new one), and so forth.

This, of course, implies that one of your activities has the means to start up another activity. For example, if somebody clicks on an event from the view-calendar activity, you might want to show the view-event activity for that event. This means that, somehow, you need to be able to cause the view-event activity to launch and show a specific event (the one the user clicked upon).

This can be further broken down into two scenarios:

1. You know what activity you want to launch, probably because it is another activity in your own application
2. You have a content `Uri` to...something, and you want your users to be able to do...something with it, but you do not know up front what the options are

This chapter covers the first scenario; the next chapter handles the second.

Peers and Subs

One key question you need to answer when you decide to launch an activity is: does your activity need to know when the launched activity ends?

For example, suppose you want to spawn an activity to collect authentication information for some Web service you are connecting to – maybe you need to authenticate with OpenID in order to use an OAuth service. In this case, your main activity will need to know when the authentication is complete so it can start to use the Web service.

On the other hand, imagine an email application in Android. When the user elects to view an attachment, neither you nor the user necessarily expect the main activity to know when the user is done viewing that attachment.

In the first scenario, the launched activity is clearly subordinate to the launching activity. In that case, you probably want to launch the child as a sub-activity, which means your activity will be notified when the child activity is complete.

In the second scenario, the launched activity is more a peer of your activity, so you probably want to launch the "child" just as a regular activity. Your activity will not be informed when the "child" is done, but, then again, your activity really doesn't need to know.

Start 'Em Up

The two pieces for starting an activity are an intent and your choice of how to start it up.

Make an Intent

As discussed in a previous chapter, intents encapsulate a request, made to Android, for some activity or other intent receiver to do something.

If the activity you intend to launch is one of your own, you may find it simplest to create an explicit intent, naming the component you wish to launch. For example, from within your activity, you could create an intent like this:

```
new Intent(this, HelpActivity.class);
```

This would stipulate that you wanted to launch the `HelpActivity`. This activity would need to be named in your `AndroidManifest.xml` file, though not necessarily with any intent filter, since you are trying to request it directly.

Or, you could put together an intent for some `Uri`, requesting a particular action:

```
Uri uri=Uri.parse("geo:"+lat.toString()+","+lon.toString());
Intent i=new Intent(Intent.ACTION_VIEW, uri);
```

Here, given that we have the latitude and longitude of some position (`lat` and `lon`, respectively) of type `Double`, we construct a `geo` scheme `Uri` and create an intent requesting to view this `Uri` (`ACTION_VIEW`).

Make the Call

Once you have your intent, you need to pass it to Android and get the child activity to launch. You have four choices:

1. The simplest option is to call `startActivity()` with the intent – this will cause Android to find the best-match activity or intent receiver and pass the intent to it for handling. Your activity will not be informed when the "child" activity is complete.

2. You can call `startSubActivity()`, passing it the intent and a number (unique to the calling activity). Android will find the best-match handler and pass the intent over to it. However, your activity will be notified when the child activity is complete via the `onActivityResult()` callback (see below).
3. You can call `broadcastIntent()`. In this case, Android will pass the intent to all registered activities and intent receivers that could possibly want this intent, not just the best match.
4. You can call `broadcastIntentSerialized()`. Here, Android will pass the intent to all candidate activities and intent receivers one at a time – if any one "consumes" the intent, the rest of the candidates are not notified.

Most of the time, you will wind up using `startActivity()` or `startSubActivity()` – broadcast intents are more typically raised by the Android system itself.

With `startSubActivity()`, as noted, you can implement the `onActivityResult()` callback to be notified when the child activity has completed its work. The callback receives the unique number supplied to `startSubActivity()`, so you can determine which child activity is the one that has completed. You also get:

- A result code, from the child activity calling `setResult()`. Typically this is `RESULT_OK` or `RESULT_CANCELLED`, though you can create your own return codes (pick a number starting with `RESULT_FIRST_USER`)
- An optional `String` containing some result data, possibly a URL to some internal or external resource – for example, a `ACTION_PICK` intent typically returns the selected bit of content via this data string
- An optional `Bundle` containing additional information beyond the result code and data string

To demonstrate launching a peer activity, take a peek at the `Launch` sample application. The XML layout is fairly straightforward: two fields for the latitude and longitude, plus a button:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <TableLayout
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:stretchColumns="1,2"
  >
    <TableRow>
      <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:paddingLeft="2dip"
        android:paddingRight="4dip"
        android:text="Location:"
      />
      <EditText android:id="@+id/lat"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:cursorVisible="true"
        android:editable="true"
        android:singleLine="true"
        android:layout_weight="1"
      />
      <EditText android:id="@+id/lon"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content"
        android:cursorVisible="true"
        android:editable="true"
        android:singleLine="true"
        android:layout_weight="1"
      />
    </TableRow>
  </TableLayout>
  <Button android:id="@+id/map"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:text="Show Me!"
  />
</LinearLayout>
```

The button's `OnClickListener` simply takes the latitude and longitude, pours them into a geo scheme `Uri`, then starts the activity.

```
package com.commonsware.android.activities;

import android.app.Activity;
import android.content.Intent;
import android.net.Uri;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;

public class LaunchDemo extends Activity {
  private EditText lat;
  private EditText lon;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    Button btn=(Button)findViewById(R.id.map);
    lat=(EditText)findViewById(R.id.lat);
    lon=(EditText)findViewById(R.id.lon);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View view) {
        String _lat=lat.getText().toString();
        String _lon=lon.getText().toString();
        Uri uri=Uri.parse("geo:"+_lat+","+_lon);

        startActivity(new Intent(Intent.ACTION_VIEW, uri));
      }
    });
  }
}
```

The activity is not much to look at:

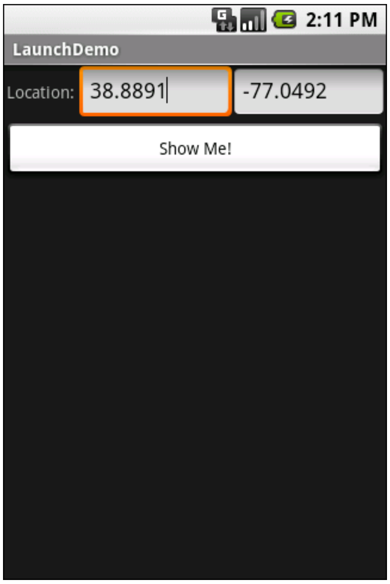


Figure 74. The LaunchDemo sample application, with a location filled in

If you fill in a location (e.g., 38.8891 latitude and -77.0492 longitude) and click the button, the resulting map is more interesting. Note that this is the built-in Android map activity – we did not create our own activity to display this map.

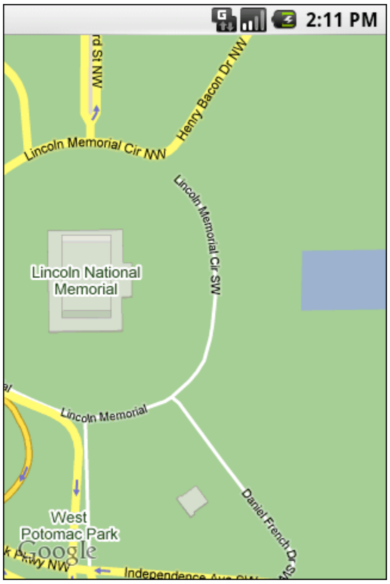


Figure 75. The map launched by Launch Demo, showing the Lincoln Memorial in Washington DC

In a later chapter, you will see how you can create maps in your own activities, in case you need greater control over how the map is displayed.

CHAPTER 25

Finding Available Actions via Introspection

Sometimes, you know just what you want to do, such as display one of your other activities.

Sometimes, you have a pretty good idea of what you want to do, such as view the content represented by a `Uri`, or have the user pick a piece of content of some MIME type.

Sometimes, you're lost. All you have is a content `Uri`, and you don't really know what you can do with it.

For example, suppose you were creating a common tagging subsystem for Android, where users could tag pieces of content – contacts, Web URLs, geographic locations, etc. Your subsystem would hold onto the `Uri` of the content plus the associated tags, so other subsystems could, say, ask for all pieces of content referencing some tag.

That's all well and good. However, you probably need some sort of maintenance activity, where users could view all their tags and the pieces of content so tagged. This might even serve as a quasi-bookmark service for items on their phone. The problem is, the user is going to expect to be able to do useful things with the content they find in your subsystem, such as dial a contact or show a map for a location.

The problem is, you have absolutely no idea what is all possible with any given content `Uri`. You probably can view any of them, but can you edit them? Can you dial them? Since new applications with new types of content could be added by any user at any time, you can't even assume you know all possible combinations just by looking at the stock applications shipped on all Android devices.

Fortunately, the Android developers thought of this.

Android offers various means by which you can present to your users a set of likely activities to spawn for a given content `Uri`...even if you have no idea what that content `Uri` really represents. This chapter explores some of these `Uri` action introspection tools.

Pick 'Em

Sometimes, you know your content `Uri` represents a collection of some type, such as `content://contacts/people` representing the list of contacts in the stock Android contacts list. In this case, you can let the user pick a contact that your activity can then use (e.g., tag it, dial it).

To do this, you need to create an intent for the `ACTION_PICK` on the target `Uri`, then start a sub activity (via `startSubActivity()`) to allow the user to pick a piece of content of the specified type. If your `onActivityResult()` callback for this request gets a `RESULT_OK` result code, your data string can be parsed into a `Uri` representing the chosen piece of content.

For example, take a look at `Pick` in the sample applications. This activity gives you a field for a collection `Uri` (with `content://contacts/people` pre-filled in for your convenience), plus a really big “Gimme!” button:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent"
  >
  <EditText android:id="@+id/type"
```

```
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:cursorVisible="true"
    android:editable="true"
    android:singleLine="true"
    android:text="content://contacts/people"
  />
  <Button
    android:id="@+id/pick"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:text="Gimme!"
    android:layout_weight="1"
  />
</LinearLayout>
```

Upon being clicked, the button creates the ACTION_PICK on the user-supplied collection Uri and starts the sub-activity. When that sub-activity completes with RESULT_OK, the ACTION_VIEW is invoked on the resulting content Uri.

```
public class PickDemo extends Activity {
  static final int PICK_REQUEST=1337;
  private EditText type;

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    type=(EditText)findViewById(R.id.type);

    Button btn=(Button)findViewById(R.id.pick);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View view) {
        Intent i=new Intent(Intent.ACTION_PICK,
                    Uri.parse(type.getText().toString()));

        startActivityForResult(i, PICK_REQUEST);
      }
    });
  }

  @Override
  protected void onActivityResult(int requestCode, int resultCode,
                                    Intent data) {
    if (requestCode==PICK_REQUEST) {
      if (resultCode==RESULT_OK) {
          startActivity(new Intent(Intent.ACTION_VIEW,
                                    data.getData()));
      }
    }
  }
}
```

The result: the user chooses a collection, picks a piece of content, and views it.

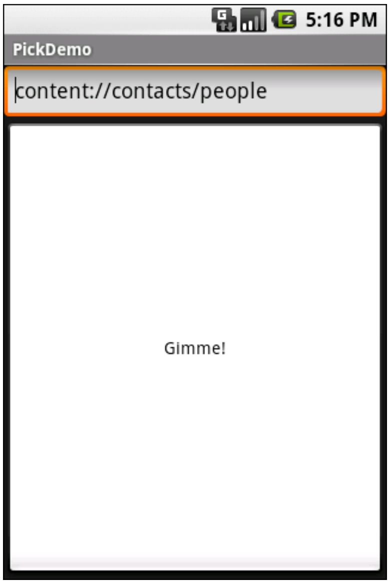
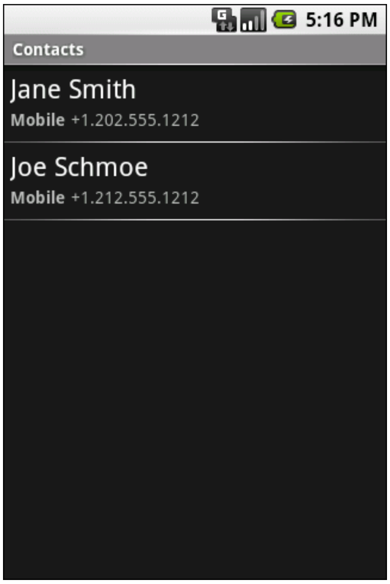


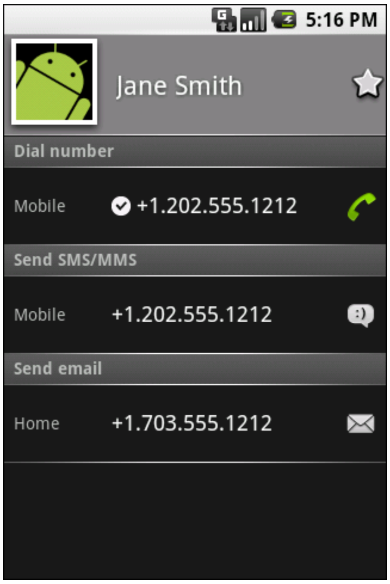
Figure 76. The PickDemo sample application, as initially launched



Jane Smith
Mobile +1.202.555.1212

Joe Schmoe
Mobile +1.212.555.1212

Figure 77. The same application, after clicking the "Gimme!" button, showing the list of available people



Dial number

Mobile +1.202.555.1212

Send SMS/MMS

Mobile +1.202.555.1212

Send email

Home +1.703.555.1212

Figure 78. A view of a contact, launched by PickDemo after choosing one of the people from the pick list

One flaw in this application is that it may not have permission to view whatever content collection the user entered. For the sample, we had to specifically request permission to read the user's contacts, via a uses-permission element in `AndroidManifest.xml`. We'll cover more about requesting (and requiring) permissions later in this book.

Would You Like to See the Menu?

Another way to give the user ways to take actions on a piece of content, without you knowing what actions are possible, is to inject a set of menu choices into the options menu via `addIntentOptions()`. This method, available on `Menu`, takes an `Intent` and other parameters and fills in a set of menu choices on the `Menu` instance, each representing one possible action. Choosing one of those menu choices spawns the associated activity.

The canonical example of using `addIntentOptions()` illustrates another flavor of having a piece of content and not knowing the actions that can be taken. In the previous example, showing `ActivityAdapter`, the content was from some other Android application, and we know nothing about it. It is also possible, though, that we know full well what the content is – it's ours. However, Android applications are perfectly capable of adding new actions to existing content types, so even though you wrote your application and know what you expect to be done with your content, there may be other options you are unaware of that are available to users.

For example, imagine the tagging subsystem mentioned in the introduction to this chapter. It would be very annoying to users if, every time they wanted to tag a piece of content, they had to go to a separate tagging tool, then turn around and pick the content they just had been working on (if that is even technically possible) before associating tags with it. Instead, they would probably prefer a menu choice in the content's own "home" activity where they can indicate they want to tag it, which leads them to the set-a-tag activity and tells that activity what content should get tagged.

To accomplish this, the tagging subsystem should set up an intent filter, supporting any piece of content, with their own action (e.g., `ACTION_TAG`) and a category of ALTERNATE_CATEGORY. The category ALTERNATE_CATEGORY is the convention for one application adding actions to another application's content.

If you want to write activities that are aware of possible add-ons like tagging, you should use addIntentOptions() to add those add-ons' actions to your options menu, such as the following:

```
Intent intent = new Intent(null, myContentUri);

intent.addCategory(Intent.ALTERNATIVE_CATEGORY);
menu.addIntentOptions(Menu.ALTERNATIVE, 0,
                      new ComponentName(this,
                                        MyActivity.class),
                      null, intent, 0, null);
```

Here, myContentUri is the content Uri of whatever is being viewed by the user in this activity, MyActivity is the name of the activity class, and menu is the menu being modified.

In this case, the Intent we are using to pick actions from requires that appropriate intent receivers support the ALTERNATIVE_CATEGORY. Then, we add the options to the menu with addIntentOptions() and the following parameters:

- The sort position for this set of menu choices, typically set to 0 (appear in the order added to the menu) or ALTERNATIVE (appear after other menu choices)
- A unique number for this set of menu choices, or 0 if you do not need a number
- A ComponentName instance representing the activity that is populating its menu – this is used to filter out the activity's own actions, so the activity can handle its own actions as it sees fit
- An array of Intent instances that are the "specific" matches – any actions matching those intents are shown first in the menu before any other possible actions
- The Intent for which you want the available actions

- A set of flags. The only one of likely relevance is represented as `MATCH_DEFAULT_ONLY`, which means matching actions must also implement the `DEFAULT_CATEGORY` category. If you do not need this, use a value of `0` for the flags.
- An array of `Menu.Item`, which will hold the menu items matching the array of `Intent` instances supplied as the "specifics", or `null` if you do not need those items (or are not using "specifics")

Asking Around

Both the `ActivityAdapter` family and `addIntentOptions()` use `queryIntentActivityOptions()` for the "heavy lifting" of finding possible actions. The `queryIntentActivityOptions()` method is implemented on `PackageManager`, which is available to your activity via `getPackageManager()`.

The `queryIntentActivityOptions()` method takes some of the same parameters as does `addIntentOptions()`, notably the caller `ComponentName`, the "specifics" array of `Intent` instances, the overall `Intent` representing the actions you are seeking, and the set of flags. It returns a `List` of `Intent` instances matching the stated criteria, with the "specifics" ones first.

If you would like to offer alternative actions to users, but by means other `addIntentOptions()`, you could call `queryIntentActivityOptions()`, get the `Intent` instances, then use them to populate some other user interface (e.g., a toolbar).

PART V – Content Providers and Services

CHAPTER 26

Using a Content Provider

Any `Uri` in Android that begins with the `content://` scheme represents a resource served up by a content provider. Content providers offer data encapsulation using `Uri` instances as handles – you neither know nor care where the data represented by the `Uri` comes from, so long as it is available to you when needed. The data could be stored in a SQLite database, or in flat files, or retrieved off a device, or be stored on some far-off server accessed over the Internet.

Given a `Uri`, you can perform basic CRUD (create, read, update, delete) operations using a content provider. `Uri` instances can represent either collections or individual pieces of content. Given a collection `Uri`, you can create new pieces of content via insert operations. Given an instance `Uri`, you can read data represented by the `Uri`, update that data, or delete the instance outright.

Android lets you use existing content providers, plus create your own. This chapter covers using content providers; the next chapter will explain how you can serve up your own data using the content provider framework.

Pieces of Me

The simplified model of the construction of a content `Uri` is the scheme, the namespace of data, and, optionally, the instance identifier, all separated by slashes in URL-style notation. The scheme of a content Uri is always `content://`.

So, a content `Uri` of `content://constants/5` represents the constants instance with an identifier of `5`.

The combination of the scheme and the namespace is known as the "base Uri" of a content provider, or a set of data supported by a content provider. In the example above, `content://constants` is the base `Uri` for a content provider that serves up information about "constants" (in this case, physical constants).

The base `Uri` can be more complicated. For example, the base `Uri` for contacts is `content://contacts/people`, as the contacts content provider may serve up other data using other base `Uri` values.

The base `Uri` represents a collection of instances. The base `Uri` combined with an instance identifier (e.g., 5) represents a single instance.

Most of the Android APIs expect these to be `Uri` objects, though in common discussion, it is simpler to think of them as strings. The `Uri.parse()` static method creates a `Uri` out of the string representation.

Getting a Handle

So, where do these `Uri` instances come from?

The most popular starting point, if you know the type of data you want to work with, is to get the base `Uri` from the content provider itself in code. For example, `android.provider.CONTENT_URI` is the base `Uri` for contacts represented as people – this maps to `content://contacts/people`. If you just need the collection, this `Uri` works as-is; if you need an instance and know its identifier, you can call `addId()` on the `Uri` to inject it, so you have a `Uri` for the instance.

You might also get `Uri` instances handed to you from other sources. In the preceding chapter, we saw how you got `Uri` handles for contacts via sub-activities responding to `ACTION_PICK` intents. In this case, the `Uri` is truly an opaque handle...unless you decide to pick it apart using the various getters on the `Uri` class.

You can also hard-wire literal `String` objects and convert them into `Uri` instances via `Uri.parse()`. For example, in the preceding chapter, the sample code used an `EditText` with `content://contacts/people` pre-filled in. This isn't an ideal solution, as the base `Uri` values could conceivably change over time.

Makin' Queries

Given a base `Uri`, you can run a query to return data out of the content provider related to that `Uri`. This has much of the feel of SQL: you specify the "columns" to return, the constraints to determine which "rows" to return, a sort order, etc. The difference is that this request is being made of a content provider, not directly of some database (e.g., SQLite).

The nexus of this is the `managedQuery()` method available to your activity. This method takes five parameters:

1. The base `Uri` of the content provider to query, or the instance `Uri` of a specific object to query
2. An array of properties of instances from that content provider that you want returned by the query
3. A constraint statement, functioning like a SQL `WHERE` clause
4. An optional set of parameters to bind into the constraint clause, replacing any `?` that appear there
5. An optional sort statement, functioning like a SQL `ORDER BY` clause

This method returns a `Cursor` object, which you can use to retrieve the data returned by the query.

"Properties" is to content providers as columns are to databases. In other words, each instance (row) returned by a query consists of a set of properties (columns), each representing some piece of data.

This will hopefully make more sense given an example.

Our content provider examples come from the Constants sample application, specifically the `ConstantsBrowser` class:

```
constantsCursor=managedQuery(Provider.Constants.CONTENT_URI,
                             PROJECTION, null, null, null);
```

In the call to `managedQuery()`, we provide:

- The `Uri` passed into the activity by the caller (`CONTENT_URI`), in this case representing the collection of physical constants managed by the content provider
- A list of properties to retrieve (see code below)
- Three null values, indicating that we do not need a constraint clause (the `Uri` represents the instance we need), nor parameters for the constraint, nor a sort order (we should only get one entry back)

```
private static final String[] PROJECTION = new String[] {
    Provider.Constants._ID, Provider.Constants.TITLE,
    Provider.Constants.VALUE};
```

The biggest "magic" here is the list of properties. The lineup of what properties are possible for a given content provider should be provided by the documentation (or source code) for the content provider itself. In this case, we define logical values on the `Provider` content provider implementation class that represent the various properties (namely, the unique identifier, the display name or title, and the value of the constant).

Adapting to the Circumstances

Now that we have a Cursor via managedQuery(), we have access to the query results and can do whatever we want with them. You might, for example, manually extract data from the Cursor to populate widgets or other objects.

However, if the goal of the query was to return a list from which the user should choose an item, you probably should consider using SimpleCursorAdapter. This class bridges between the Cursor and a selection widget, such as a ListView or Spinner. Pour the Cursor into a SimpleCursorAdapter, hand the adapter off to the widget, and you're set – your widget will show the available options.

For example, here is the onCreate() method from ConstantsBrowser, which gives the user a list of physical constants:

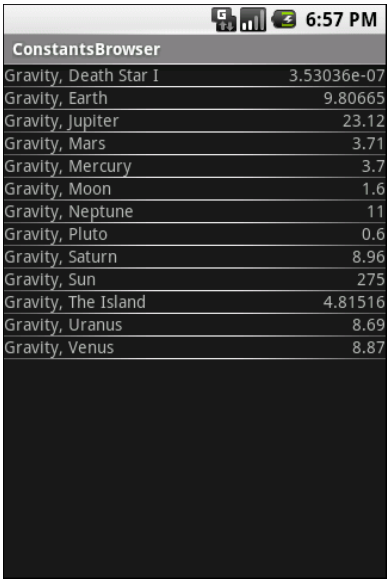
```
@Override
public void onCreate(Bundle savedInstanceState) {
  super.onCreate(savedInstanceState);

  constantsCursor=managedQuery(Provider.Constants.CONTENT_URI,
                               PROJECTION, null, null, null);

  ListAdapter adapter=new SimpleCursorAdapter(this,
                    R.layout.row, constantsCursor,
                    new String[] {Provider.Constants.TITLE,
                                  Provider.Constants.VALUE},
                    new int[] {R.id.title, R.id.value});

  setListAdapter(adapter);
  registerForContextMenu(getListView());
}
```

After executing the managedQuery() and getting the Cursor, ConstantsBrowser creates a SimpleCursorAdapter with the following parameters:

- The activity (or other Context) creating the adapter; in this case, the ConstantsBrowser itself
- The identifier for a layout to be used for rendering the list entries (R.layout.row)
- The cursor (constantsCursor)

- The properties to pull out of the cursor and use for configuring the list entry View instances (`TITLE` and `VALUE`)
- The corresponding identifiers of `TextView` widgets in the list entry layout that those properties should go into (`R.id.title` and `R.id.value`)

After that, we put the adapter into the `ListView`, and we get:



```
6:57 PM
ConstantsBrowser
Gravity, Death Star I          3.53036e-07
Gravity, Earth                     9.80665
Gravity, Jupiter                     23.12
Gravity, Mars                         3.71
Gravity, Mercury                       3.7
Gravity, Moon                          1.6
Gravity, Neptune                        11
Gravity, Pluto                         0.6
Gravity, Saturn                       8.96
Gravity, Sun                           275
Gravity, The Island                4.81516
Gravity, Uranus                       8.69
Gravity, Venus                        8.87
```

Figure 79. ConstantsBrowser, showing a list of physical constants

If you need more control over the views than you can reasonably achieve with the stock view construction logic, subclass `SimpleCursorAdapter` and override `getView()` to create your own widgets to go into the list, as demonstrated earlier in this book.

Doing It By Hand

Of course, you can always do it the "hard way" – pulling data out of the `Cursor` by hand. The `Cursor` interface is similar in concept to other database access APIs offering cursors as objects, though, as always, the devil is in the details.

Position

`Cursor` instances have a built-in notion of position, akin to the Java `Iterator` interface. To get to the various rows, you can use:

- `moveToFirst()` to move to the first row in the result set or `moveToLast()` to move to the last row in the result set
- `moveToNext()` to move to the next row and determine if there is yet another row to process (`moveToNext()` returns `true` if it points to another row after moving, `false` otherwise)
- `moveToPrevious()` to move to the previous row, as the opposite to `moveToNext()`
- `moveToPosition()` to move to a specific index, or `move()` to move to a relative position plus or minus from your current position
- `getPosition()` to return your current index
- a whole host of condition methods, including `isFirst()`, `isLast()`, `isBeforeFirst()`, and `isAfterLast()`

Getting Properties

Once you have the `Cursor` positioned at a row of interest, you have a variety of methods to retrieve properties from that row, with different methods supporting different types (`getString()`, `getInt()`, `getFloat()`, etc.). Each method takes the zero-based index of the property you want to retrieve.

If you want to see if a given property has a value, you can use `isNull()` to test it for `null`-ness.

Give and Take

Of course, content providers would be astonishingly weak if you couldn't add or remove data from them, only update what is there. Fortunately, content providers offer these abilities as well.

To insert data into a content provider, you have two options available on the `ContentProvider` interface (available through `getContentProvider()` to your activity):

1. Use `insert()` with a collection `Uri` and a `ContentValues` structure describing the initial set of data to put in the row
2. Use `bulkInsert()` with a collection `Uri` and an array of `ContentValues` structures to populate several rows at once

The `insert()` method returns a `Uri` for you to use for future operations on that new object. The `bulkInsert()` method returns the number of created rows; you would need to do a query to get back at the data you just inserted.

For example, here is a snippet of code from `ConstantsBrowser` to insert a new constant into the content provider, given a `DialogWrapper` that can provide access to the title and value of the constant:

```
private void processAdd(DialogWrapper wrapper) {
  ContentValues values=new ContentValues(2);

  values.put(Provider.Constants.TITLE, wrapper.getTitle());
  values.put(Provider.Constants.VALUE, wrapper.getValue());

  getContentResolver().insert(Provider.Constants.CONTENT_URI,
                              values);
  constantsCursor.requery();
}
```

In this case, all we do is populate the title. Since we get a `Uri` back, we can turn around and get a `Cursor` on that `Uri` (via `managedQuery(uri, PROJECTION, null, null)`) and reuse our existing update logic to add in any additional data beyond the title itself.

Also, if we already have an outstanding `Cursor` for the content provider's contents, call `requery()` on that to update `Cursor`. This, in turn, will update any `SimpleCursorAdapter` you may have wrapping the `Cursor` – and that will update any selection widgets (e.g., `ListView`) you have using the adapter.

To delete one or more rows from the content provider, use the `delete()` method on `ContentResolver`. This works akin to a SQL `DELETE` statement and takes three parameters:

1. A `Uri` representing the collection (or instance) you wish to update
2. A constraint statement, functioning like a SQL `WHERE` clause, to determine which rows should be updated
3. An optional set of parameters to bind into the constraint clause, replacing any `?` that appear there

Beware of the BLOB!

Binary large objects – BLOBs – are supported in many databases, including SQLite. However, the Android model is more aimed at supporting such hunks of data via their own separate content `Uri` values. A content provider, therefore, does not provide direct access to binary data, like photos, via a `Cursor`. Rather, a property in the content provider will give you the content `Uri` for that particular BLOB. You can use `getInputStream()` and `getOutputStream()` on your `ContentProvider` to read and write the binary data.

Quite possibly, the rationale is to minimize unnecessary data copying. For example, the primary use of a photo in Android is to display it to the user. The `ImageView` widget can do just that, via a content `Uri` to a JPEG. By storing the photo in a manner that has its own `Uri`, you do not need to copy data out of the content provider into some temporary holding area just to be able to display it – just use the `Uri`. The expectation, presumably, is that few Android applications will do much more than upload binary data and use widgets or built-in activities to display that data.

CHAPTER 27

Building a Content Provider

Building a content provider is probably the most complicated and tedious task in all of Android development. There are many requirements of a content provider, in terms of methods to implement and public data members to supply. And, until you try using it, you have no great way of telling if you did any of it correctly (versus, say, building an activity and getting validation errors from the resource compiler).

That being said, building a content provider is of huge importance if your application wishes to make data available to other applications. If your application is keeping its data solely to itself, you may be able to avoid creating a content provider, just accessing the data directly from your activities. But, if you want your data to possibly be used by others – for example, you are building a feed reader and you want other programs to be able to access the feeds you are downloading and caching – then a content provider is right for you.

First, Some Dissection

As was discussed in the previous chapter, the content `Uri` is the linchpin behind accessing data inside a content provider. When using a content provider, all you really need to know is the provider's base `Uri`; from there you can run queries as needed, or construct a `Uri` to a specific instance if you know the instance identifier.

When building a content provider, though, you need to know a bit more about the innards of the content `Uri`.

A content `Uri` has two to four pieces, depending on situation:

- It always has a scheme (`content://`), indicating it is a content `Uri` instead of a `Uri` to a Web resource (`http://`).
- It always has an authority, which is the first path segment after the scheme. The authority is a unique string identifying the content provider that handles the content associated with this `Uri`.
- It may have a data type path, which is the list of path segments after the authority and before the instance identifier (if any). The data type path can be empty, if the content provider only handles one type of content. It can be a single path segment (`foo`) or a chain of path segments (`foo/bar/goo`) as needed to handle whatever data access scenarios the content provider requires.
- It may have an instance identifier, which is an integer identifying a specific piece of content. A content `Uri` without an instance identifier refers to the collection of content represented by the authority (and, where provided, the data path).

For example, a content `Uri` could be as simple as `content://sekrits`, which would refer to the collection of content held by whatever content provider was tied to the `sekrits` authority (e.g., `SecretsProvider`). Or, it could be as complex as `content://sekrits/card/pin/17`, which would refer to a piece of content (identified as `17`) managed by the `sekrits` content provider that is of the data type `card/pin`.

Next, Some Typing

Next, you need to come up with some MIME types corresponding with the content your content provider will provide.

Android uses both the content `Uri` and the MIME type as ways to identify content on the device. A collection content `Uri` – or, more accurately, the combination authority and data type path – should map to a pair of MIME types. One MIME type will represent the collection; the other will represent an instance. These map to the `Uri` patterns above for no-identifier and identifier, respectively. As you saw earlier in this book, you can fill in a MIME type into an `Intent` to route the `Intent` to the proper activity (e.g., `ACTION_PICK` on a collection MIME type to call up a selection activity to pick an instance out of that collection).

The collection MIME type should be of the form `vnd.X.cursor.dir/Y`, where `X` is the name of your firm, organization, or project, and `Y` is a dot-delimited type name. So, for example, you might use `vnd.tlagency.cursor.dir/sekrits.card.pin` as the MIME type for your collection of secrets.

The instance MIME type should be of the form `vnd.X.cursor.item/Y`, usually for the same values of `X` and `Y` as you used for the collection MIME type (though that is not strictly required).

Step #1: Create a Provider Class

Just as an activity and intent receiver are both Java classes, so is a content provider. So, the big step in creating a content provider is crafting its Java class, with a base class of `ContentProvider`.

In your subclass of `ContentProvider`, you are responsible for implementing six methods that, when combined, perform the services that a content provider is supposed to offer to activities wishing to create, read, update, or delete content.

onCreate()

As with an activity, the main entry point to a content provider is `onCreate()`. Here, you can do whatever initialization you want. In particular, here is where you should lazy-initialize your data store. For example, if you plan on storing your data in such-and-so directory on an SD card, with an XML file serving as a "table of contents", you should check and see if that directory and XML file are there and, if not, create them so the rest of your content provider knows they are out there and available for use.

Similarly, if you have rewritten your content provider sufficiently to cause the data store to shift structure, you should check to see what structure you have now and adjust it if what you have is out of date. You don't write your own "installer" program and so have no great way of determining if, when `onCreate()` is called, if this is the first time ever for the content provider, the first time for a new release of a content provider that was upgraded in-place, or if this is just a normal startup.

If your content provider uses SQLite for storage, you can detect to see if your tables exist by querying on the `sqlite_master` table. This is useful for lazy-creating a table your content provider will need.

For example, here is the `onCreate()` method for `Provider`, from the Constants sample application:

```
@Override
public boolean onCreate() {
  db=(new DatabaseHelper(getContext())).getWritableDatabase();

  return (db == null) ? false : true;
}
```

While that doesn't seem all that special, the "magic" is in the private `DatabaseHelper` object, described in the chapter on database access.

query()

As one might expect, the `query()` method is where your content provider gets details on a query some activity wants to perform. It is up to you to actually process said query.

The query method gets, as parameters:

- A `Uri` representing the collection or instance being queried

- A `String[]` representing the list of properties that should be returned
- A `String` representing what amounts to a SQL `WHERE` clause, constraining which instances should be considered for the query results
- A `String[]` representing values to "pour into" the `WHERE` clause, replacing any `?` found there
- A `String` representing what amounts to a SQL `ORDER BY` clause

You are responsible for interpreting these parameters however they make sense and returning a `Cursor` that can be used to iterate over and access the data.

As you can imagine, these parameters are aimed towards people using a SQLite database for storage. You are welcome to ignore some of these parameters (e.g., you elect not to try to roll your own SQL `WHERE` clause parser), but you need to document that fact so activities only attempt to query you by instance `Uri` and not using parameters you elect not to handle.

For SQLite-backed storage providers, however, the `query()` method implementation should be largely boilerplate. Use a `SQLiteQueryBuilder` to convert the various parameters into a single SQL statement, then use `query()` on the builder to actually invoke the query and give you a `Cursor` back. The `Cursor` is what your `query()` method then returns.

For example, here is `query()` from `Provider`:

```
@Override
public Cursor query(Uri url, String[] projection, String selection,
                    String[] selectionArgs, String sort) {
  SQLiteQueryBuilder qb=new SQLiteQueryBuilder();

  qb.setTables(getTableName());

  if (isCollectionUri(url)) {
    qb.setProjectionMap(getDefaultProjection());
  }
  else {
    qb.appendWhere(getIdColumnName()+"="+url.getPathSegments().get(1));
  }

  String orderBy;

  if (TextUtils.isEmpty(sort)) {
    orderBy=getDefaultSortOrder();
  } else {
    orderBy=sort;
  }

  Cursor c=qb.query(db, projection, selection, selectionArgs,
                    null, null, orderBy);
  c.setNotificationUri(getContext().getContentResolver(), url);
  return c;
}
```

We create a `SQLiteQueryBuilder` and pour the query details into the builder. Note that the query could be based around either a collection or an instance `Uri` – in the latter case, we need to add the instance ID to the query. When done, we use the `query()` method on the builder to get a `Cursor` for the results.

insert()

Your insert() method will receive a `Uri` representing the collection and a `ContentValues` structure with the initial data for the new instance. You are responsible for creating the new instance, filling in the supplied data, and returning a `Uri` to the new instance.

If this is a SQLite-backed content provider, once again, the implementation is mostly boilerplate: validate that all required values were supplied by the activity, merge your own notion of default values with the supplied data, and call `insert()` on the database to actually create the instance.

For example, here is `insert()` from `Provider`:

```
@Override
public Uri insert(Uri url, ContentValues initialValues) {
  long rowID;
  ContentValues values;

  if (initialValues!=null) {
    values=new ContentValues(initialValues);
  } else {
    values=new ContentValues();
  }

  if (!isCollectionUri(url)) {
    throw new IllegalArgumentException("Unknown URL " + url);
  }

  for (String colName : getRequiredColumns()) {
    if (values.containsKey(colName) == false) {
      throw new IllegalArgumentException("Missing column: "+colName);
    }
  }

  populateDefaultValues(values);

  rowID=db.insert(getTableName(), getNullColumnHack(), values);
  if (rowID > 0) {
    Uri uri=ContentUris.withAppendedId(getContentUri(), rowID);
    getContext().getContentResolver().notifyChange(uri, null);
    return uri;
  }

  throw new SQLException("Failed to insert row into " + url);
}
```

The pattern is the same as before: use the provider particulars plus the data to be inserted to actually do the insertion. Of note:

- You can only insert into a collection `Uri`, so we validate that by calling `isCollectionUri()`
- The provider also knows what columns are required (`getRequiredColumns()`), so we iterate over those and confirm our supplied values cover the requirements
- The provider is also responsible for filling in any default values (`populateDefaultValues()`) for columns not supplied in the `insert()` call and not automatically handled by the SQLite table definition

update()

Your `update()` method gets the `Uri` of the instance or collection to change, a `ContentValues` structure with the new values to apply, a String for a SQL `WHERE` clause, and a `String[]` with parameters to use to replace `?` found in the `WHERE` clause. Your responsibility is to identify the instance(s) to be modified (based on the Uri and WHERE clause), then replace those instances' current property values with the ones supplied.

This will be annoying, unless you're using SQLite for storage. Then, you can pretty much pass all the parameters you received to the update() call to the database, though the update() call will vary slightly depending on whether you are updating one instance or several.

For example, here is update() from Provider:

```
@Override
public int update(Uri url, ContentValues values, String where, String[]
whereArgs) {
  int count;

  if (isCollectionUri(url)) {
    count=db.update(getTableName(), values, where, whereArgs);
  }
  else {
    String segment=url.getPathSegments().get(1);
    count=db
        .update(getTableName(), values, getIdColumnName()+"="
            + segment
            + (!TextUtils.isEmpty(where) ? " AND (" + where
              + ')' : ""), whereArgs);
  }

  getContext().getContentResolver().notifyChange(url, null);
  return count;
}
```

In this case, updates can either be to a specific instance or applied across the entire collection, so we check the Uri (isCollectionUri()) and, if it is an update for the collection, just perform the update. If we are updating a single instance, we need to add a constraint to the WHERE clause to only update for the requested row.

delete()

As with update(), delete() receives a Uri representing the instance or collection to work with and a WHERE clause and parameters. If the activity is deleting a single instance, the Uri should represent that instance and the WHERE clause may be null. But, the activity might be requesting to delete an open-ended set of instances, using the WHERE clause to constrain which ones to delete.

As with update(), though, this is simple if you are using SQLite for database storage (sense a theme?). You can let it handle the idiosyncrasies of parsing and applying the WHERE clause – all you have to do is call delete() on the database.

For example, here is delete() from Provider:

```
@Override
public int delete(Uri url, String where, String[] whereArgs) {
  int count;
  long rowId=0;

  if (isCollectionUri(url)) {
    count=db.delete(getTableName(), where, whereArgs);
  }
  else {
    String segment=url.getPathSegments().get(1);
    rowId=Long.parseLong(segment);
    count=db
        .delete(getTableName(), getIdColumnName()+"="
            + segment
            + (!TextUtils.isEmpty(where) ? " AND (" + where
                + ')' : ""), whereArgs);
  }

  getContext().getContentResolver().notifyChange(url, null);
  return count;
}
```

This is almost a clone of the update() implementation described above – either delete a subset of the entire collection or delete a single instance (if it also satisfies the supplied WHERE clause).

getType()

The last method you need to implement is getType(). This takes a Uri and returns the MIME type associated with that Uri. The Uri could be a collection or an instance Uri; you need to determine which was provided and return the corresponding MIME type.

For example, here is getType() from Provider:

```
@Override
public String getType(Uri url) {
  if (isCollectionUri(url)) {
    return(getCollectionType());
  }

  return(getSingleType());
}
```

As you can see, most of the logic delegates to private getCollectionType() and getSingleType() methods:

```
private String getCollectionType() {
  return("vnd.android.cursor.dir/vnd.commonsware.constant");
}

private String getSingleType() {
  return("vnd.android.cursor.item/vnd.commonsware.constant");
}
```

Step #2: Supply a Uri

You also need to add a public static member...somewhere, containing the Uri for each collection your content provider supports. Typically, this is a public static final Uri put on the content provider class itself:

```
public static final Uri CONTENT_URI=
  Uri.parse("content://com.commonsware.android.tourit.Provider/tours");
```

You may wish to use the same namespace for the content Uri that you use for your Java classes, to reduce the chance of collision with others.

Step #3: Declare the Properties

Remember those properties you referenced when you were using a content provider, in the previous chapter? Well, you need to have those too for your own content provider.

Specifically, you want a public static class implementing `BaseColumns` that contains your property names, such as this example from `Provider`:

```
public static final class Constants implements BaseColumns {
  public static final Uri CONTENT_URI
      =Uri.parse("content://com.commonsware.android.constants.Provider/constants
");
  public static final String DEFAULT_SORT_ORDER="title";
  public static final String TITLE="title";
  public static final String VALUE="value";
}
```

If you are using SQLite as a data store, the values for the property name constants should be the corresponding column name in the table, so you can just pass the projection (array of properties) to SQLite on a `query()`, or pass the `ContentValues` on an `insert()` or `update()`.

Note that nothing in here stipulates the types of the properties. They could be strings, integers, or whatever. The biggest limitation is what a `Cursor` can provide access to via its property getters. The fact that there is nothing in code that enforces type safety means you should document the property types well, so people attempting to use your content provider know what they can expect.

Step #4: Update the Manifest

The glue tying the content provider implementation to the rest of your application resides in your `AndroidManifest.xml` file. Simply add a `<provider>` element as a child of the `<application>` element:

```
<provider
  android:name=".Provider"
  android:authorities="com.commonsware.android.tourit.Provider" />
```

The `android:name` property is the name of the content provider class, with a leading dot to indicate it is in the stock namespace for this application's classes (just like you use with activities).

The `android:authorities` property should be a semicolon-delimited list of the authority values supported by the content provider. Recall, from earlier in this chapter, that each content `Uri` is made up of a scheme, authority, data type path, and instance identifier. Each authority from each `CONTENT_URI` value should be included in the `android:authorities` list.

Now, when Android encounters a content `Uri`, it can sift through the providers registered through manifests to find a matching authority. That tells Android which application and class implements the content provider, and from there Android can bridge between the calling activity and the content provider being called.

Notify-On-Change Support

An optional feature your content provider to its clients is notify-on-change support. This means that your content provider will let clients know if the data for a given content `Uri` changes.

For example, suppose you have created a content provider that retrieves RSS and Atom feeds from the Internet based on the user's feed subscriptions (via OPML, perhaps). The content provider offers read-only access to the contents of the feeds, with an eye towards several applications on the phone using those feeds versus everyone implementing their own feed poll-fetch-and-cache system. You have also implemented a service that will get updates to those feeds asynchronously, updating the underlying data store. Your content provider could alert applications using the feeds that such-and-so feed was updated, so applications using that specific feed can refresh and get the latest data.

On the content provider side, to do this, call `notifyChange()` on your `ContentResolver` instance (available in your content provider via `getContext().getContentResolver()`). This takes two parameters: the `Uri` of the piece of content that changed and the `ContentObserver` that initiated the change. In many cases, the latter will be `null`; a non-`null` value simply means that observer will not be notified of its own changes.

On the content consumer side, an activity can call `registerContentObserver()` on its `ContentResolver` (via `getContentResolver()`). This ties a `ContentObserver` instance to a supplied `Uri` – the observer will be notified whenever `notifyChange()` is called for that specific `Uri`. When the consumer is done with the `Uri`, `unregisterContentObserver()` releases the connection.

CHAPTER 28

Requesting and Requiring Permissions

In the late 1990's, a wave of viruses spread through the Internet, delivered via email, using contact information culled from Microsoft Outlook. A virus would simply email copies of itself to each of the Outlook contacts that had an email address. This was possible because, at the time, Outlook did not take any steps to protect data from programs using the Outlook API, since that API was designed for ordinary developers, not virus authors.

Nowadays, many applications that hold onto contact data secure that data by requiring that a user explicitly grant rights for other programs to access the contact information. Those rights could be granted on a case-by-case basis or a once at install time.

Android is no different, in that it requires permissions for applications to read or write contact data. Android's permission system is useful well beyond contact data, and for content providers and services beyond those supplied by the Android framework.

You, as an Android developer, will frequently need to ensure your applications have the appropriate permissions to do what you want to do with other applications' data. You may also elect to require permissions for other applications to use your data or services, if you make those available to other Android components. This chapter covers how to accomplish both these ends.

Mother, May I?

Requesting the use of other applications' data or services requires the uses-permission element to be added to your AndroidManifest.xml file. Your manifest may have zero or more uses-permission elements, all as direct children of the root manifest element.

The uses-permission element takes a single attribute, android:name, which is the name of the permission your application requires:

```
<uses-permission
  android:name="android.permission.ACCESS_LOCATION" />
```

The stock system permissions all begin with android.permission and are listed in the Android SDK documentation for Manifest.permission. Third-party applications may have their own permissions, which hopefully they have documented for you. Here are some of the more important built-in permissions:

- ACCESS_MOCK_LOCATION, if you are using the built-in mock location provider
- INTERNET, if your application wishes to access the Internet through any means, from raw Java sockets through the WebView widget
- READ_CALENDAR, READ_CONTACTS, and the like for reading data out of the built-in content providers
- WRITE_CALENDAR, WRITE_CONTACTS, and the like for modifying data in the built-in content providers

Permissions are confirmed at the time the application is installed – the user will be prompted to confirm it is OK for your application to do what the permission calls for. This prompt is not available in the current emulator, however.

If you do not have the desired permission and try to do something that needs it, you may get a SecurityException informing you of the missing permission, but this is not a guarantee – failures may come in other forms, depending on if something else is catching and trying to handle that exception.

To see the effects of permissions, go back to the `Pick` example project. If you look at the `AndroidManifest.xml` file, you will see it requests the `READ_CONTACTS` permission. This is what allows you to view the contact information. Comment out the `uses-permission` element in the manifest, recompile, and try out the new version in the emulator. You should get a `SecurityException`. **NOTE**: you may need to restart the emulator, if you were using the `PickDemo` before during this same emulator session.

Halt! Who Goes There?

The other side of the coin, of course, is to secure your own application. If your application is merely activities and intent receivers, security may be just an “outbound” thing, where you request permission to use resources of other applications. If, on the other hand, you put content providers or services in your application, you will want to implement “inbound” security to control which applications can do what with the data.

Note that the issue here is less about whether other applications might “mess up” your data, but rather about privacy of the user's information or use of services that might incur expense. That is where the stock permissions for built-in Android applications are focused – can you read or modify contacts, can you send SMS, etc. If your application does not store information that might be considered private, security is less an issue. If, on the other hand, your application stores private data, such as medical information, security is much more important.

The first step to securing your own application using permissions is to declare said permissions, once again in the `AndroidManifest.xml` file. In this case, instead of `uses-permission`, you add `permission` elements. Once again, you can have zero or more `permission` elements, all as direct children of the root `manifest` element.

Declaring a permission is slightly more complicated than using a permission. There are three pieces of information you need to supply:

1. The symbolic name of the permission. To keep your permissions from colliding with those from other applications, you should use your application's Java namespace as a prefix
2. A label for the permission: something short that would be understandable by users
3. A description for the permission: something a wee bit longer that is understandable by your users

```
<permission
  android:name="vnd.tlagency.sekrits.SEE_SEKRITS"
  android:label="@string/see_sekrits_label"
  android:description="@string/see_sekrits_description" />
```

This does not enforce the permission. Rather, it indicates that it is a possible permission; your application must still flag security violations as they occur.

Enforcing Permissions via the Manifest

There are two ways for your application to enforce permissions, dictating where and under what circumstances they are required. The easier one is to indicate in the manifest where permissions are required.

Activities, services, and intent receivers can all declare an attribute named `android:permission`, whose value is the name of the permission that is required to access those items:

```
<activity
  android:name=".SekritApp"
  android:label="Top Sekrit"
  android:permission="vnd.tlagency.sekrits.SEE_SEKRITS">
  <intent-filter>
    <action android:name="android.intent.action.MAIN" />
    <category
      android:name="android.intent.category.LAUNCHER" />
  </intent-filter>
</activity>
```

Only applications that have requested your indicated permission will be able to access the secured component. In this case, "access" means:

- Activities cannot be started without the permission
- Services cannot be started, stopped, or bound to an activity without the permission
- Intent receivers ignore messages sent via `broadcastIntent()` unless the sender has the permission

Content providers offer two distinct attributes: `readPermission` and `writePermission`:

```
<provider
  android:name=".SekritProvider"
  android:authorities="vnd.tla.sekrits.SekritProvider"
  android:readPermission="vnd.tla.sekrits.SEE_SEKRITS"
  android:writePermission="vnd.tla.sekrits.MOD_SEKRITS" />
```

In this case, `readPermission` controls access to querying the content provider, while `writePermission` controls access to insert, update, or delete data in the content provider.

Enforcing Permissions Elsewhere

In your code, you have two additional ways to enforce permissions.

Your services can check permissions on a per-call basis via `checkCallingPermission()`. This returns `PERMISSION_GRANTED` or `PERMISSION_DENIED` depending on whether the caller has the permission you specified. For example, if your service implements separate read and write methods, you could get the effect of `readPermission` and `writePermission` in code by checking those methods for the permissions you need from Java.

Also, you can include a permission when you call `sendBroadcast()`. This means that eligible receivers must hold that permission; those without the permission are ineligible to receive it. For example, the Android subsystem presumably includes the `RECEIVE_SMS` permission when it broadcasts that an

SMS message has arrived – this will restrict the receivers of that intent to be only those authorized to receive SMS messages.

May I See Your Documents?

There is no automatic discovery of permissions at compile time; all permission failures occur at runtime. Hence, it is important that you document the permissions required for your public APIs, including content providers, services, and activities intended for launching from other activities. Otherwise, the programmers attempting to interface with your application will have to find out the permission rules by trial and error.

Furthermore, you should expect that users of your application will be prompted to confirm any permissions your application says it needs. Hence, you need to document for your users what they should expect, lest they get confused by the question posed by the phone and elect to not install or use your application.

CHAPTER 29

Creating a Service

As noted previously, Android services are for long-running processes that may need to keep running even when decoupled from any activity. Examples include playing music even if the "player" activity gets garbage-collected, polling the Internet for RSS/Atom feed updates, and maintaining an online chat connection even if the chat client loses focus due to an incoming phone call.

Services are created when manually started (via an API call) or when some activity tries connecting to the service via inter-process communication (IPC). Services will live until no longer needed and if RAM needs to be reclaimed. Running for a long time isn't without its costs, though, so services need to be careful not to use too much CPU or keep radios active too much of the time, lest the service cause the device's battery to get used up too quickly.

This chapter covers how you can create your own services; the next chapter covers how you can use such services from your activities or other contexts. Both chapters will analyze the WeatherPlus sample application, with this chapter focusing mostly on the `WeatherPlusService` implementation. `WeatherPlusService` extends the weather-fetching logic of the original Weather sample, by bundling it in a service that monitors changes in location, so the weather is updated as the emulator is "moved".

Service with Class

Creating a service implementation shares many characteristics with building an activity. You inherit from an Android-supplied base class, override some lifecycle methods, and hook the service into the system via the manifest.

So, the first step in creating a service is to extend the `Service` class, in our case with our own `WeatherPlusService` subclass.

Just as activities have `onCreate()`, `onResume()`, `onPause()` and kin, `Service` implementations can override three different lifecycle methods:

1. `onCreate()`, which, as with services, is called when the service process is created
2. `onStart()`, which is called when a service is manually started by some other process, versus being implicitly started as the result of an IPC request (discussed more in the next chapter)
3. `onDestroy()` which is called as the service is being shut down

Common startup and shutdown logic should go in `onCreate()` and `onDestroy()`; `onStart()` is mostly if your service needs data passed into it from the starting process and you don't wish to use IPC.

For example, here is the `onCreate()` method for `WeatherPlusService`:

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

  client=new DefaultHttpClient();
  format=getString(R.string.url);

  myLocationManager=(LocationManager)getSystemService(Context.LOCATION_SERVICE);
  myLocationManager.requestLocationUpdates("gps", 10000,
                                          10000.0f,
                                          onLocationChange);
}
```

First, we chain upward to the superclass, so Android can do any setup work it needs to have done. Then we initialize our `HttpClient` and format string as we did in the Weather demo. We then get the `LocationManager` instance for our application and request to get updates as our location changes, via the `gps` `LocationProvider`, which will be discussed in greater detail in the chapter on location-based services.

The `onDestroy()` method is much simpler:

```
@Override
public void onDestroy() {
  super.onDestroy();

  myLocationManager.removeUpdates(onLocationChange);
}
```

Here, we just shut down the location-monitoring logic, in addition to chaining upward to the superclass for any Android internal bookkeeping that might be needed.

In addition to those lifecycle methods, though, your service also needs to implement `onBind()`. This method returns an `IBinder`, which is the linchpin behind the IPC mechanism. If you're creating a service class while reading this chapter, just have this method return null for now, and we'll fill in the full implementation in the next section.

When IPC Attacks!

Services will tend to offer inter-process communication (IPC) as a means of interacting with activities or other Android components. Each service declares what methods it is making available over IPC; those methods are then available for other components to call, with Android handling all the messy details involved with making method calls across component or process boundaries.

The guts of this, from the standpoint of the developer, is expressed in AIDL: the Android Interface Description Language. If you have used IPC mechanisms like COM, CORBA, or the like, you will recognize the notion of

IDL. AIDL spells out the public IPC interface, and Android supplies tools to build the client and server side of that interface.

With that in mind, let's take a look at AIDL and IPC.

Write the AIDL

IDLs are frequently written in a "language-neutral" syntax. AIDL, on the other hand, looks a lot like a Java interface. For example, here is the AIDL for the `IWeather`:

```
package com.commonsware.android.service;

// Declare the interface.
interface IWeather {
  String getForecastPage();
}
```

As with a Java interface, you declare a package at the top. As with a Java interface, the methods are wrapped in an interface declaration (`interface IWeather { ... }`). And, as with a Java interface, you list the methods you are making available.

The differences, though, are critical.

First, not every Java type can be used as a parameter. Your choices are:

- Primitive values (`int`, `float`, `double`, `boolean`, etc.)
- `String` and `CharSequence`
- `List` and `Map` (from `java.util`)
- Any other AIDL-defined interfaces
- Any Java classes that implement the `Parcelable` interface, which is Android's flavor of serialization (see below)

In the case of the latter two categories, you need to include `import` statements referencing the names of the classes or interfaces that you are using (e.g., `import com.commonsware.android.ISomething`). This is true even if these classes are in your own package – you have to import them anyway.

Next, parameters can be classified as `in`, `out`, or `inout`. Values that are `out` or `inout` can be changed by the service and those changes will be propagated back to the client. Primitives (e.g., `int`) can only be `in`; we included in for the AIDL for `enable()` just for illustration purposes.

Also, you cannot throw any exceptions. You will need to catch all exceptions in your code, deal with them, and return failure indications some other way (e.g., error code return values).

Name your AIDL files with the `.aidl` extension and place them in the proper directory based on the package name.

When you build your project, either via an IDE or via Ant, the `aidl` utility from the Android SDK will translate your AIDL into a server stub and a client proxy.

Implement the Interface

Given the AIDL-created server stub, now you need to implement the service, either directly in the stub, or by routing the stub implementation to other methods you have already written.

The mechanics of this are fairly straightforward:

- Create a private instance of the AIDL-generated `.Stub` class (e.g., `IWeather.Stub`)
- Implement methods matching up with each of the methods you placed in the AIDL
- Return this private instance from your `onBind()` method in the `Service` subclass

For example, here is the `IWeather.Stub` instance:

```
private final IWeather.Stub binder=new IWeather.Stub() {
  public String getForecastPage() {
    return(getForecastPageImpl());
  }
};
```

In this case, the stub calls the corresponding method on the service itself. That method, which simply returns the cached most-recent weather forecast for the current location, is shown below:

```
synchronized private String getForecastPageImpl() {
  return(forecast);
}
```

Note that AIDL IPC calls are synchronous, and so the caller is blocked until the IPC method returns. Hence, your services need to be quick about their work.

Manifest Destiny

Finally, you need to add the service to your `AndroidManifest.xml` file, for it to be recognized as an available service for use. That is simply a matter of adding a `service` element as a child of the `application` element, providing `android:name` to reference your service class.

For example, here is the `AndroidManifest.xml` file for WeatherPlus:

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.commonsware.android.service">
  <uses-permission android:name="android.permission.VIBRATE" />
  <uses-permission android:name="android.permission.INTERNET" />
  <uses-permission android:name="android.permission.ACCESS_LOCATION" />
  <uses-permission android:name="android.permission.ACCESS_MOCK_LOCATION" />
  <uses-permission android:name="android.permission.ACCESS_FINE_LOCATION" />
  <application android:label="@string/app_name">
    <activity android:name=".WeatherPlus" android:label="@string/app_name">
      <intent-filter>
        <action android:name="android.intent.action.MAIN" />
        <category android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
    </activity>
    <service android:name=".WeatherPlusService" />
  </application>
</manifest>
```

Since the service class is in the same Java namespace as everything else in this application, we can use the shorthand dot-notation (`".WeatherPlusService"`) to reference our class.

If you wish to require some permission of those who wish to start or bind to the service, add an `android:permission` attribute naming the permission you are mandating – see the chapter on permissions for more details.

Lobbing One Over the Fence

Classic IPC is one-way: the client calls functions on the service. It is possible, through the creative use of AIDL, to allow the service to call back into an activity. However, this is a bit fragile, as the service may not know if the activity is still around or if it has been killed off to free up some memory.

An alternative approach, first mentioned in the chapter on `Intent` filters, is to have the service send a broadcast `Intent` that can be picked up by the activity...assuming the activity is still around and is not paused. We will examine the client side of this exchange in the next chapter; for now, let us examine how the service can send a broadcast.

The theory behind the `WeatherPlusService` implementation is that the service gets "tickled" when the device (or emulator) position changes. At that point, the service calls out to the Web service and generates a new forecast Web page for the activity to display. At the same time, though, the service also sends a broadcast, to alert the activity that there is a page update available if it wants it.

Here is the high-level implementation of the aforementioned flow:

```
private void updateForecast(Location loc) {
  String url=String.format(format, loc.getLatitude(),
                           loc.getLongitude());
  HttpGet getMethod=new HttpGet(url);
  try {
    ResponseHandler<String> responseHandler=new BasicResponseHandler();
    String responseBody=client.execute(getMethod, responseHandler);
    String page=generatePage(buildForecasts(responseBody));

    synchronized(this) {
      forecast=page;
    }

    sendBroadcast(broadcast);
  }
  catch (Throwable t) {
    android.util.Log.e("WeatherPlus",
                       "Exception in updateForecast()", t);
  }
}
```

Much of this is similar to the equivalent piece of the original Weather demo – perform the HTTP request, convert that into a set of `Forecast` objects, and turn those into a Web page. The first difference is that the Web page is simply cached in the service, since the service cannot directly put the page into the activity's `WebView`. The second difference is that we call `sendBroadcast()`, which takes an Intent and sends it out to all interested parties. That `Intent` is declared up front in the class prologue:

```
private Intent broadcast=new Intent(BROADCAST_ACTION);
```

Here, `BROADCAST_ACTION` is simply a static `String` with a value that will distinguish this `Intent` from all others:

```
public static final String BROADCAST_ACTION=
          "com.commonsware.android.service.ForecastUpdateEvent";
```

Where's the Remote? And the Rest of the Code?

In Android, services can either be local or remote. Local services run in the same process as the launching activity; remote services run in their own process. A detailed discussion of remote services will be added to a future edition of this book.

We will return to this service in the chapter on location-based services, at which point we will flesh out how locations are tracked (and, in this case, mocked up).

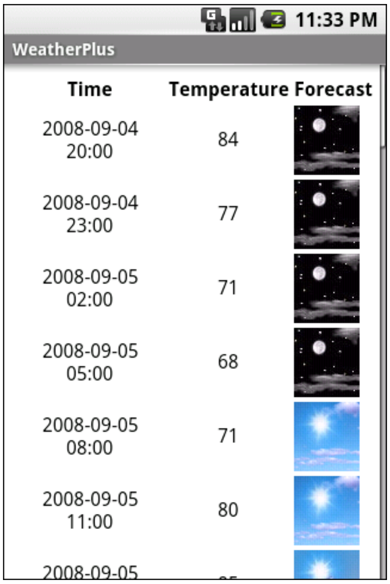
CHAPTER 30

Invoking a Service

Services can be used by any application component that "hangs around" for a reasonable period of time. This includes activities, content providers, and other services. Notably, it does not include pure intent receivers (i.e., intent receivers that are not part of an activity), since those will get garbage collected immediately after each instance processes one incoming `Intent`.

To use a service, you need to get an instance of the AIDL interface for the service, then call methods on that interface as if it were a local object. When done, you can release the interface, indicating you no longer need the service.

In this chapter, we will look at the client side of the WeatherPlus sample application (`WeatherPlus`). The WeatherPlus activity looks an awful lot like the original Weather application – just a Web page showing a weather forecast:



Time	Temperature	Forecast
2008-09-04 20:00	84	
2008-09-04 23:00	77	
2008-09-05 02:00	71	
2008-09-05 05:00	68	
2008-09-05 08:00	71	
2008-09-05 11:00	80	
2008-09-05		

Figure 80. The WeatherPlus service client

The difference is that, as the emulator "moves", the weather forecast changes, based on updates provided by the service.

Bound for Success

To use a service, you first need to create an instance of your own `ServiceConnection` class. `ServiceConnection`, as the name suggests, represents your connection to the service for the purposes of making IPC calls. For example, here is the `ServiceConnection` from the `WeatherPlus` class in the `WeatherPlus` project:

```
private ServiceConnection svcConn=new ServiceConnection() {
  public void onServiceConnected(ComponentName className,
                  IBinder binder) {
    service=IWeather.Stub.asInterface(binder);

    browser.postDelayed(new Runnable() {
      public void run() {
        updateForecast();
      }
    }, 1000);
  }
  public void onServiceDisconnected(ComponentName className) {
    service=null;
  }
};
```

Your `ServiceConnection` subclass needs to implement two methods:

1. `onServiceConnected()`, which is called once your activity is bound to the service
2. `onServiceDisconnected()`, which is called if your connection ends normally, such as you unbinding your activity from the service

Each of those methods receives a `ComponentName`, which simply identifies the service you connected to. More importantly, `onServiceConnected()` receives an `IBinder` instance, which is your gateway to the IPC interface. You will want to convert the `IBinder` into an instance of your AIDL interface class, so you can use IPC as if you were calling regular methods on a regular Java class (`IWeather.Stub.asInterface(binder)`).

To actually hook your activity to the service, call `bindService()` on the activity:

```
bindService(serviceIntent, svcConn, BIND_AUTO_CREATE);
```

The `bindService()` method takes three parameters:

1. An `Intent` representing the service you wish to invoke – for your own service, it's easiest to use an intent referencing the service class directly (`new Intent(this, WeatherPlusService.class)`)
2. Your `ServiceConnection` instance
3. A set of flags – most times, you will want to pass in `BIND_AUTO_CREATE`, which will start up the service if it is not already running

After your `bindService()` call, your `onServiceConnected()` callback in the `ServiceConnection` will eventually be invoked, at which time your connection is ready for use.

Request for Service

Once your service interface object is ready (`IWeather.Stub.asInterface(binder)`), you can start calling methods on it as you need to. In fact, if you disabled some widgets awaiting the connection, now is a fine time to re-enable them.

However, you will want to trap two exceptions. One is `DeadObjectException` – if this is raised, your service connection terminated unexpectedly. In this case, you should unwind your use of the service, perhaps by calling `onServiceDisconnected()` manually, as shown above. The other is `RemoteException`, which is a more general-purpose exception indicating a cross-process communications problem. Again, you should probably unwind your use of the service.

Prometheus Unbound

When you are done with the IPC interface, call `unbindService()`, passing in the `ServiceConnection`. Eventually, your connection's `onServiceDisconnected()` callback will be invoked, at which point you should null out your interface object, disable relevant widgets, or otherwise flag yourself as no longer being able to use the service.

For example, in the WeatherPlus implementation of `onServiceDisconnected()` shown above, we null out the `IWeather` service object.

You can always reconnect to the service, via `bindService()`, if you need to use it again.

Manual Transmission

In addition to binding to the service for the purposes of IPC, you can manually start and stop the service. This is particularly useful in cases where you want the service to keep running independently of your activities –

otherwise, once you unbind the service, your service could well be closed down.

To start a service, simply call `startService()`, providing two parameters:

1. The `Intent` specifying the service to start (again, the easiest way is probably to specify the service class, if its your own service)
2. A `Bundle` providing configuration data, which eventually gets passed to the service's `onStart()` method

Conversely, to stop the service, call `stopService()` with the `Intent` you used in the corresponding `startService()` call.

Catching the Lob

In the preceding chapter, we showed how the service sends a broadcast to let the `WeatherPlus` activity know a change was made to the forecast based on movement. Now, we can see how the activity receives and uses that broadcast.

Here are the implementations of `onResume()` and `onPause()` for `WeatherPlus`:

```
@Override
public void onResume() {
  super.onResume();

  registerReceiver(receiver,
        new IntentFilter(WeatherPlusService.BROADCAST_ACTION));
}

@Override
public void onPause() {
  super.onPause();

  unregisterReceiver(receiver);
}
```

In `onResume()`, we register a static `BroadcastReceiver` to receive `Intents` matching the action declared by the service. In `onPause()`, we disable that

`BroadcastReceiver`, since we will not be receiving any such `Intents` while paused, anyway.

The `BroadcastReceiver`, in turn, simply arranges to update the forecast on the UI thread:

```
private BroadcastReceiver receiver=new BroadcastReceiver() {
  public void onReceive(Context context, Intent intent) {
    runOnUiThread(new Runnable() {
      public void run() {
        updateForecast();
      }
    });
  }
};
```

And `updateForecast()` uses the interface stub to call into the service and retrieve the latest forecast page, also handling the case where the forecast is not yet ready (`null`):

```
private void updateForecast() {
  try {
    String page=service.getForecastPage();

    if (page==null) {
      browser.postDelayed(new Runnable() {
        public void run() {
          updateForecast();
        }
      }, 4000);

      Toast
        .makeText(this, "No forecast available", 2500)
        .show();
    }
    else {
      browser.loadDataWithBaseURL(null, page, "text/html",
                                 "UTF-8", null);
    }
  }
  catch (final Throwable t) {
    svcConn.onServiceDisconnected(null);

    runOnUiThread(new Runnable() {
      public void run() {
        goBlooey(t);
      }
    });
    }
}
```

CHAPTER 31

Alerting Users Via Notifications

Pop-up messages. Tray icons and their associated "bubble" messages. Bouncing dock icons. You are no doubt used to programs trying to get your attention, sometimes for good reason.

Your phone also probably chirps at you for more than just incoming calls: low battery, alarm clocks, appointment notifications, incoming text message or email, etc.

Not surprisingly, Android has a whole framework for dealing with these sorts of things, collectively called "notifications".

Types of Pestering

A service, running in the background, needs a way to users know something of interest has occurred, such as when email has been received. Moreover, the service may need some way to steer the user to an activity where they can act upon the event – reading a received message, for example. For this, Android supplies status bar icons, flashing lights, and other indicators collectively known as "notifications".

Your current phone may well have such icons, to indicate battery life, signal strength, whether Bluetooth is enabled, and the like. With Android, applications can add their own status bar icons, with an eye towards having them appear only when needed (e.g., a message has arrived).

In Android, you can raise notifications via the `NotificationManager`. The `NotificationManager` is a system service. To use it, you need to get the service object via `getSystemService(NOTIFICATION_SERVICE)` from your activity.

The `NotificationManager` gives you three methods: one to pester (`notify()`) and two to stop pestering (`cancel()` and `cancelAll()`).

The `notify()` method takes a `Notification`, which is a data structure that spells out what form your pestering should take. Here is what is at your disposal (bearing in mind that not all devices will necessarily support all of these):

Hardware Notifications

You can flash LEDs on the device by setting lights to true, also specifying the color (as an `#ARGB` value in `ledARGB`) and what pattern the light should blink in (by providing off/on durations in milliseconds for the light via `ledOnMS` and `ledOffMS`).

You can play a sound, using a `Uri` to a piece of content held, perhaps, by a `ContentManager` (`sound`). Think of this as a "ringtone" for your application.

You can vibrate the device, controlled via a `long[]` indicating the on/off patterns (in milliseconds) for the vibration (`vibrate`). You might do this by default, or you might make it an option the user can choose when circumstances require a more subtle notification than a ringtone.

Icons

While the flashing lights, sounds, and vibrations are aimed at getting somebody to look at the device, icons are designed to take them the next step and tell them what's so important.

To set up an icon for a `Notification`, you need to set `icon`, where you provide the identifier of a `Drawable` resource representing the icon, and contentIntent, where you supply an PendingIntent to be raised when the icon is clicked. You should be sure the PendingIntent will be caught by something, perhaps your own application code, to take appropriate steps to let the user deal with the event triggering the notification.

You can also supply a text blurb to appear when the icon is put on the status bar (tickerText).

If you want all three, the simpler approach is to call setLatestEventInfo(), which wraps all three of those in a single call.

Seeing Pestering in Action

Let us now take a peek at the Notify1 sample project, in particular the NotifyDemo class:

```
public class NotifyDemo extends Activity {
  private static final int NOTIFY_ME_ID=1337;
  private Timer timer=new Timer();

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

    Button btn=(Button)findViewById(R.id.notify);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View view) {
        TimerTask task=new TimerTask() {
          public void run() {
            notifyMe();
          }
        };

        timer.schedule(task, 5000);
      }
    });

    btn=(Button)findViewById(R.id.cancel);

    btn.setOnClickListener(new View.OnClickListener() {
      public void onClick(View view) {
        NotificationManager mgr=
          (NotificationManager)getSystemService(NOTIFICATION_SERVICE);
        mgr.cancel(NOTIFY_ME_ID);
      }
    });
  }

  private void notifyMe() {
    final NotificationManager mgr=
      (NotificationManager)getSystemService(NOTIFICATION_SERVICE);
    Notification note=new Notification(R.drawable.red_ball,
                                       "Status message!",
                                       System.currentTimeMillis());
    PendingIntent i=PendingIntent.getActivity(this, 0,
                            new Intent(this, NotifyMessage.class),
                                             0);

    note.setLatestEventInfo(this, "Notification Title",
                            "This is the notification message", i);

    mgr.notify(NOTIFY_ME_ID, note);
  }
}
```

This activity sports two large buttons, one to kick off a notification after a five-second delay, and one to cancel that notification (if it is active):

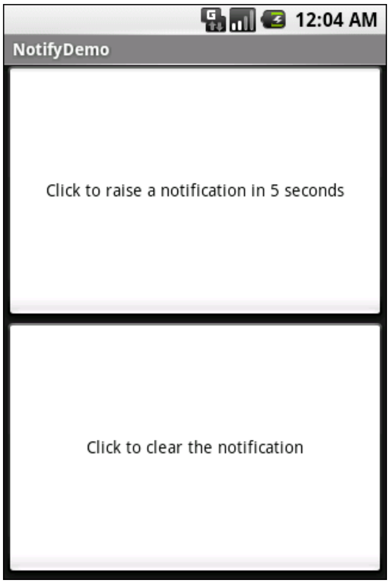

12:04 AM
NotifyDemo
Click to raise a notification in 5 seconds
Click to clear the notification

Figure 81. The NotifyDemo activity main view

Creating the notification, in `notifyMe()`, is accomplished in five steps:

1. Get access to the `NotificationManager` instance
2. Create a `Notification` object with our icon (red ball), a message to flash on the status bar as the notification is raised, and the time associated with this event
3. Create a `PendingIntent` that will trigger the display of another activity (`NotifyMessage`)
4. Use `setLatestEventInfo()` to specify that, when the notification is clicked on, we are to display a certain title and message, and if that is clicked on, we launch the `PendingIntent`
5. Tell the `NotificationManager` to display the notification

Hence, if we click the top button, after five seconds, our red ball icon will appear in the status bar, briefly along with our status message:

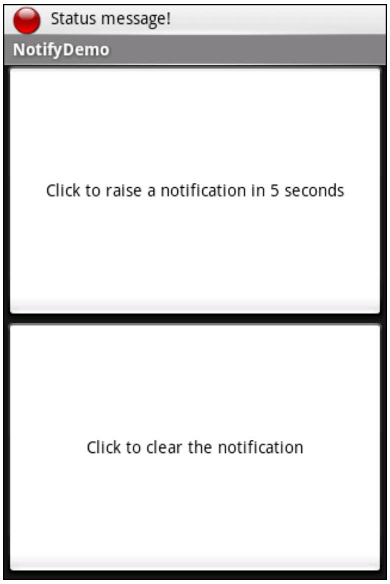
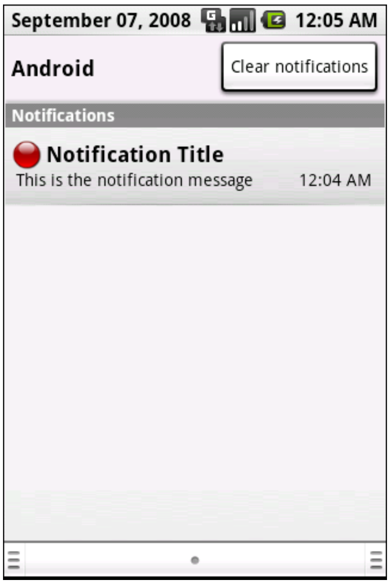

Status message!
NotifyDemo
Click to raise a notification in 5 seconds
Click to clear the notification

Figure 82. Our notification as it appears on the status bar, with our status message

If you click on the red ball, a drawer will appear beneath the status bar. Drag that drawer all the way to the bottom of the screen to show the outstanding notifications, including our own:



Notification Title
This is the notification message 12:04 AM

Figure 83. The notifications drawer, fully expanded, with our notification

If you click on the notification entry in the drawer, you'll be taken to a trivial activity displaying a message – though in a real application, this activity would do something useful based upon the event that occurred (e.g., take users to the newly-arrived mail messages).

Clicking on the cancel button, or clicking on the Clear Notifications button in the drawer, will remove the red ball from the status bar.

PART VI – Other Android Capabilities and Tools

CHAPTER 32

Accessing Location-Based Services

A popular feature on current-era mobile devices is GPS capability, so the device can tell you where you are at any point in time. While the most popular use of GPS service is mapping and directions, there are other things you can do if you know your location. For example, you might set up a dynamic chat application where the people you can chat with are based on physical location, so you're chatting with those you are nearest. Or, you could automatically "geotag" posts to Twitter or similar services.

GPS is not the only way a mobile device can identify your location. Alternatives include:

- The European equivalent to GPS, called Galileo, which is still under development at the time of this writing
- Cell tower triangulation, where your position is determined based on signal strength to nearby cell towers
- Proximity to public WiFi "hotspots" that have known geographic locations

Android devices may have one or more of these services available to them. You, as a developer, can ask the device for your location, plus details on what providers are available. There are even ways for you to simulate your location in the emulator, for use in testing your location-enabled applications.

Location Providers: They Know Where You're Hiding

Android devices can have access to several different means of determining your location. Some will have better accuracy than others. Some may be free, while others may have a cost associated with them. Some may be able to tell you more than just your current position, such as your elevation over sea level, or your current speed.

Android, therefore, has abstracted all this out into a set of `LocationProvider` objects. Your Android environment will have zero or more `LocationProvider` instances, one for each distinct locating service that is available on the device. Providers know not only your location, but their own characteristics, in terms of accuracy, cost, etc.

You, as a developer, will use a `LocationManager`, which holds the `LocationProvider` set, to figure out which `LocationProvider` is right for your particular circumstance. You will also need the `ACCESS_LOCATION` permission in your application, or the various location APIs will fail due to a security violation. Depending on which location providers you wish to use, you may need other permissions as well, such as `ACCESS_GPS`, `ACCESS_ASSISTED_GPS`, `ACCESS_CELL_ID`, or, as the WeatherPlus sample requires, `ACCESS_MOCK_LOCATION`.

Finding Yourself

The obvious thing to do with a location service is to figure out where you are right now.

To do that, you need to get a `LocationManager` – call `getSystemService(LOCATION_SERVICE)` from your activity or service and cast it to be a `LocationManager`.

The next step to find out where you are is to get the name of the `LocationProvider` you want to use. Here, you have two main options:

1. Ask the user to pick a provider
2. Find the best-match provider based on a set of criteria

If you want the user to pick a provider, calling `getProviders()` on the `LocationManager` will give you a `List` of providers, which you can then present to the user for selection.

Or, you can create and populate a `Criteria` object, stating the particulars of what you want out of a `LocationProvider`, such as:

- `setAltitudeRequired()` to indicate if you need the current altitude or not
- `setAccuracy()` to set a minimum level of accuracy, in meters, for the position
- `setCostAllowed()` to control if the provider must be free or if it can incur a cost on behalf of the device user

Given a filled-in `Critieria` object, call `getBestProvider()` on your `LocationManager`, and Android will sift through the criteria and give you the best answer. Note that not all of your criteria will be met – all but the monetary cost criterion might be relaxed if nothing matches.

You are also welcome to hard-wire in a LocationProvider name (e.g., `gps`), perhaps just for testing purposes.

Once you know the name of the `LocationProvider`, you can call `getLastKnownPosition()` to find out where you were recently. Note, however, that "recently" might be fairly out of date (e.g., phone was turned off) or even `null` if there has been no location recorded for that provider yet. On the other hand, `getLastKnownPosition()` incurs no monetary or power cost, since the provider does not need to be activated to get the value.

These methods return a `Location` object, which can give you the latitude and longitude of the device in degrees as a Java `double`. If the particular location provider offers other data, you can get at that as well:

- For altitude, `hasAltitude()` will tell you if there is an altitude value, and `getAltitude()` will return the altitude in meters.
- For bearing (i.e., compass-style direction), `hasBearing()` will tell you if there is a bearing available, and `getBearing()` will return it as degrees east of true north.
- For speed, `hasSpeed()` will tell you if the speed is known and `getSpeed()` will return the speed in meters per second.

A more likely approach to getting the `Location` from a `LocationProvider`, though, is to register for updates, as described in the next section.

On the Move

Not all location providers are necessarily immediately responsive. GPS, for example, requires activating a radio and getting a fix from the satellites before you get a location. That is why Android does not offer a `getMeMyCurrentLocationNow()` method. Combine that with the fact that your users may well want their movements to be reflected in your application, and you are probably best off registering for location updates and using that as your means of getting the current location.

The code sample shown in the preceding section not only shows finding the best-available provider via a set of `Criteria`, but it also shows how to register for updates – call `requestLocationUpdates()` on your `LocationManager` instance. This takes four parameters:

1. The name of the location provider you wish to use
2. How long, in milliseconds, must have elapsed before we might get a location update
3. How far, in meters, must the device have moved before we might get a location update
4. A `LocationListener` that will be notified of key location-related events, as shown below:

```
LocationListener onLocationChange=new LocationListener() {
  public void onLocationChanged(Location location) {
    updateForecast(location);
  }

  public void onProviderDisabled(String provider) {
    // required for interface, not used
  }

  public void onProviderEnabled(String provider) {
    // required for interface, not used
  }

  public void onStatusChanged(String provider, int status,
                              Bundle extras) {
    // required for interface, not used
  }
};
```

Here, all we do is call `updateForecast()` with the `Location` supplied to the `onLocationChanged()` callback method. The `updateForecast()` implementation, as shown in the chapter on creating services, builds a Web page with the current forecast for the location and sends a broadcast so the activity knows an update is available.

When you no longer need the updates, call `removeUpdates()` with the `LocationListener` you registered.

Are We There Yet? Are We There Yet? Are We There Yet?

Sometimes, you want to know not where you are now, or even when you move, but when you get to where you're going. This could be an end destination, or it could be getting to the next step on a set of directions, so you can give the user the next turn.

To accomplish this, `LocationManager` offers `addProximityAlert()`. This registers an `PendingIntent`, which will be fired off when the device gets within a certain distance of a certain location. The `addProximityAlert()` method takes, as parameters:

- The latitude and longitude of the position that you are interested in

- A radius, specifying how close you should be to that position for the `Intent` to be raised
- A duration for the registration, in milliseconds – after this period, the registration automatically lapses. A value of `-1` means the registration lasts until you manually remove it via `removeProximityAlert()`.
- The `PendingIntent` to be raised when the device is within the "target zone" expressed by the position and radius

Note that it is not guaranteed that you will actually receive an `Intent`, if there is an interruption in location services, or if the device is not in the target zone during the period of time the proximity alert is active. For example, if the position is off by a bit, and the radius is a little too tight, the device might only skirt the edge of the target zone, or go by so quickly that the device's location isn't sampled while in the target zone.

It is up to you to arrange for an activity or intent receiver to respond to the `Intent` you register with the proximity alert. What you then do when the `Intent` arrives is up to you: set up a notification (e.g., vibrate the device), log the information to a content provider, post a message to a Web site, etc. Note that you will receive the `Intent` whenever the position is sampled and you are within the target zone – not just upon entering the zone. Hence, you will get the `Intent` several times, perhaps quite a few times depending on the size of the target zone and the speed of the device's movement.

Testing...Testing...

The Android emulator does not have the ability to get a fix from GPS, triangulate your position from cell towers, or identify your location by some nearby WiFi signal. So, if you want to simulate a moving device, you will need to have some means of providing mock location data to the emulator.

For whatever reason, this particular area has undergone significant changes as Android itself has evolved. It used to be that you could provide mock location data within your application, which was very handy for demonstration purposes. Alas, those options have all been removed as of Android 1.0.

The best option for supplying mock location data is the Dalvik Debug Monitor Service (DDMS). This is an external program, separate from the emulator, where you can feed it single location points or full routes to traverse, in a few different formats. DDMS is described in greater detail in the chapter on Android development tools.

CHAPTER 33

Mapping with MapView and MapActivity

One of Google's most popular services – after search, of course – is Google Maps, where you can find everything from the nearest pizza parlor to directions from New York City to San Francisco (only 2,905 miles!) to street views and satellite imagery.

Android, not surprisingly, integrates Google Maps. There is a mapping activity available to users straight off the main Android launcher. More relevant to you, as a developer, are `MapView` and `MapActivity`, which allow you to integrate maps into your own applications. Not only can you display maps, control the zoom level, and allow people to pan around, but you can tie in Android's location-based services to show where the device is and where it is going.

Fortunately, integrating basic mapping features into your Android project is fairly easy. However, there is a fair bit of power available to you, if you want to get fancy.

The Bare Bones

Far and away the simplest way to get a map into your application is to create your own subclass of `MapActivity`. Like `ListActivity`, which wraps up some of the smarts behind having an activity dominated by a `ListView`, MapActivity handles some of the nuances of setting up an activity dominated by a MapView.

In your layout for the MapActivity subclass, you need to add an element named, at the time of this writing, com.google.android.maps.MapView. This is the "longhand" way to spell out the names of widget classes, by including the full package name along with the class name. This is necessary because MapView is not in the com.google.android.widget namespace. You can give the MapView widget whatever android:id attribute value you want, plus handle all the layout details to have it render properly alongside your other widgets.

However, you do need to have:

- android:apiKey, which in production will need to be a Google Maps API key. For now, though, you can substitute whatever string you like here.
- android:clickable = "true", if you want users to be able to click and pan through your map

For example, from the NooYawk sample application, here is the main layout:

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent">
  <com.google.android.maps.MapView android:id="@+id/map"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:apiKey="NooYawk"
    android:clickable="true" />
  <LinearLayout android:id="@+id/zoom"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_alignParentBottom="true"
    android:layout_alignParentLeft="true" />
</RelativeLayout>
```

We'll cover that mysterious zoom LinearLayout in the next section.

In addition, you will need a couple of extra things in your AndroidManifest.xml file:

- The INTERNET and ACCESS_COARSE_LOCATION permissions
- Inside your `<application>`, a `<uses-library>` element with `android:name = "com.google.android.maps"`, to indicate you are using one of the optional Android APIs

Here is the AndroidManifest.xml file for NooYawk:

```xml
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.commonsware.android.maps">
  <uses-permission android:name="android.permission.INTERNET" />
  <uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION" />

  <application android:label="@string/app_name">
    <uses-library android:name="com.google.android.maps" />
    <activity android:name=".NooYawk" android:label="@string/app_name">
      <intent-filter>
        <action android:name="android.intent.action.MAIN" />
        <category android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
    </activity>
  </application>
</manifest>
```

That is pretty much all you need for starters, plus to subclass your activity from MapActivity. If you were to do nothing else, and built that project and tossed it in the emulator, you'd get a nice map of the world. Note, however, that MapActivity is abstract – you need to implement isRouteDisplayed() to indicate if you are supplying some sort of driving directions or not.

In theory, the user could pan around the map using the directional pad. However, that's not terribly useful when the user has the whole world in her hands.

Since a map of the world is not much good by itself, we need to add a few things...

Exercising Your Control

You can find your MapView widget by findViewById(), no different than any other widget. The widget itself then offers a getMapController() method.

Between the `MapView` and `MapController`, you have a fair bit of capability to determine what the map shows and how it behaves. Here are some likely features you will want to use:

Zoom

The map of the world you start with is rather broad. Usually, people looking at a map on a phone will be expecting something a bit narrower in scope, such as a few city blocks.

You can control the zoom level directly via the `setZoom()` method on the `MapController`. This takes an integer representing the level of zoom, where 1 is the world view and 21 is the tightest zoom you can get. Each level is a doubling of the effective resolution: 1 has the equator measuring 256 pixels wide, while 21 has the equator measuring 268,435,456 pixels wide. Since the phone's display probably doesn't have 268,435,456 pixels in either dimension, the user sees a small map focused on one tiny corner of the globe. A level of 16 will show you several city blocks in each dimension and is probably a reasonable starting point for you to experiment with.

If you wish to allow users to change the zoom level, you will need to do a few things:

- First, pick a spot on the screen where you want the zoom controls to appear. These are not huge, and they only appear when being used, so they can overlay the actual map itself if you choose. In the layout shown above, for example, the zoom controls are placed over the map, in the lower-left corner of the screen. You should use a `LinearLayout` or other simple container for the zoom controls' position in your layout.
- In your activity's `onCreate()` method, get your zoom controls' container via `findViewById()`
- Add the result of `map.getZoomControls()` to that container

For example, here are the lines from the `NooYawk` activity's `onCreate()` method that accomplish the latter points:

```
ViewGroup zoom=(ViewGroup)findViewById(R.id.zoom);

zoom.addView(map.getZoomControls());
```

Then, you can manually get the zoom controls to appear by calling `displayZoomControls()` on your `MapView`, or they will automatically appear when the user pans the map.

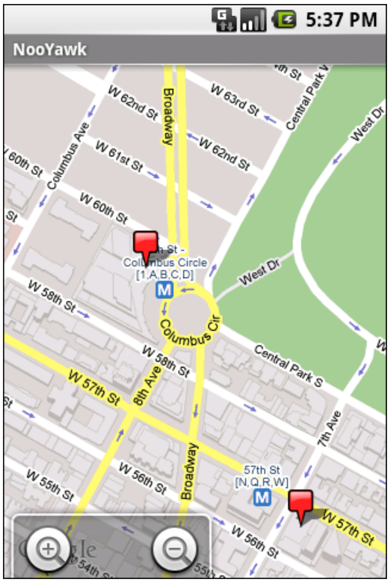


Figure 84. Map with zoom indicator

Center

Typically, you will need to control what the map is showing, beyond the zoom level, such as the user's current location, or a location saved with some data in your activity. To change the map's position, call `setCenter()` on the `MapController`.

This takes a `GeoPoint` as a parameter. A `GeoPoint` represents a location, via latitude and longitude. The catch is that the Point stores latitude and longitude as integers representing the actual latitude and longitude multiplied by `1E6`. This saves a bit of memory versus storing a `float` or `double`, and it probably speeds up some internal calculations Android needs to do to convert the GeoPoint into a map position. However, it does mean you have to remember to multiple the "real world" latitude and longitude by 1E6.

Rugged Terrain

Just as the Google Maps you use on your full-size computer can display satellite imagery, so too can Android maps.

MapView offers toggleSatellite(), which, as the names suggest, toggle on and off this perspective on the area being viewed. You can have the user trigger these via an options menu or, in the case of NooYawk, via keypresses:

```
@Override
 public boolean onKeyDown(int keyCode, KeyEvent event) {
   if (keyCode == KeyEvent.KEYCODE_S) {
     map.setSatellite(!map.isSatellite());
     return(true);
   }
   else if (keyCode == KeyEvent.KEYCODE_Z) {
     map.displayZoomControls(true);
     return(true);
   }

   return(super.onKeyDown(keyCode, event));
 }
```

Layers Upon Layers

If you have ever used the full-size edition of Google Maps, you are probably used to seeing things overlaid atop the map itself, such as "push-pins" indicating businesses near the location being searched. In map parlance – and, for that matter, in many serious graphic editors – the push-pins are on a separate layer than the map itself, and what you are seeing is the composition of the push-pin layer atop the map layer.

Android's mapping allows you to create layers as well, so you can mark up the maps as you need to based on user input and your application's purpose. For example, NooYawk uses a layer to show where select buildings are located in the island of Manhattan.

Overlay Classes

Any overlay you want to add to your map needs to be implemented as a subclass of `Overlay`. There is an `ItemizedOverlay` subclass available if you are looking to add push-pins or the like; `ItemizedOverlay` simplifies this process.

To attach an overlay class to your map, just call `getOverlays()` on your `MapView` and `add()` your `Overlay` instance to it:

```
Drawable marker=getResources().getDrawable(R.drawable.marker);

marker.setBounds(0, 0, marker.getIntrinsicWidth(),
                        marker.getIntrinsicHeight());

map.getOverlays().add(new SitesOverlay(marker));
```

We will explain that `marker` in just a bit.

Drawing the ItemizedOverlay

As the name suggests, `ItemizedOverlay` allows you to supply a list of points of interest to be displayed on the map – specifically, instances of `OverlayItem`. The overlay, then, handles much of the drawing logic for you. Here are the minimum steps to make this work:

- First, override `ItemizedOverlay<OverlayItem>` as your own subclass (in this example, `SitesOverlay`)
- In the constructor, build your roster of `OverlayItem` instances, and call `populate()` when they are ready for use by the overlay
- Implement `size()` to return the number of items to be handled by the overlay
- Override `createItem()` to return `OverlayItem` instances given an index
- When you instantiate your `ItemizedOverlay` subclass, provide it with a `Drawable` that represents the default icon (e.g., push-pin) to display for each item

The marker from the NooYawk constructor is the `Drawable` used for the last bullet above – it shows a push-pin, as illustrated in the screen shot shown earlier in this chapter.

You may also wish to override `draw()` to do a better job of handling the shadow for your markers. While the map will handle casting a shadow for you, it appears you need to provide a bit of assistance for it to know where the "bottom" of your icon is, so it can draw the shadow appropriately.

For example, here is `SitesOverlay`:

```
private class SitesOverlay extends ItemizedOverlay<OverlayItem> {
  private List<OverlayItem> items=new ArrayList<OverlayItem>();
  private Drawable marker=null;

  public SitesOverlay(Drawable marker) {
    super(marker);
    this.marker=marker;

    items.add(new OverlayItem(getPoint(40.748963847316034,
                                        -73.96807193756104),
                              "UN", "United Nations"));
    items.add(new OverlayItem(getPoint(40.76866299974387,
                                        -73.98268461227417),
                              "Lincoln Center",
                              "Home of Jazz at Lincoln Center"));
    items.add(new OverlayItem(getPoint(40.765136435316755,
                                        -73.97989511489868),
                              "Carnegie Hall",
              "Where you go with practice, practice, practice"));
    items.add(new OverlayItem(getPoint(40.70686417491799,
                                        -74.01572942733765),
                              "The Downtown Club",
                      "Original home of the Heisman Trophy"));

    populate();
  }

  @Override
  protected OverlayItem createItem(int i) {
    return(items.get(i));
  }

  @Override
  public void draw(Canvas canvas, MapView mapView,
                    boolean shadow) {
    super.draw(canvas, mapView, shadow);

    boundCenterBottom(marker);
  }

  @Override
  protected boolean onTap(int i) {
    Toast.makeText(NooYawk.this,
                    items.get(i).getSnippet(),
                    Toast.LENGTH_SHORT).show();

    return(true);
  }

  @Override
  public int size() {
    return(items.size());
  }
}
```

Handling Screen Taps

An Overlay subclass can also implement onTap(), to be notified when the user taps on the map, so the overlay can adjust what it draws. For example, in full-size Google Maps, clicking on a push-pin pops up a bubble with information about the business at that pin's location. With onTap(), you can do much the same in Android.

The onTap() method for ItemizedOverlay receives the index of the OverlayItem that was clicked. It is up to you to do something worthwhile with this event.

In the case of SitesOverlay, as shown above, onTap() looks like this:

```
@Override
protected boolean onTap(int i) {
  Toast.makeText(NooYawk.this,
                  items.get(i).getSnippet(),
                  Toast.LENGTH_SHORT).show();

  return(true);
}
```

Here, we just toss up a short Toast with the "snippet" from the OverlayItem, returning true to indicate we handled the tap.

CHAPTER 34

Handling Telephone Calls

Many, if not most, Android devices will be phones. As such, not only will users be expecting to place and receive calls using Android, but you will have the opportunity to help them place calls, if you wish.

Why might you want to?

- Maybe you are writing an Android interface to a sales management application (a la Salesforce.com) and you want to offer users the ability to call prospects with a single button click, and without them having to keep those contacts both in your application and in the phone's contacts application
- Maybe you are writing a social networking application, and the roster of phone numbers that you can access shifts constantly, so rather than try to "sync" the social network contacts with the phone's contact database, you let people place calls directly from your application
- Maybe you are creating an alternative interface to the existing contacts system, perhaps for users with reduced motor control (e.g., the elderly), sporting big buttons and the like to make it easier for them to place calls

Whatever the reason, Android has the means to let you manipulate the phone just like any other piece of the Android system.

Report To The Manager

To get at much of the phone API, you use the `TelephonyManager`. That class lets you do things like:

- Determine if the phone is in use via `getCallState()`, with return values of `CALL_STATE_IDLE` (phone not in use), `CALL_STATE_RINGING` (call requested but still being connected), and `CALL_STATE_OFFHOOK` (call in progress)
- Find out the SIM ID (IMSI) via `getSubscriberId()`
- Find out the phone type (e.g., GSM) via `getPhoneType()` or find out the data connection type (e.g., GPRS, EDGE) via `getNetworkType()`

You Make the Call!

You can also initiate a call from your application, such as from a phone number you obtained through your own Web service. To do this, simply craft an `ACTION_DIAL` `Intent` with a `Uri` of the form `tel:NNNNN` (where `NNNNN` is the phone number to dial) and use that `Intent` with `startActivity()`. This will not actually dial the phone; rather, it activates the dialer activity, from which the user can then press a button to place the call.

For example, let's look at the `Dialer` sample application. Here's the crude-but-effective layout:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    >
  <LinearLayout
    android:orientation="horizontal"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    >
    <TextView
      android:layout_width="wrap_content"
      android:layout_height="wrap_content"
      android:text="Number to dial:"
      />
    <EditText android:id="@+id/number"
      android:layout_width="fill_parent"
      android:layout_height="wrap_content"
      android:cursorVisible="true"
      android:editable="true"
      android:singleLine="true"
    />
  </LinearLayout>
  <Button android:id="@+id/dial"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:layout_weight="1"
    android:text="Dial It!"
  />
</LinearLayout>
```

We have a labeled field for typing in a phone number, plus a button for dialing said number.

The Java code simply launches the dialer using the phone number from the field:

```
package com.commonsware.android.dialer;

import android.app.Activity;
import android.content.Intent;
import android.net.Uri;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;

public class DialerDemo extends Activity {
  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);

    final EditText number=(EditText)findViewById(R.id.number);
    Button dial=(Button)findViewById(R.id.dial);

    dial.setOnClickListener(new Button.OnClickListener() {
      public void onClick(View v) {
        String toDial="tel:"+number.getText().toString();

        startActivity(new Intent(Intent.ACTION_DIAL,
                                  Uri.parse(toDial)));
      }
    });
  }
}
```

The activity's own UI is not that impressive:

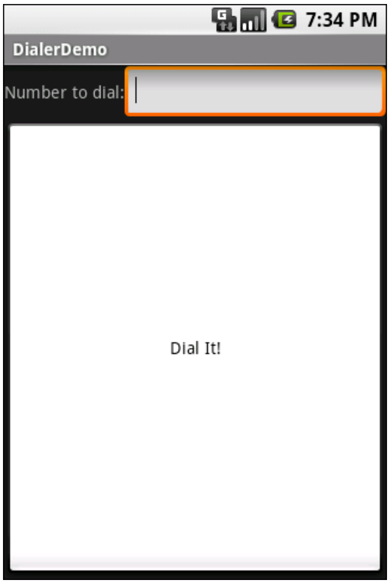


Figure 85. The DialerDemo sample application, as initially launched

However, the dialer you get from clicking the dial button is better, showing you the number you are about to dial:

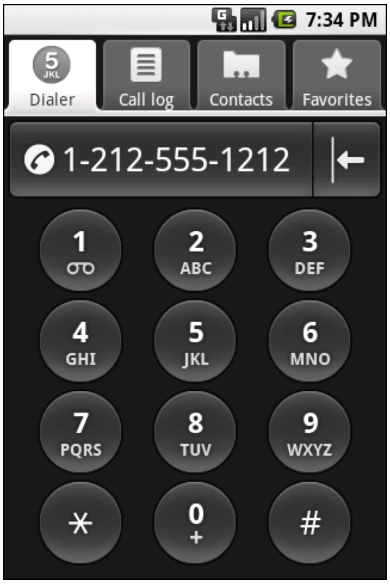


Figure 86. The Android Dialer activity, as launched from DialerDemo

CHAPTER 35

Searching with SearchManager

One of the firms behind the Open Handset Alliance – Google – has a teeny weeny Web search service, one you might have heard of in passing. Given that, it's not surprising that Android has some amount of built-in search capabilities.

Specifically, Android has "baked in" the notion of searching not only on the device for data, but over the air to Internet sources of data.

Your applications can participate in the search process, by triggering searches or perhaps by allowing your application's data to be searched.

Note that this is fairly new to the Android platform, and so some shifting in the APIs is likely. Stay tuned for updates to this chapter.

Hunting Season

There are two types of search in Android: local and global. Local search searches within the current application; global search searches the Web via Google's search engine. You can initiate either type of search in a variety of ways, including:

- You can call `onSearchRequested()` from a button or menu choice, which will initiate a local search (unless you override this method in your activity)

- You can directly call `startSearch()` to initiate a local or global search, including optionally supplying a search string to use as a starting point
- You can elect to have keyboard entry kick off a search via `setDefaultKeyMode()`, for either local search (`setDefaultKeyMode(DEFAULT_KEYS_SEARCH_LOCAL)`) or global search (`setDefaultKeyMode(DEFAULT_KEYS_SEARCH_GLOBAL)`)

In either case, the search appears as a set of UI components across the top of the screen, with your activity blurred underneath it.

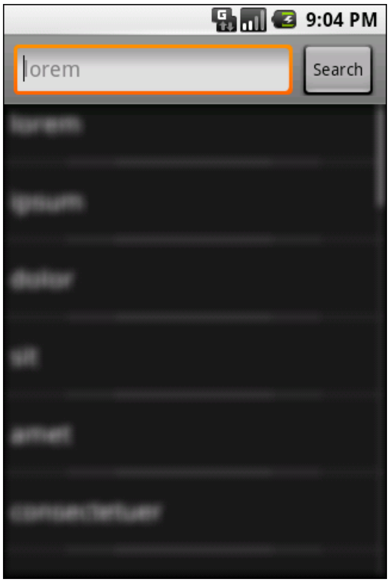


Figure 87. The Android local search popup

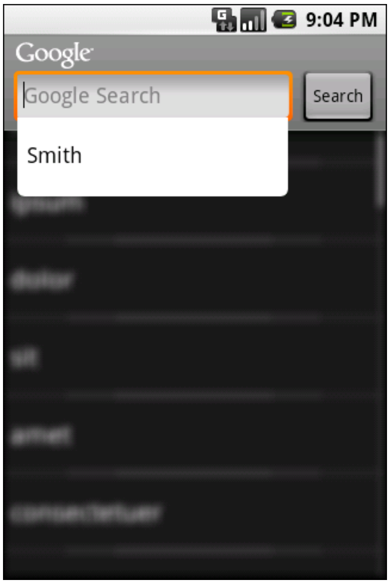


Figure 88. The Android global search popup, showing a drop-down with previous searches

Search Yourself

Over the long haul, there will be two flavors of search available via the Android search system:

1. Query-style search, where the user's search string is passed to an activity which is responsible for conducting the search and displaying the results
2. Filter-style search, where the user's search string is passed to an activity on every keypress, and the activity is responsible for updating a displayed list of matches

Since the latter approach is under heavy development right now by the Android team, let's focus on the first one.

Craft the Search Activity

The first thing you are going to want to do if you want to support query-style search in your application is to create a search activity. While it might be possible to have a single activity be both opened from the launcher and opened from a search, that might prove somewhat confusing to users. Certainly, for the purposes of learning the techniques, having a separate activity is cleaner.

The search activity can have any look you want. In fact, other than watching for queries, a search activity looks, walks, and talks like any other activity in your system.

All the search activity needs to do differently is check the intents supplied to `onCreate()` (via `getIntent()`) and `onNewIntent()` to see if one is a search, and, if so, to do the search and display the results.

For example, let's look at the `Lorem` sample application. This starts off as a clone of the list-of-lorem-ipsum-words application that we first built back when showing off the `ListView` container, then later with XML resources. Now, we update it to support searching the list of words for ones containing the search string.

The main activity and the search activity both share a common layout: a `ListView` plus a `TextView` showing the selected entry:

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
  android:orientation="vertical"
  android:layout_width="fill_parent"
  android:layout_height="fill_parent" >
  <TextView
    android:id="@+id/selection"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
  />
  <ListView
    android:id="@android:id/list"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:drawSelectorOnTop="false"
  />
</LinearLayout>
```

In terms of Java code, most of the guts of the activities are poured into an abstract `LoremBase` class:

```
abstract public class LoremBase extends ListActivity {
  abstract ListAdapter makeMeAnAdapter(Intent intent);

  private static final int LOCAL_SEARCH_ID = Menu.FIRST+1;
  private static final int GLOBAL_SEARCH_ID = Menu.FIRST+2;
  private static final int CLOSE_ID = Menu.FIRST+3;
  TextView selection;
  ArrayList<String> items=new ArrayList<String>();

  @Override
  public void onCreate(Bundle icicle) {
    super.onCreate(icicle);
    setContentView(R.layout.main);
    selection=(TextView)findViewById(R.id.selection);

    try {
      XmlPullParser xpp=getResources().getXml(R.xml.words);

      while (xpp.getEventType()!=XmlPullParser.END_DOCUMENT) {
        if (xpp.getEventType()==XmlPullParser.START_TAG) {
          if (xpp.getName().equals("word")) {
            items.add(xpp.getAttributeValue(0));
          }
        }

        xpp.next();
      }
    }
    catch (Throwable t) {
      Toast
        .makeText(this, "Request failed: "+t.toString(), 4000)
        .show();
    }

    setDefaultKeyMode(DEFAULT_KEYS_SEARCH_LOCAL);

    onNewIntent(getIntent());
  }

  @Override
  public void onNewIntent(Intent intent) {
    ListAdapter adapter=makeMeAnAdapter(intent);

    if (adapter==null) {
      finish();
    }
    else {
      setListAdapter(adapter);
    }
  }

  public void onListItemClick(ListView parent, View v, int position,
                long id) {
    selection.setText(items.get(position).toString());
  }

  @Override
  public boolean onCreateOptionsMenu(Menu menu) {
    menu.add(Menu.NONE, LOCAL_SEARCH_ID, Menu.NONE, "Local Search")
            .setIcon(android.R.drawable.ic_search_category_default);
    menu.add(Menu.NONE, GLOBAL_SEARCH_ID, Menu.NONE, "Global Search")
            .setIcon(R.drawable.search)
            .setAlphabeticShortcut(SearchManager.MENU_KEY);
    menu.add(Menu.NONE, CLOSE_ID, Menu.NONE, "Close")
            .setIcon(R.drawable.eject)
            .setAlphabeticShortcut('c');

    return(super.onCreateOptionsMenu(menu));
  }

  @Override
  public boolean onOptionsItemSelected(MenuItem item) {
    switch (item.getItemId()) {
      case LOCAL_SEARCH_ID:
        onSearchRequested();
        return(true);

      case GLOBAL_SEARCH_ID:
        startSearch(null, false, null, true);
        return(true);

      case CLOSE_ID:
        finish();
        return(true);
    }

    return(super.onOptionsItemSelected(item));
  }
}
```

This activity takes care of everything related to showing a list of words, even loading the words out of the XML resource. What it does not do is come up with the `ListAdapter` to put into the `ListView` – that is delegated to the subclasses.

The main activity – `LoremDemo` – just uses a `ListAdapter` for the whole word list:

```
package com.commonsware.android.search;

import android.content.Intent;
import android.widget.ArrayAdapter;
import android.widget.ListAdapter;

public class LoremDemo extends LoremBase {
  @Override
  ListAdapter makeMeAnAdapter(Intent intent) {
    return(new ArrayAdapter<String>(this,
                     android.R.layout.simple_list_item_1,
                     items));
  }
}
```

The search activity, though, does things a bit differently.

First, it inspects the `Intent` supplied to the abstract `makeMeAnAdpater()` method. That `Intent` comes from either `onCreate()` or `onNewIntent()`. If the intent is a `ACTION_SEARCH`, then we know this is a search. We can get the search query and, in the case of this silly demo, spin through the loaded list of words and find only those containing the search string. That list then gets wrapped in a `ListAdapter` and returned for display:

```
package com.commonsware.android.search;

import android.app.SearchManager;
import android.content.Intent;
import android.widget.ArrayAdapter;
import android.widget.ListAdapter;
import java.util.ArrayList;
import java.util.List;

public class LoremSearch extends LoremBase {
  @Override
  ListAdapter makeMeAnAdapter(Intent intent) {
    ListAdapter adapter=null;

    if (intent.getAction().equals(Intent.ACTION_SEARCH)) {
      String query=intent.getStringExtra(SearchManager.QUERY);
      List<String> results=searchItems(query);

      adapter=new ArrayAdapter<String>(this,
                     android.R.layout.simple_list_item_1,
                     results);
      setTitle("LoremSearch for: "+query);
    }

    return(adapter);
  }

  private List<String> searchItems(String query) {
    List<String> results=new ArrayList<String>();

    for (String item : items) {
      if (item.indexOf(query)>-1) {
        results.add(item);
      }
    }

    return(results);
  }
}
```

Update the Manifest

While this implements search, it doesn't tie it into the Android search system. That requires a few changes to the auto-generated `AndroidManifest.xml` file:

```
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
  package="com.commonsware.android.search">
  <application>
    <activity android:name=".LoremDemo" android:label="LoremDemo">
      <intent-filter>
        <action android:name="android.intent.action.MAIN" />
        <category android:name="android.intent.category.LAUNCHER" />
      </intent-filter>
      <meta-data android:name="android.app.default_searchable"
            android:value=".LoremSearch" />
    </activity>
    <activity
      android:name=".LoremSearch"
      android:label="LoremSearch"
      android:launchMode="singleTop">
      <intent-filter>
        <action android:name="android.intent.action.SEARCH" />
        <category android:name="android.intent.category.DEFAULT" />
      </intent-filter>
      <meta-data android:name="android.app.searchable"
            android:resource="@xml/searchable" />
    </activity>
  </application>
</manifest>
```

The changes that are needed are:

1. The `LoremDemo` main activity gets a `meta-data` element, with an `android:name` of `android.app.default_searchable` and a `android:value` of the search implementation class (`.LoremSearch`)
2. The `LoremSearch` activity gets an intent filter for `android.intent.action.SEARCH`, so search intents will be picked up
3. The `LoremSearch` activity is set to have `android:launchMode = "singleTop"`, which means at most one instance of this activity will be open at any time, so we don't wind up with a whole bunch of little search activities cluttering up the activity stack
4. The `LoremSearch` activity gets a `meta-data` element, with an `android:name` of `android.app.searchable` and a `android:value` of an XML resource containing more information about the search facility offered by this activity (`@xml/searchable`)

```
<searchable xmlns:android="http://schemas.android.com/apk/res/android"
    android:label="@string/searchLabel"
    android:hint="@string/searchHint" />
```

That XML resource provides two bits of information today:

1. What name should appear in the search domain button to the left of the search field, identifying to the user where she is searching (`android:label`)
2. What hint text should appear in the search field, to give the user a clue as to what they should be typing in (`android:hint`)

Searching for Meaning In Randomness

Given all that, search is now available – Android knows your application is searchable, what search domain to use when searching from the main activity, and the activity knows how to do the search.

The options menu for this application has both local and global search options. In the case of local search, we just call `onSearchRequested()`; in the case of global search, we call `startSearch()` with true in the last parameter, indicating the scope is global.

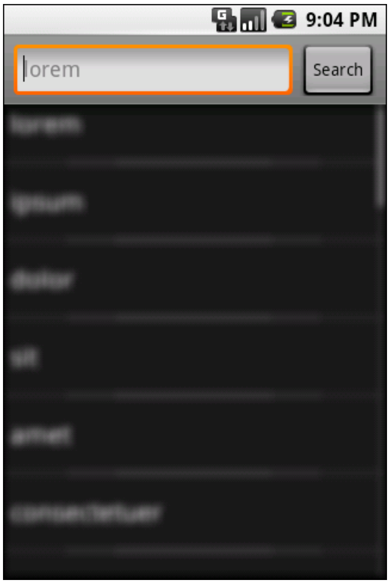


Figure 89. The Lorem sample application, showing the local search popup

Typing in a letter or two, then clicking Search, will bring up the search activity and the subset of words containing what you typed, with your search query in the activity title bar:

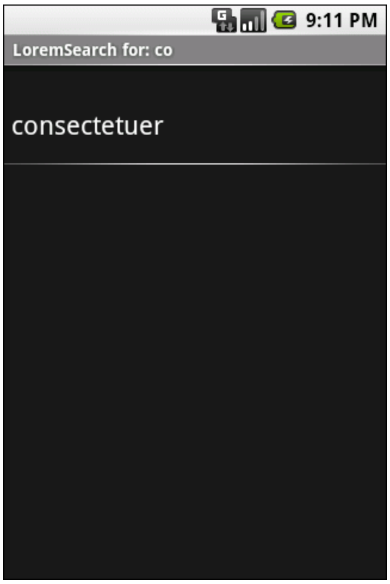


Figure 90. The results of searching for 'co' in the Lorem search sample

You can get the same effect if you just start typing in the main activity, since it is set up for triggering a local search.

CHAPTER 36

Development Tools

The Android SDK is more than a library of Java classes and API calls. It also includes a number of tools to assist in application development.

Much of the focus has been on the Eclipse plug-in, to integrate Android development with that IDE. Secondary emphasis has been placed on the plug-in's equivalents for use in other IDEs or without an IDE, such as `adb` for communicating with a running emulator.

This chapter will cover other tools beyond those two groups.

Hierarchical Management

Android comes with a Hierarchy Viewer tool, designed to help you visualize your layouts as they are seen in a running activity in a running emulator. So, for example, you can determine how much space a certain widget is taking up, or try to find where a widget is hiding that does not appear on the screen.

To use the Hierarchy Viewer, you first need to fire up your emulator, install your application, launch your activity, and navigate to spot you wish to examine. For illustration purposes, we'll use the ReadWrite demo application we introduced back in the chapter on file access:

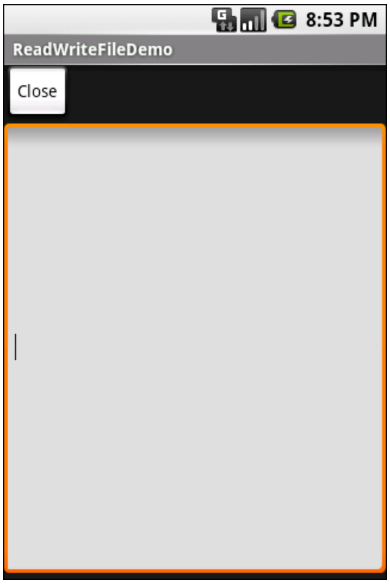


Figure 91. ReadWrite demo application

You can launch the Hierarchy Viewer via the `hierarchyviewer` program, found in the `tools/` directory in your Android SDK installation. This brings up the main Hierarchy Viewer window:

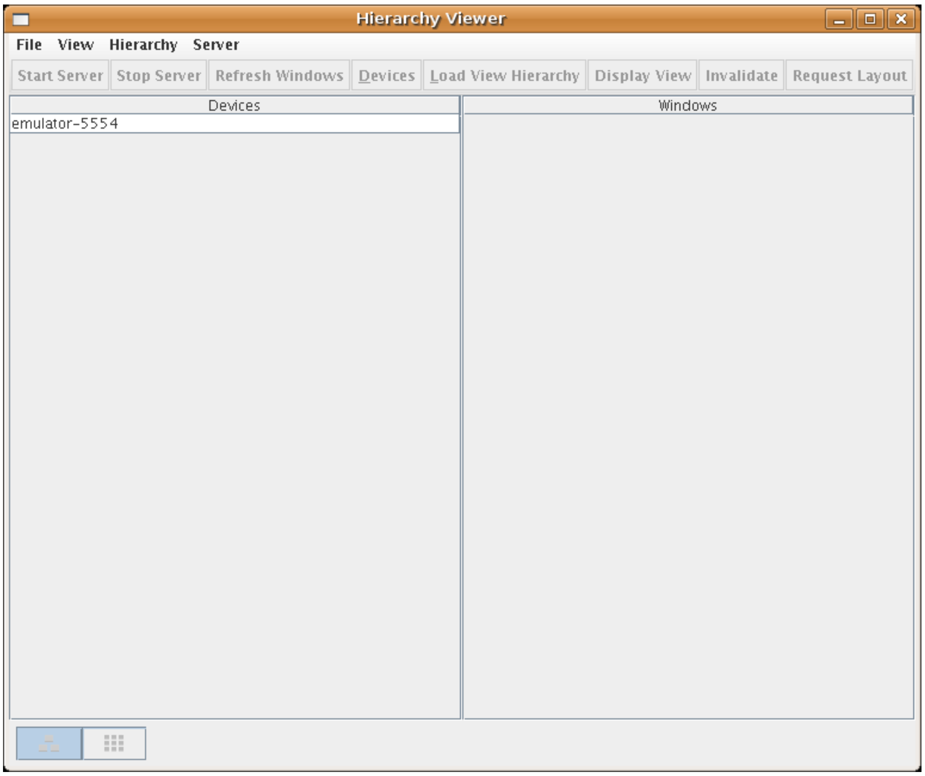
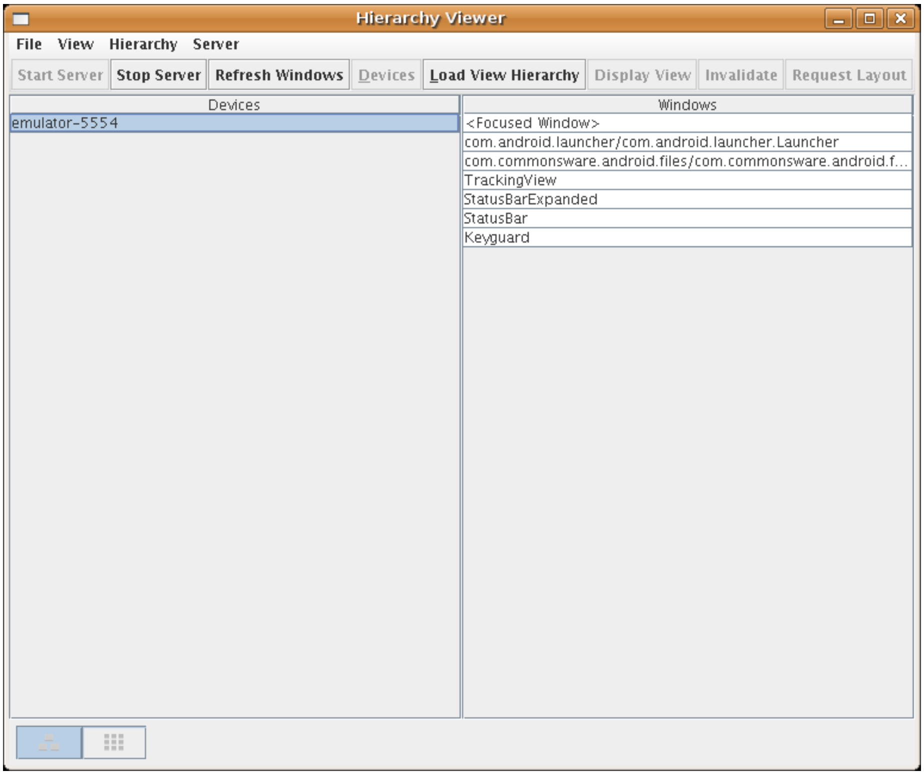


Figure 92. Hierarchy Viewer main window

The list on the left shows the various emulators you have opened. The number after the hyphen should line up with the number in parentheses in your emulator's title bar.

Clicking on an emulator shows, on the right, the list of "windows" available for examination:



emulator-5554

<Focused Window>
com.android.launcher/com.android.launcher.Launcher
com.commonsware.android.files/com.commonsware.android.f...
TrackingView
StatusBarExpanded
StatusBar
Keyguard

Figure 93. Hierarchy Viewer list of available windows

Note how there are many other windows besides our open activity, including the Launcher (i.e., the home screen), the Keyguard (i.e., the "Press Menu to Unlock" black screen you get when first opening the emulator), and so on. Your activity will be identified by application package and class (e.g., `com.commonsware.android.files/...`).

Where things get interesting, though, is when you choose a window and click Load View Hierarchy. After a few seconds, the details spring into view, in a perspective called the Layout View:

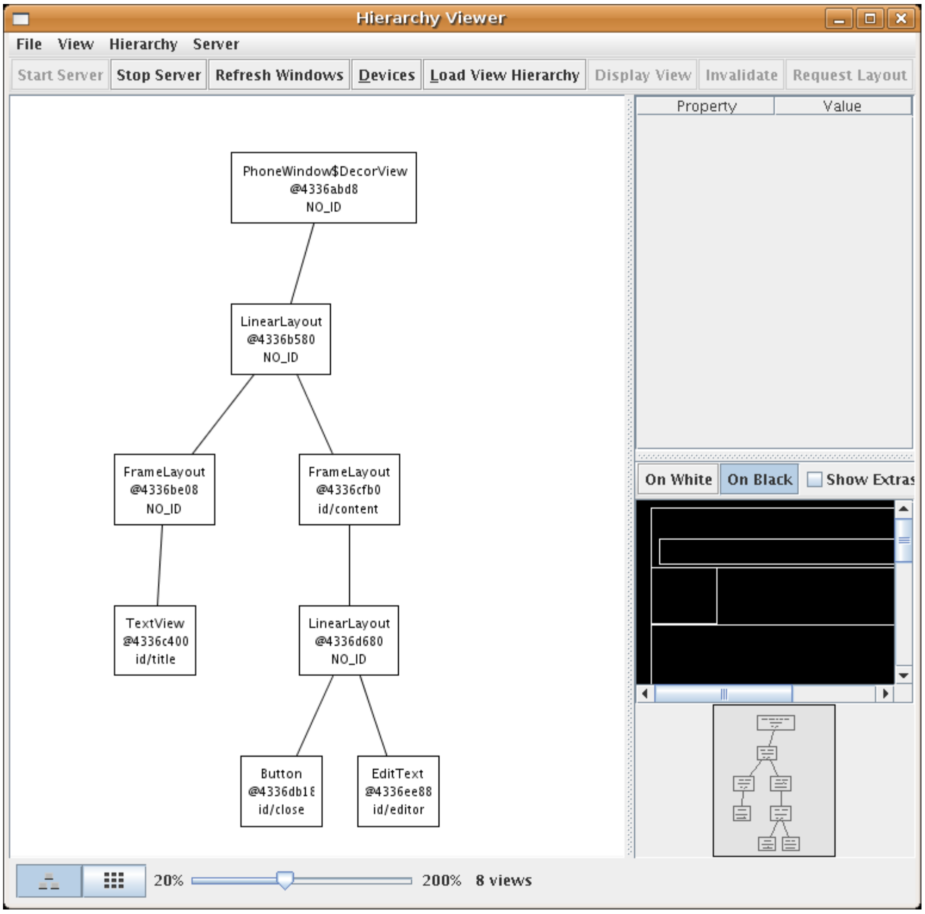
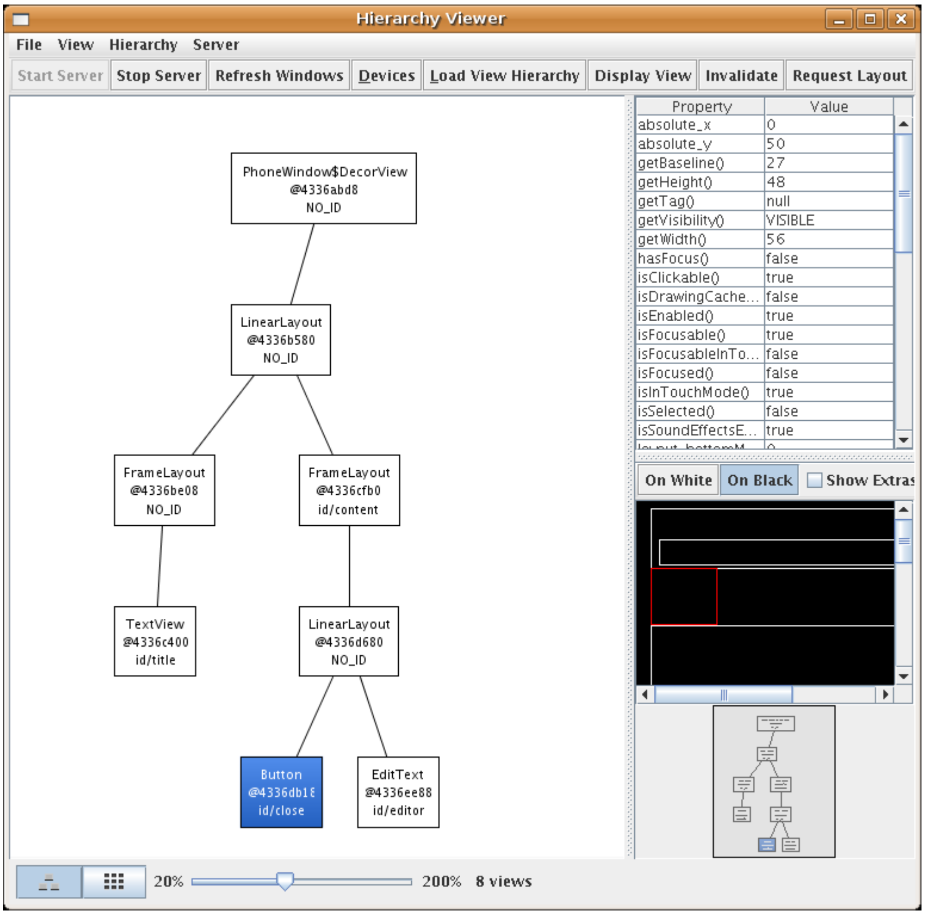

Hierarchy Viewer
File View Hierarchy Server
Start Server
Stop Server
Refresh Windows
Devices
Load View Hierarchy
Display View
Invalidate
Request Layout
Property
Value
PhoneWindow$DecorView @4336abd8 NO_ID
LinearLayout @4336b580 NO_ID
FrameLayout @4336be08 NO_ID
FrameLayout @4336cfb0 id/content
TextView @4336c400 id/title
LinearLayout @4336d680 NO_ID
Button @4336db18 id/close
EditText @4336ee88 id/editor
On White
On Black
Show Extras
20%
200%
8 views

Figure 94. Hierarchy Viewer Layout View

The main area of the Layout View shows a tree of the various Views that make up your activity, starting from the overall system window and driving down into the individual UI widgets that users are supposed to interact with. You will see, on the lower-right branch of the tree, the `LinearLayout`, `Button`, and `EditText` shown in the above code listing. The remaining `Views` are all supplied by the system, including the title bar.

Clicking on one of the views adds more information to this perspective:


Hierarchy Viewer
File
View
Hierarchy
Server
Start Server
Stop Server
Refresh Windows
Devices
Load View Hierarchy
Display View
Invalidate
Request Layout
PhoneWindow$DecorView @4336abd8 NO_ID
LinearLayout @4336b580 NO_ID
FrameLayout @4336be08 NO_ID
FrameLayout @4336cfb0 id/content
TextView @4336c400 id/title
LinearLayout @4336d680 NO_ID
Button @4336db18 id/close
EditText @4336ee88 id/editor
On White
On Black
Show Extras
20%
200%
8 views

Property	Value
absolute_x	0
absolute_y	50
getBaseline()	27
getHeight()	48
getTag()	null
getVisibility()	VISIBLE
getWidth()	56
hasFocus()	false
isClickable()	true
isDrawingCache...	false
isEnabled()	true
isFocusable()	true
isFocusableInTo...	false
isFocused()	false
isInTouchMode()	true
isSelected()	false
isSoundEffectsE...	true

Figure 95. Hierarchy Viewer View properties

Now, in the upper-right region of the Viewer, we see properties of the selected widget — in this case, the `Button`. Alas, these properties do not appear to be editable.

Also, the widget is highlighted in red in the wireframe of the activity, shown beneath the properties (by default, views are shown as white outlines on a black background). This can help you ensure you have selected the right widget, if, say, you have several buttons and cannot readily tell from the tree what is what.

And, if you double-click on a `View` in the tree, you are given a pop-up pane showing just that `View` (and its children), isolated from the rest of your activity.

Down in the lower-left corner, you will see two toggle buttons, with the tree button initially selected. Clicking on the grid button changes puts the Viewer in a whole new perspective, called the Pixel Perfect View:

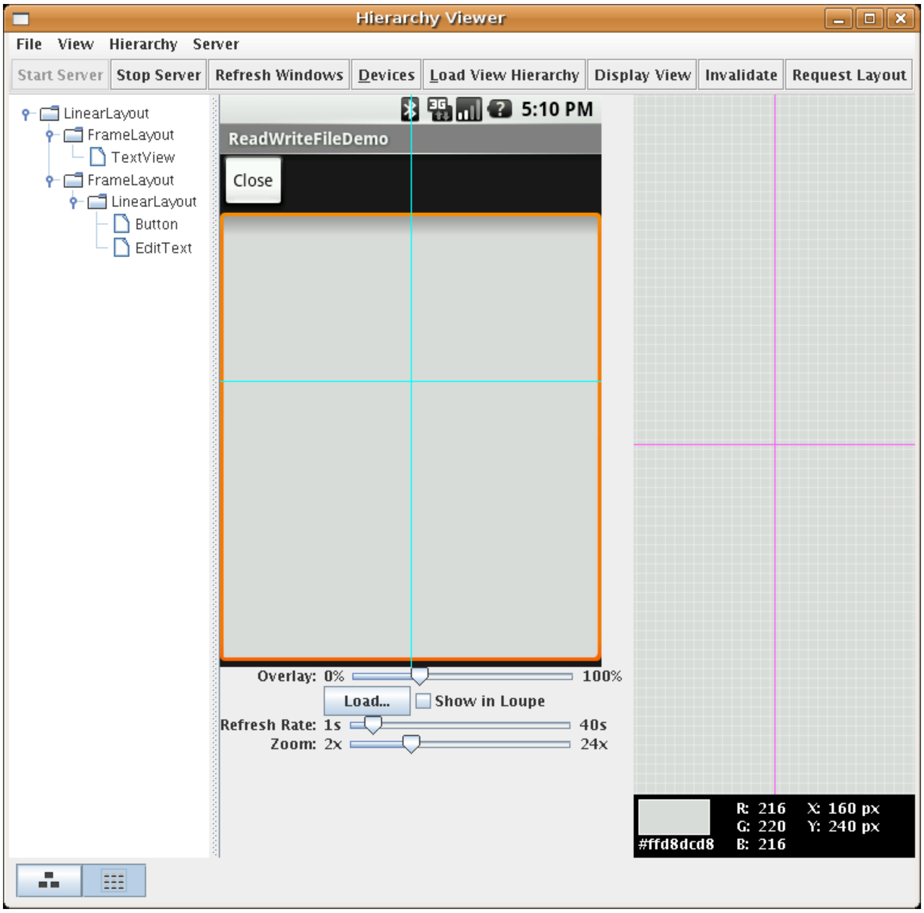


Figure 96. Hierarchy Viewer Pixel Perfect View

On the left, you see a tree representing the widgets and other `Views` in your activity. In the middle, you see your activity (the Normal View), and on the right, you see a zoomed edition of your activity (the Loupe View).

What may not be initially obvious is that this imagery is live. Your activity is polled every so often, controlled by the Refresh Rate slider. Anything you do in the activity will then be reflected in the Pixel Perfect View's Normal and Loupe Views.

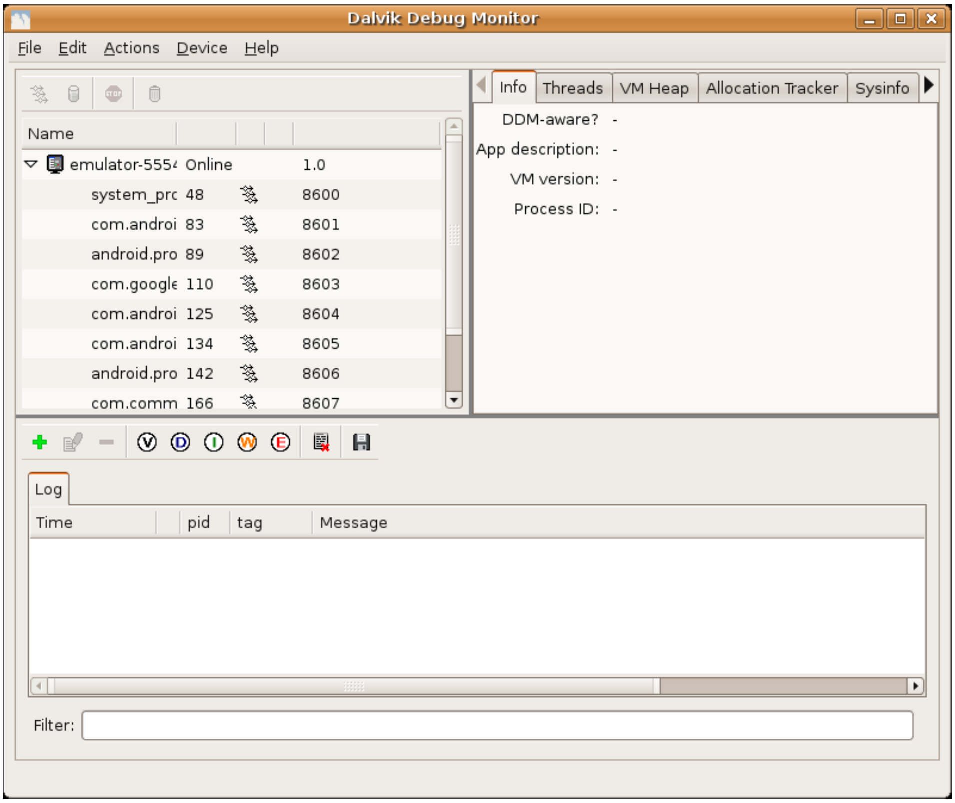
The hairlines (cyan) overlaying the activity show the position being zoomed upon — just click on a new area to change where the Loupe View is inspecting. And, of course, there is another slider to adjust how much the Loupe View is zoomed.

Delightful Dalvik Debugging Detailed, Demoed

Another tool in the Android developer's arsenal is the Dalvik Debug Monitor Service (DDMS). This is a "Swiss army knife", allowing you to do everything from browse log files, update the GPS location provided by emulator, simulate incoming calls and messages, and browse the on-emulator storage to push and pull files.

Eventually, this section will contain a complete overview of DDMS. For now, the focus will be on using it to update GPS location data, in support of the chapters needing the emulator to provide a location.

To launch DDMS, run the `ddms` program inside the `tools/` directory in your Android SDK distribution. It will initially display just a tree of emulators and running programs on the left:



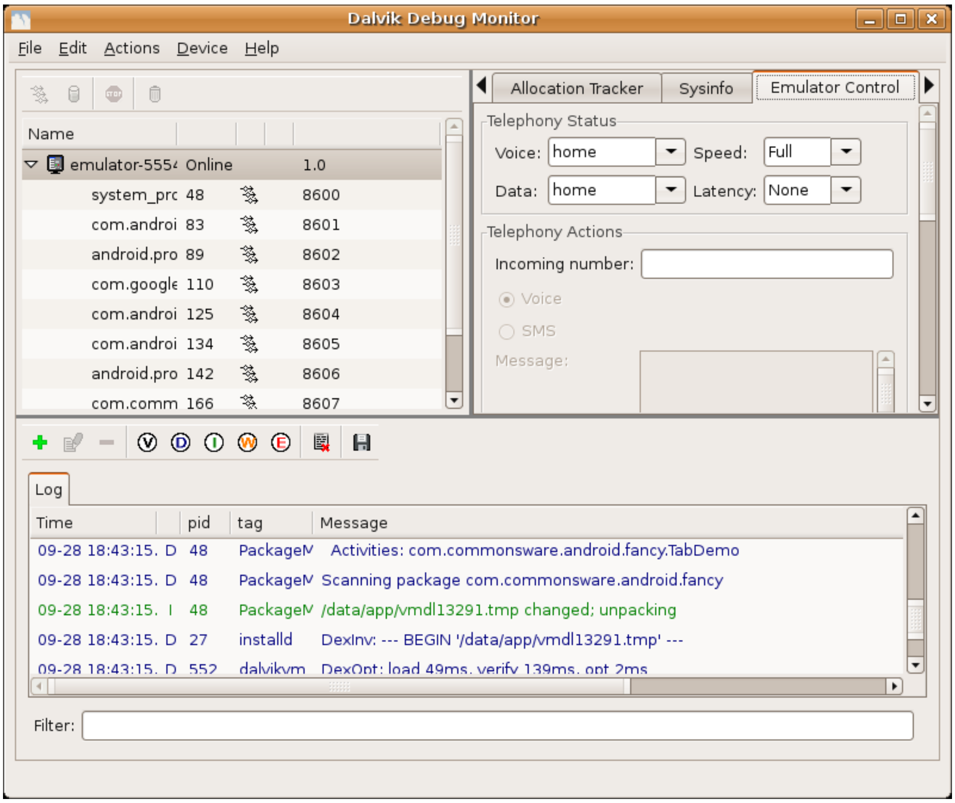
Name			
emulator-5554	Online		1.0
system_prc	48		8600
com.androi	83		8601
android.pro	89		8602
com.google	110		8603
com.androi	125		8604
com.androi	134		8605
android.pro	142		8606
com.comm	166		8607

DDM-aware? -
App description: -
VM version: -
Process ID: -

Time	pid	tag	Message

Figure 97. DDMS initial view

Clicking on an emulator allows you to browse the event log on the bottom and manipulate the emulator via the tabs on the right:



```
Name
emulator-5554  Online        1.0
  system_prc   48            8600
  com.androi   83            8601
  android.pro  89            8602
  com.google   110           8603
  com.androi   125           8604
  com.androi   134           8605
  android.pro  142           8606
  com.comm     166           8607
```

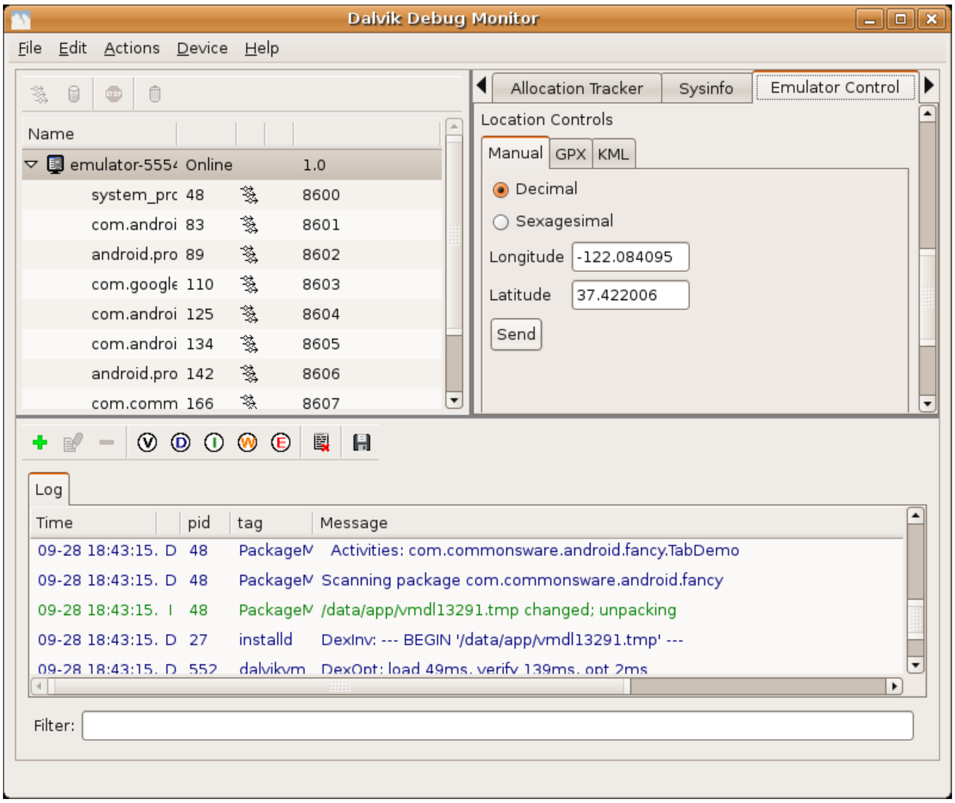
```
Time                 pid   tag        Message
09-28 18:43:15. D    48    PackageM   Activities: com.commonsware.android.fancy.TabDemo
09-28 18:43:15. D    48    PackageM   Scanning package com.commonsware.android.fancy
09-28 18:43:15. I    48    PackageM   /data/app/vmdl13291.tmp changed; unpacking
09-28 18:43:15. D    27    installd   DexInv: --- BEGIN '/data/app/vmdl13291.tmp' ---
09-28 18:43:15. D    552   dalvikvm   DexOpt: load 49ms, verify 139ms, opt 2ms
```

Figure 98. DDMS, with emulator selected

Location Updates

To use DDMS to supply location updates to your application, the first thing you must do is have your application use the gps LocationProvider, as that is the one that DDMS is set to update.

Then, click on the Emulator Control tab and scroll down to the Location Controls section. Here, you will find a smaller tabbed pane with three options for specifying locations: Manual, GPX, and KML:



Decimal [✓]
Sexagesimal

Longitude	-122.084095
Latitude	37.422006

Name			
emulator-5554	Online		1.0
system_prc	48		8600
com.androi	83		8601
android.pro	89		8602
com.google	110		8603
com.androi	125		8604
com.androi	134		8605
android.pro	142		8606
com.comm	166		8607

```
Time              pid  tag       Message
09-28 18:43:15. D  48  PackageM  Activities: com.commonsware.android.fancy.TabDemo
09-28 18:43:15. D  48  PackageM  Scanning package com.commonsware.android.fancy
09-28 18:43:15. I  48  PackageM  /data/app/vmdl13291.tmp changed; unpacking
09-28 18:43:15. D  27  installd  DexInv: --- BEGIN '/data/app/vmdl13291.tmp' ---
09-28 18:43:15. D  552 dalvikvm  DexOpt: load 49ms, verify 139ms, opt 2ms
```

Figure 99. DDMS location controls

The Manual tab is fairly self-explanatory: provide a latitude and longitude and click the Send button to submit that location to the emulator. The emulator, in turn will notify any location listeners of the new position.

Discussion of the GPX and KML options is reserved for a future edition of this book.

Keyword Index