Mobile Application Development

Produced by

David Drohan (ddrohan@wit.ie)

Department of Computing & Mathematics
Waterford Institute of Technology
http://www.wit.ie

Waterford Institute *of* Technology
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Android Anatomy

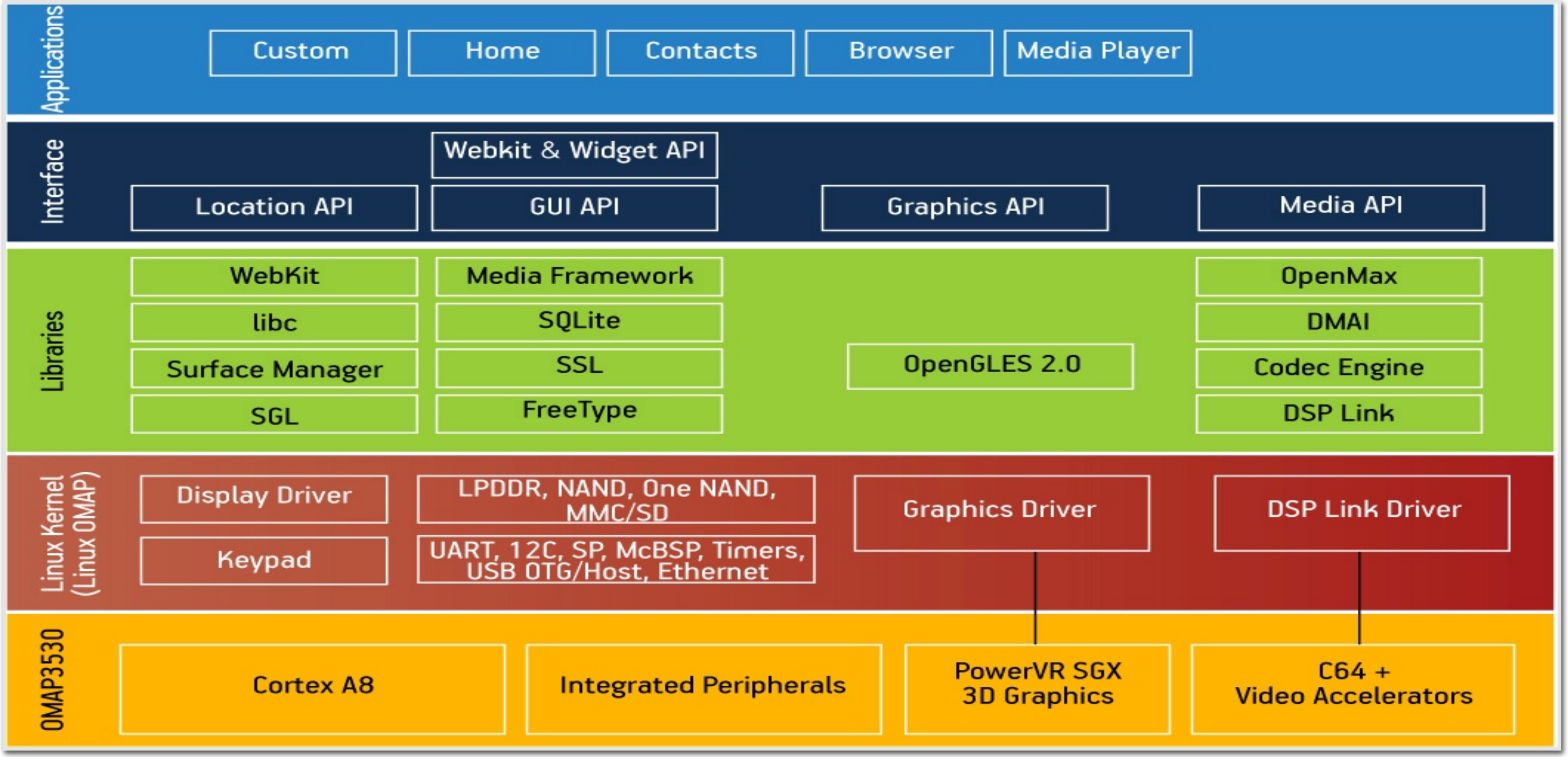
Agenda

- ❑ Quick Recap - What is Android (and it's Layered Framework)
- ❑ Important Android Application Components
- ❑ The Android Application (Activity/Fragment) Life Cycle
- ❑ The Online Developer Resources
- ❑ Our "*CoffeeMate*" Case Study – a first look…

What is Android? (Recap)

- An open source software toolkit created, updated and maintained by Google and the OHA
    - 30+ technology companies
    - Commitment to openness, shared vision, and concrete plans
- Designed for Mobile Devices
    - 2.X series and previous: mobile phones
    - 3.X series: extended to also support tablets
    - 4.X series: unified API framework
    - 5.X / 6.X series: more integration with Google services and more tablet-specific features, run on ‘wearable’ devices, TV, vehicles etc..
- Comprehensive Framework

Layered Software Framework (s/w stack)



Applications

Custom

Home

Contacts

Browser

Media Player

Interface

Webkit & Widget API

Location API

GUI API

Graphics API

Media API

Libraries

WebKit

libc

Surface Manager

SGL

Media Framework

SQLite

SSL

FreeType

OpenGLES 2.0

OpenMax

DMAI

Codec Engine

DSP Link

Linux Kernel (Linux OMAP)

Display Driver

Keypad

LPDDR, NAND, One NAND, MMC/SD

UART, 12C, SP, McBSP, Timers, USB OTG/Host, Ethernet

Graphics Driver

DSP Link Driver

OMAP3530

Cortex A8

Integrated Peripherals

PowerVR SGX 3D Graphics

C64 + Video Accelerators

Key Parts of the Framework

❑ The key parts of the Android Framework are

- The Activity Manager: starts, stops, pauses and resumes applications
- The Resource Manager: allows apps to access the resources bundled with them
- Content Providers: objects that encapsulate data that is shared between applications
- Location Manager and Notification Manager (events)
- Media Manager for Audio and Video playback

Android App Components

- App components are the essential building blocks of an Android app. Each component is a different point through which the system can enter your app.
- Not all components are actual entry points for the user and some depend on each other, but each one exists as its own entity and plays a specific role—each one is a unique building block that helps define your app's overall behavior.
- There are four main different types of app components. Each type serves a distinct purpose and has a distinct lifecycle that defines how the component is created and destroyed.
- We'll briefly mention a few other components (of sorts) that also make up your App.

Android App Components

1. Activities

- represents a single screen with a user interface
- acts as the ‘controller’ for everything the user sees on its associated screen
- implemented as a subclass of Activity
- e.g. email app (listing your emails)

2. Services

- a component that runs in the background to perform long-running operations or to perform work for remote processes
- does not provide a user interface
- can be started by an activity
- is implemented as a subclass of Service
- e.g. music player (playing in background)

Android App Components

3. Content Providers

- manages a shared set of app data
- can store the data in the file system, an SQLite database, on the web, or any other persistent storage location your app can access
- through the content provider, other apps can query or even modify the data
- e.g. Users Contacts (your app could update contact details)

4. Broadcast Receivers

- a component that responds to system-wide broadcast announcements
- broadcasts can be from both the system and your app
- implemented as a subclass of BroadcastReceiver and each broadcast is delivered as an Intent object
- e.g. battery low (system) or new email (app via notification)

How it all Fits Together *

Big N.B. for all these!

- Based on the *Model View Controller* design pattern.
- Don’t think of your program as a linear execution model:
  - Think of your program as existing in logical blocks, each of which performs some actions.
- The blocks communicate back and forth via message passing (*Intents*)
  - Added advantage, **physical user interaction (screen clicks) and inter process interaction can have the same programming interface**
  - Also the OS can bring different pieces of the app to life depending on memory needs and program use

See the Appendix for a more detailed explanation of these components

- For each distinct logical piece of program behavior you’ll write a Java class (derived from a base class).
- Activities/Fragments: Things the user can ***see*** on the screen. Basically, the ‘controller’ for each different screen in your program.
- Services: Code that isn’t associated with a screen (background stuff, fairly common)
- Content providers: Provides an interface to exchange data between programs (usually SQL based)
- You’ll also design your layouts (screens), with various types of widgets (Views), which is what the user sees via *Activities & Fragments*

The (Application) Activity Life Cycle *

- ❑ Android is designed around the unique requirements of mobile applications.
  - In particular, Android recognizes that resources (memory and battery, for example) are limited on most mobile devices, and provides mechanisms to conserve those resources.
- ❑ The mechanisms are evident in the *Android Activity Lifecycle*, which defines the states or events that an activity goes through from the time it is created until it finishes running.

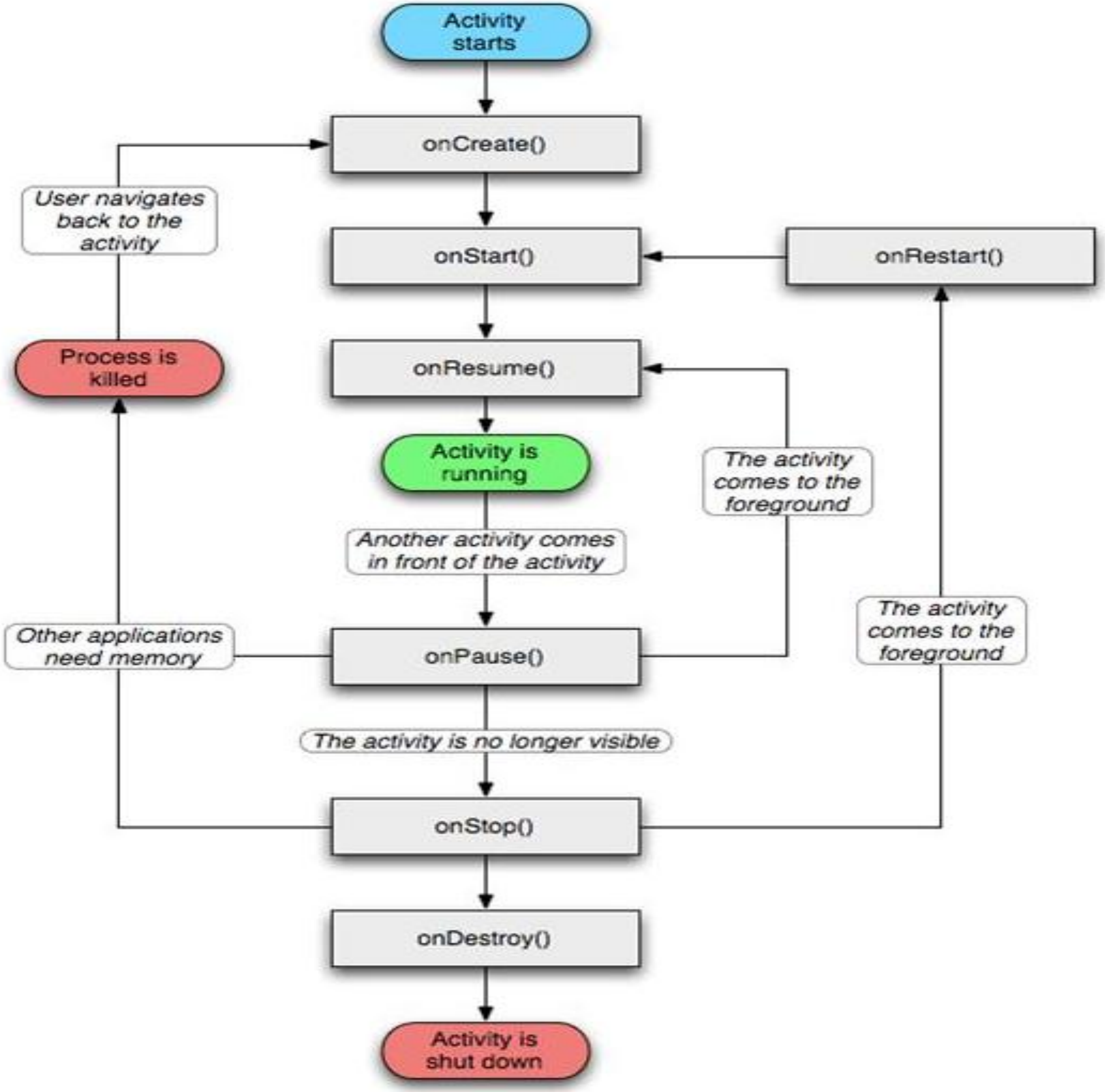
See the Appendix for a more detailed explanation of these ‘states’

The (Application) Activity Life Cycle

- An application itself is a set of activities with a Linux process to contain them
  - However, an application DOES NOT EQUAL a process
  - Due to (the previously mentioned) low memory conditions, an activity might be suspended at any time and its process be discarded
    - The activity manager remembers the state of the activity however and can reactivate it at any time
    - Thus, an activity may span multiple processes over the life time of an application

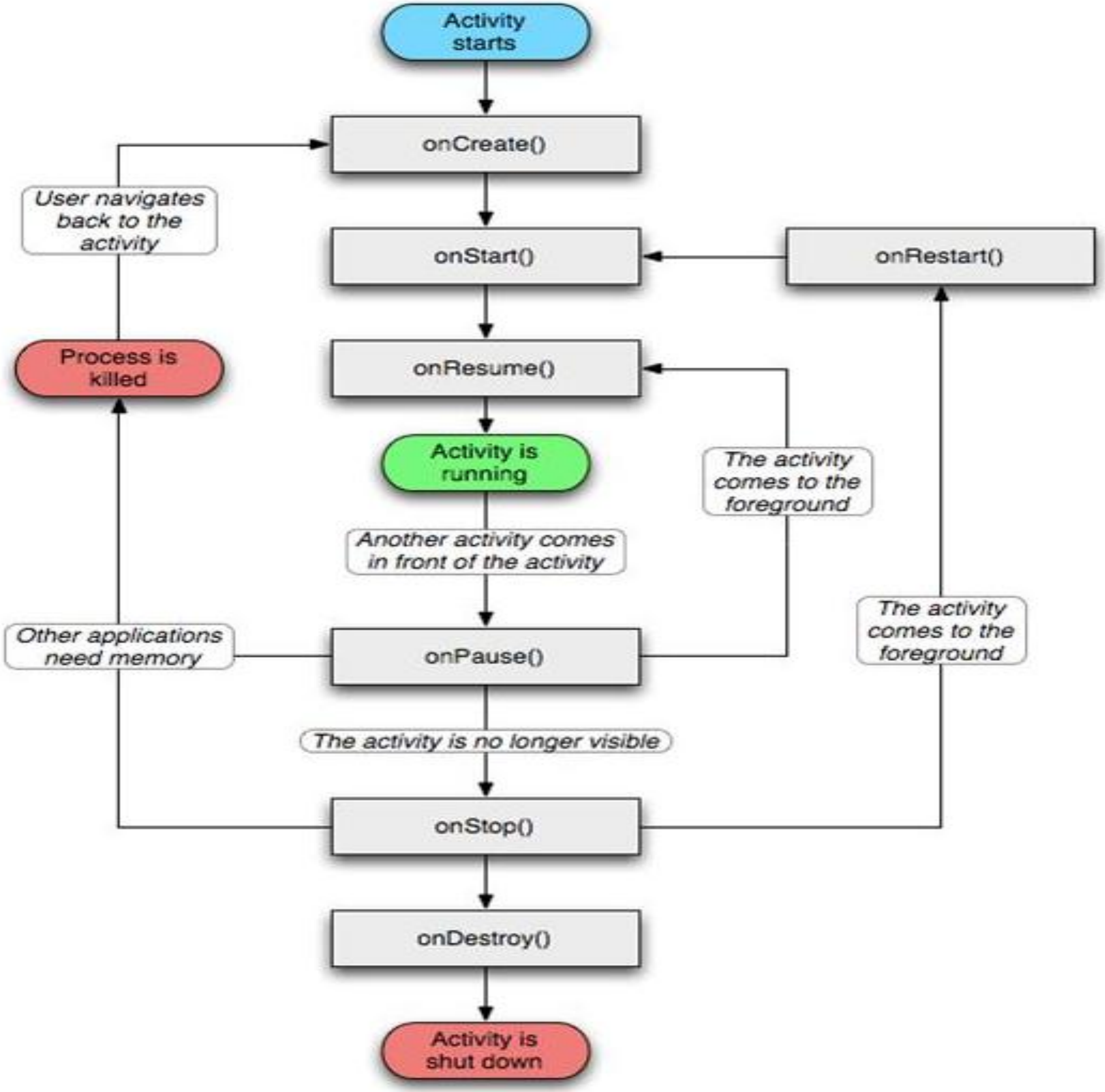
The Activity Life Cycle *

- The Activity has a number of predefined functions that you override to handle events from the system.
- If you don’t specify what should be done the system will perform the default actions to handle events.
- Why would you want to handle events such as **`onPause()`**, etc… ?
  - You will probably want to do things like release resources, stop network connections, back up data if necessary, etc.


Activity starts
onCreate()
User navigates back to the activity
onStart()
onRestart()
Process is killed
onResume()
Activity is running
The activity comes to the foreground
Another activity comes in front of the activity
Other applications need memory
onPause()
The activity comes to the foreground
The activity is no longer visible
onStop()
onDestroy()
Activity is shut down

The Activity Life Cycle

- At the *very minimum* ,you need (and is supplied) **`onCreate()`**
- **`onStop()`** and **`onDestroy()`** are optional and may never be called
- If you need persistence, the save needs to happen in **`onPause()`**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The activity comes to the foreground
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Other applications need memory
onPause()
The activity comes to the foreground
The activity is no longer visible
onStop()
onDestroy()
Activity is shut down

Fragments

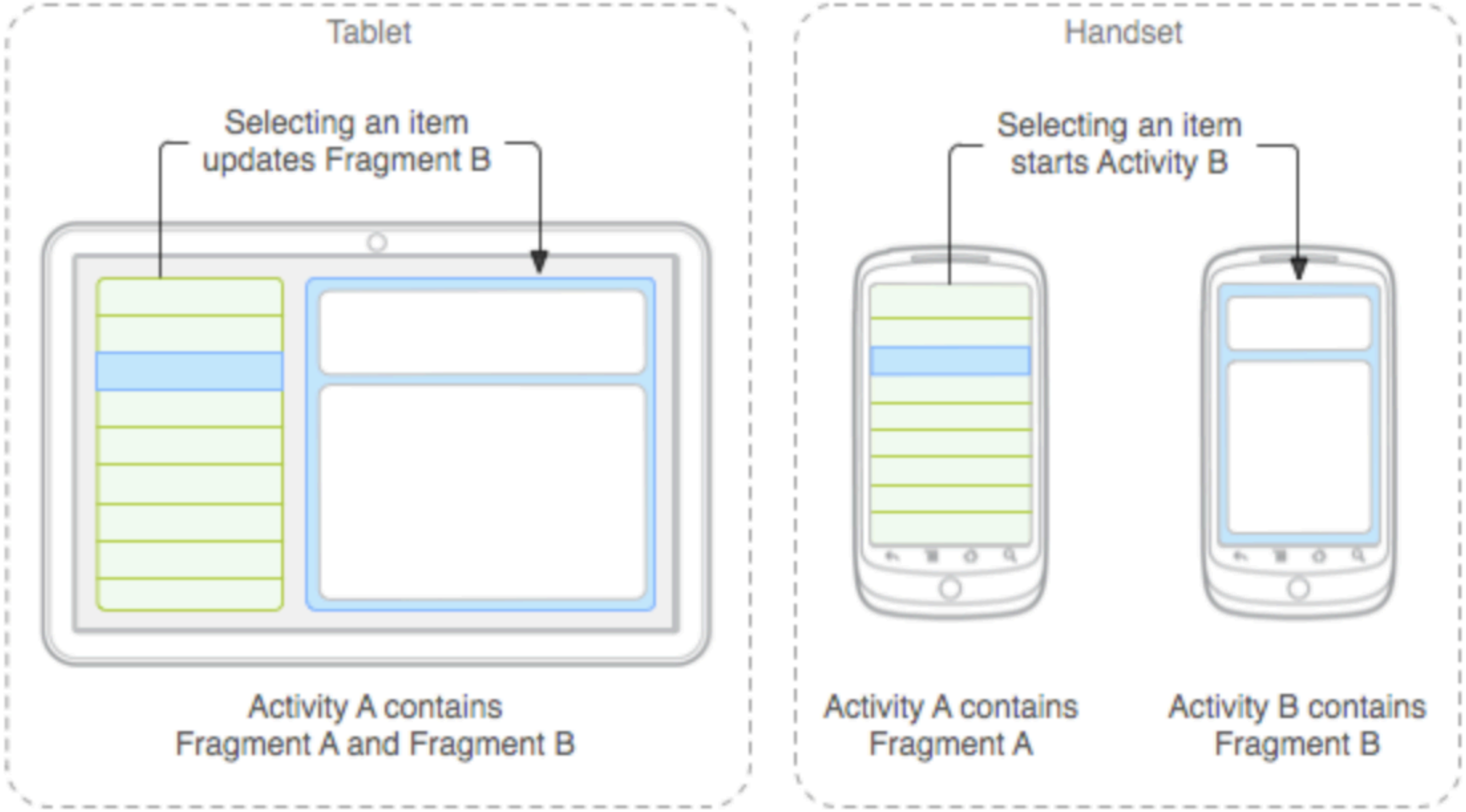
- Fragments represents a behaviour or a portion of a user interface *in an* ***Activity***.
- Introduced in Android 3.0 (API level 11), primarily supports more dynamic and flexible UI designs on larger screens.
- You can combine multiple fragments in a single activity to build a multi-pane UI and *reuse a fragment in multiple activities*.
- Each Fragment has its own lifecycle, receives its own input events, and you can add or remove it while the activity is running.
- A fragment must always be embedded in an activity and the fragment's lifecycle is directly affected by the host activity's lifecycle.
- When you perform a ***fragment transaction***, you can also add it to a back stack that's managed by the activity.
- The back stack allows the user to reverse a fragment transaction (navigate backwards), by pressing the *Back* button.
- When you add a fragment as a part of your activity layout, it lives in a *ViewGroup* inside the activity's view hierarchy and the fragment defines its own view layout.

Designing Fragments *

- You should design each fragment as a modular and reusable activity component.
- When designing your application to support both tablets and handsets, you can *reuse your fragments* in different layout configurations to optimize the user experience based on the available screen space.

- For example, on a handset, it might be necessary for separate fragments to provide a single-pane UI when more than one cannot fit within the same activity. (Next Slide)

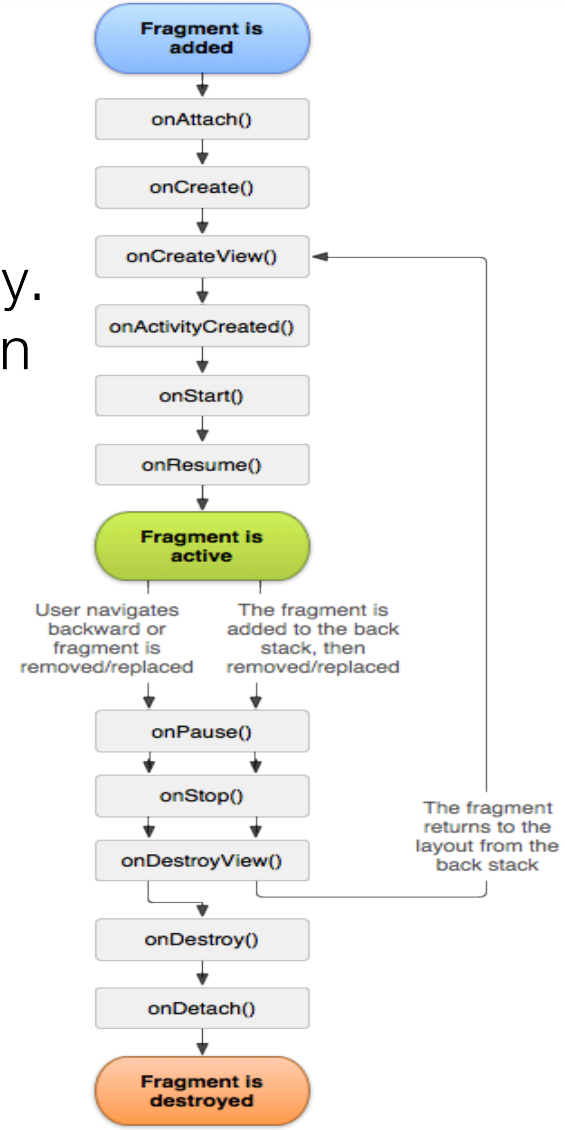
Designing Fragments

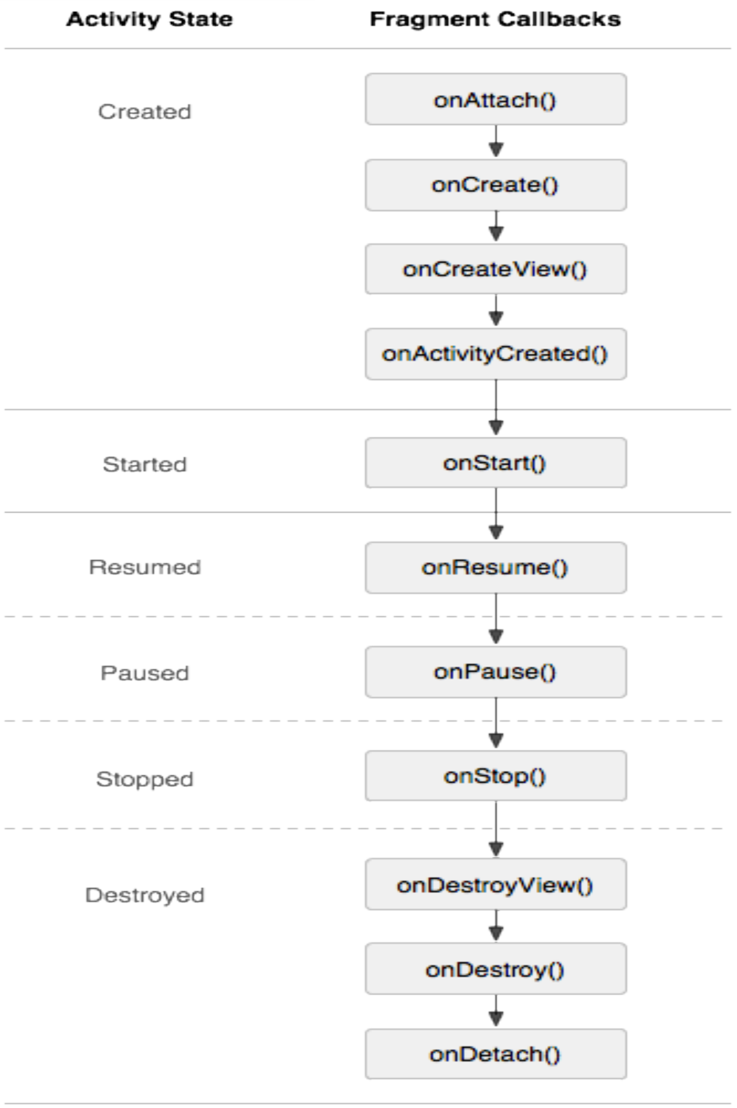

Tablet
Selecting an item updates Fragment B
Activity A contains Fragment A and Fragment B
Handset
Selecting an item starts Activity B
Activity A contains Fragment A
Activity B contains Fragment B

An example of how two UI modules defined by fragments can be combined into one activity for a tablet design, but separated for a handset design.

The Fragment Life Cycle

- To create a fragment, you must subclass Fragment (or an existing subclass of it).
- Has code that looks a lot like an Activity. Contains callback methods similar to an activity, such as *onCreate()*, *onStart()*, *onPause()*, and *onStop()*.
- Usually, you should implement at least *onCreate()*, *onCreateView()* and *onPause()*

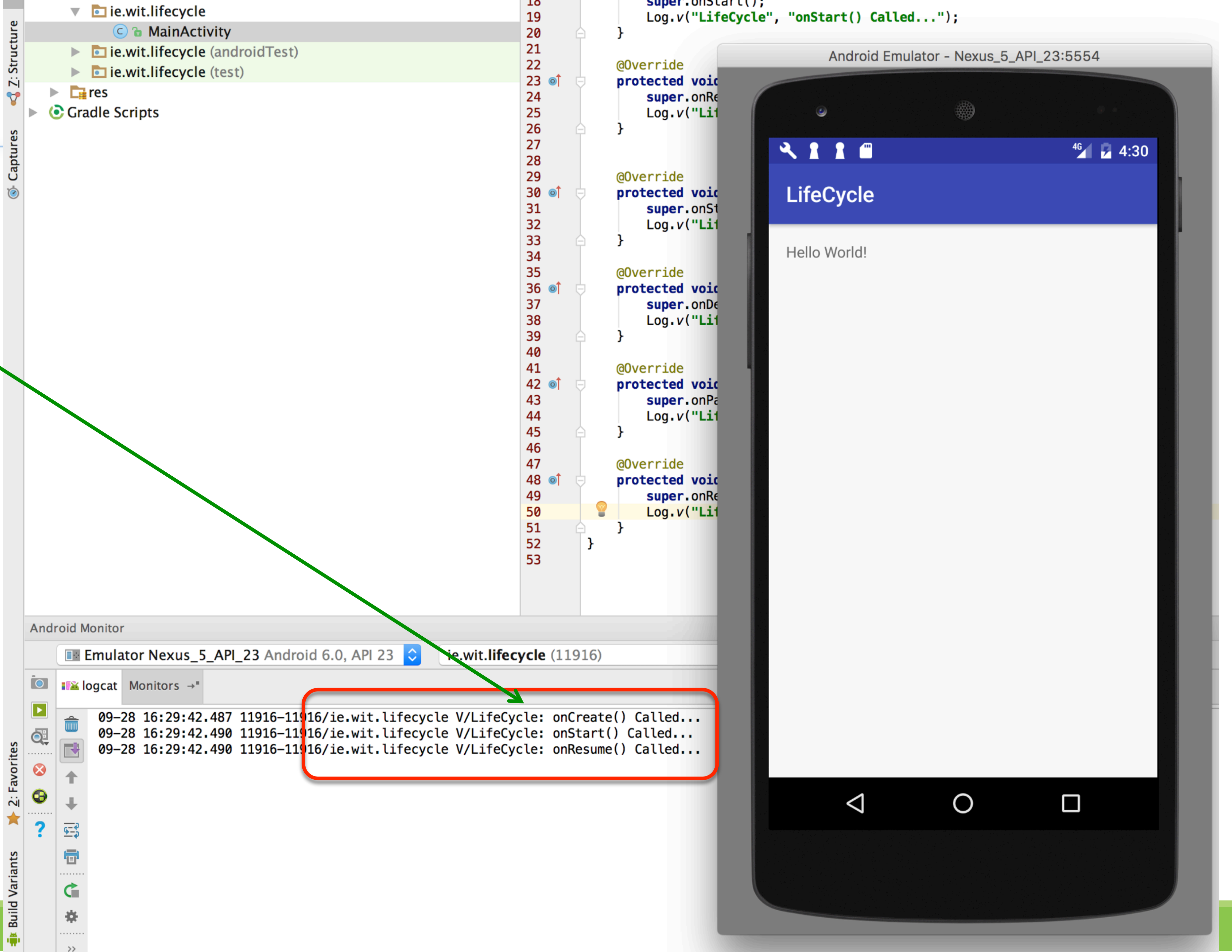




Activity State	Fragment Callbacks
Created	onAttach()
	onCreate()
	onCreateView()
	onActivityCreated()
Started	onStart()
Resumed	onResume()
Paused	onPause()
Stopped	onStop()
Destroyed	onDestroyView()
	onDestroy()
	onDetach()

LifeCycle Example (1) *

User Launches App

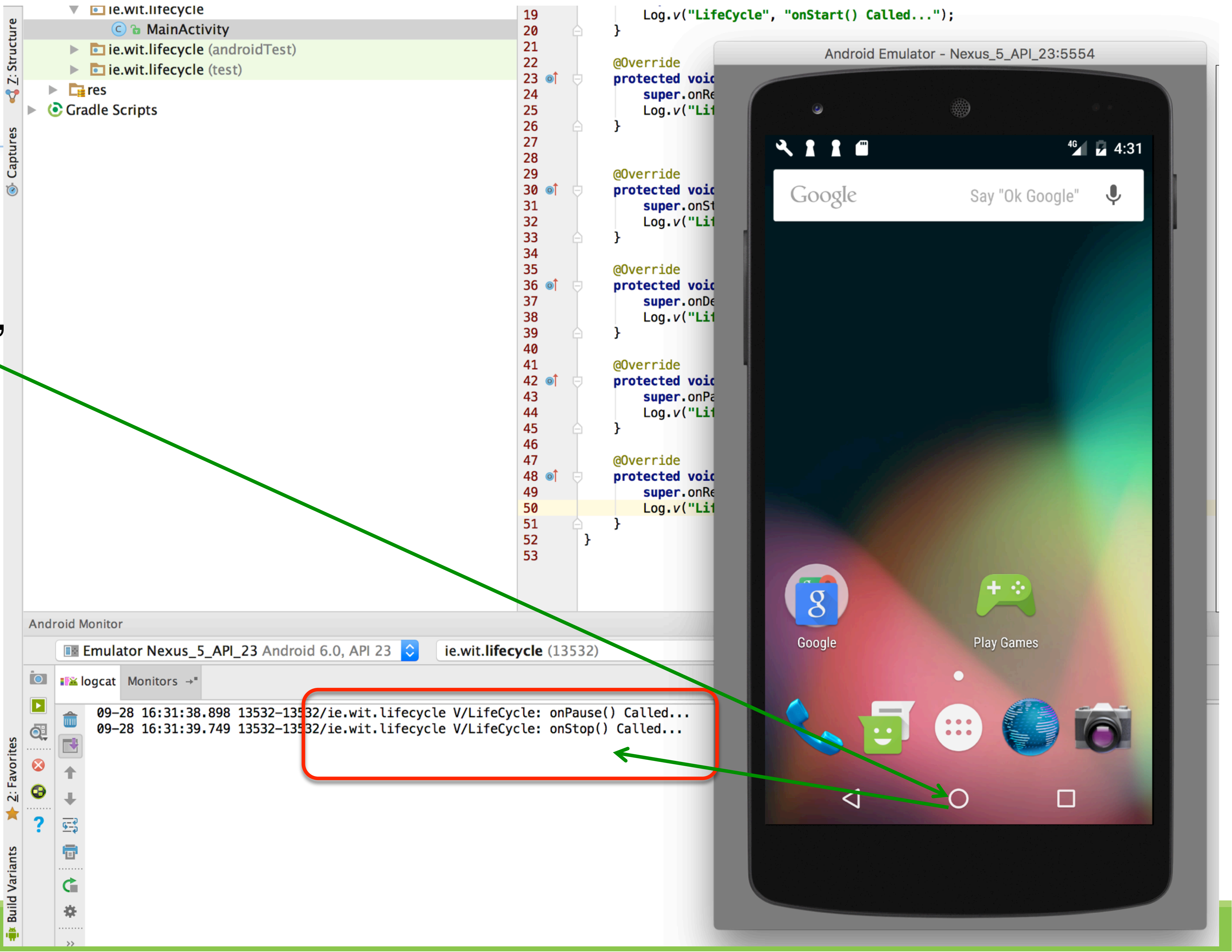


```
        super.onStart();
        Log.v("LifeCycle", "onStart() Called...");
    }

    @Override
    protected voi
        super.onRe
        Log.v("Li
    }


    @Override
    protected voi
        super.onSt
        Log.v("Li
    }

    @Override
    protected voi
        super.onDe
        Log.v("Li
    }

    @Override
    protected voi
        super.onPa
        Log.v("Li
    }

    @Override
    protected voi
        super.onRe
        Log.v("Li
    }
}
```

```
09-28 16:29:42.487 11916-11916/ie.wit.lifecycle V/LifeCycle: onCreate() Called...
09-28 16:29:42.490 11916-11916/ie.wit.lifecycle V/LifeCycle: onStart() Called...
09-28 16:29:42.490 11916-11916/ie.wit.lifecycle V/LifeCycle: onResume() Called...
```

LifeCycle Example (2) *

User Selects ‘Home’

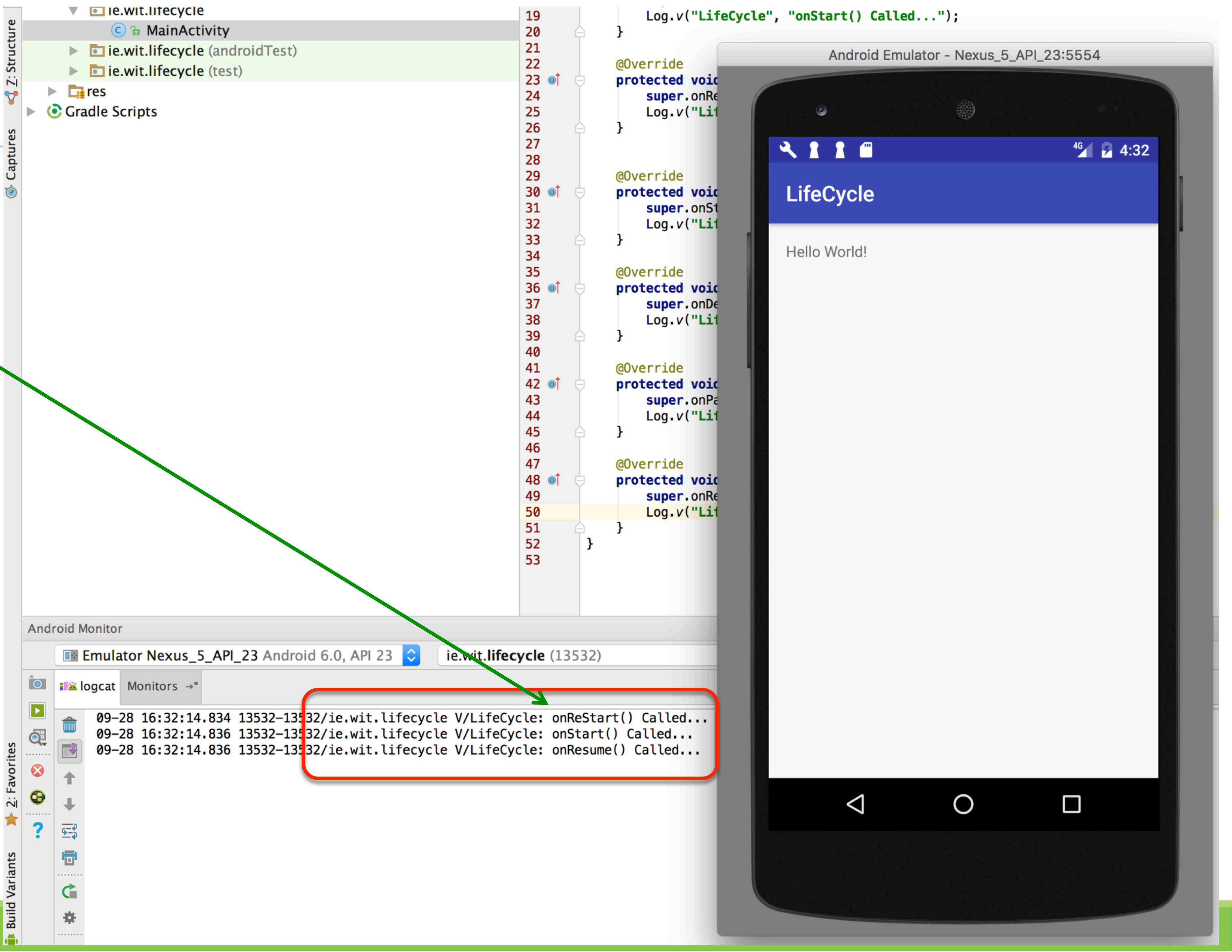


```
        Log.v("LifeCycle", "onStart() Called...");
    }

    @Override
    protected voic
        super.onRe
        Log.v("Lif
    }

    @Override
    protected voic
        super.onSt
        Log.v("Lif
    }

    @Override
    protected voic
        super.onDe
        Log.v("Lif
    }

    @Override
    protected voic
        super.onPa
        Log.v("Lif
    }

    @Override
    protected voic
        super.onRe
        Log.v("Lif
    }
}
```

```
09-28 16:31:38.898 13532-13532/ie.wit.lifecycle V/LifeCycle: onPause() Called...
09-28 16:31:39.749 13532-13532/ie.wit.lifecycle V/LifeCycle: onStop() Called...
```

LifeCycle Example (3) *

User restarts App

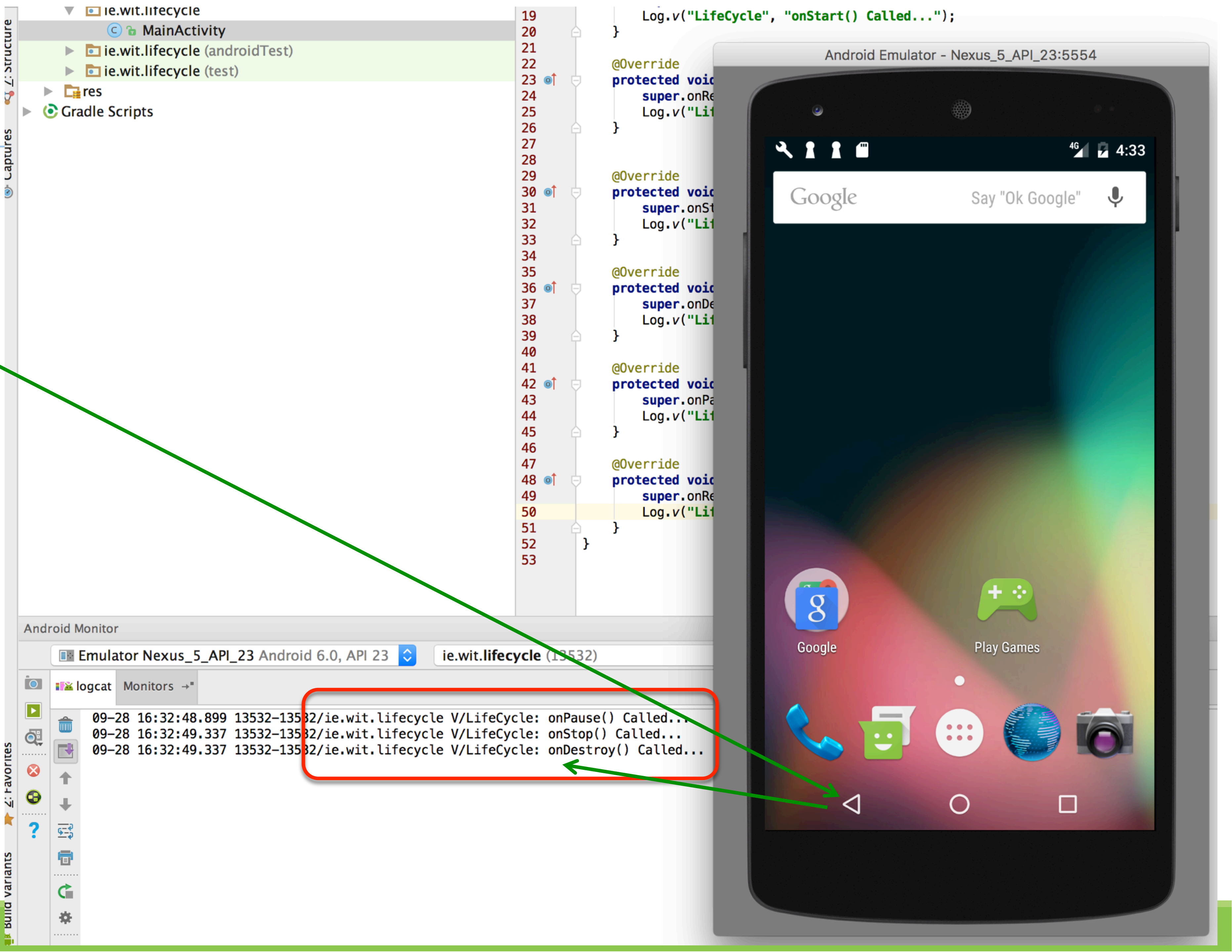


```
        Log.v("LifeCycle", "onStart() Called...");
    }

    @Override
    protected voic
        super.onRe
        Log.v("Lif
    }


    @Override
    protected voic
        super.onSt
        Log.v("Lif
    }

    @Override
    protected voic
        super.onDe
        Log.v("Lif
    }

    @Override
    protected voic
        super.onPa
        Log.v("Lif
    }

    @Override
    protected voic
        super.onRe
        Log.v("Lif
    }
}
```

```
09-28 16:32:14.834 13532-13532/ie.wit.lifecycle V/LifeCycle: onReStart() Called...
09-28 16:32:14.836 13532-13532/ie.wit.lifecycle V/LifeCycle: onStart() Called...
09-28 16:32:14.836 13532-13532/ie.wit.lifecycle V/LifeCycle: onResume() Called...
```

LifeCycle Example (4) *

User Selects ‘Back’

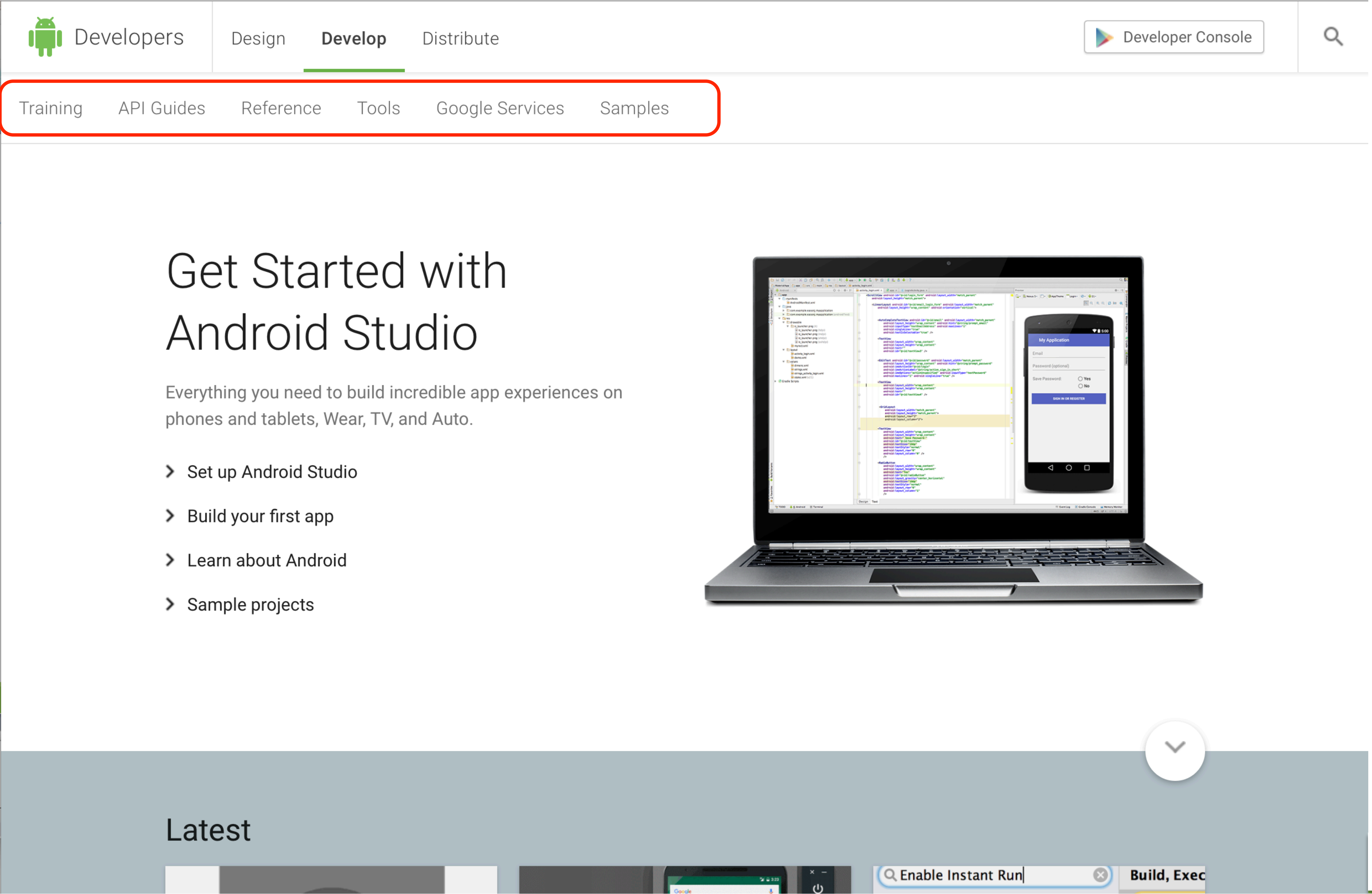


```
            Log.v("LifeCycle", "onStart() Called...");
        }

        @Override
        protected voic
            super.onRe
            Log.v("Lif
        }


        @Override
        protected voic
            super.onSt
            Log.v("Lif
        }

        @Override
        protected voic
            super.onDe
            Log.v("Lif
        }

        @Override
        protected voic
            super.onPa
            Log.v("Lif
        }

        @Override
        protected voic
            super.onRe
            Log.v("Lif
        }
    }
```

```
09-28 16:32:48.899 13532-13532/ie.wit.lifecycle V/LifeCycle: onPause() Called...
09-28 16:32:49.337 13532-13532/ie.wit.lifecycle V/LifeCycle: onStop() Called...
09-28 16:32:49.337 13532-13532/ie.wit.lifecycle V/LifeCycle: onDestroy() Called...
```

So, after all that, how do I Design my App?

- The way the system architecture is set up is fairly open:
  - App design is somewhat up to you, but you still have to live with the Android execution model.
- Start with the different *screens/ layouts* (Views) that the user will see. These are controlled by the different *Activities* (Controllers) that will comprise your system.
- Think about the *transitions* between the screens, these will be the *Intents* passed between the Activities.
- Think about what background *services* you might need to incorporate.
  - Exchanging data
  - Listening for connections?
  - Periodically downloading network information from a server?
- Think about what *information* must be stored in long term memory (SQLite) and possibly design a content provider around it.
- Now connect the Activities, services, etc… with Intents…
- Don't forget good OOP ☺ and
- USE THE ONLINE DEVELOPER DOCs & GUIDES (next few slides)

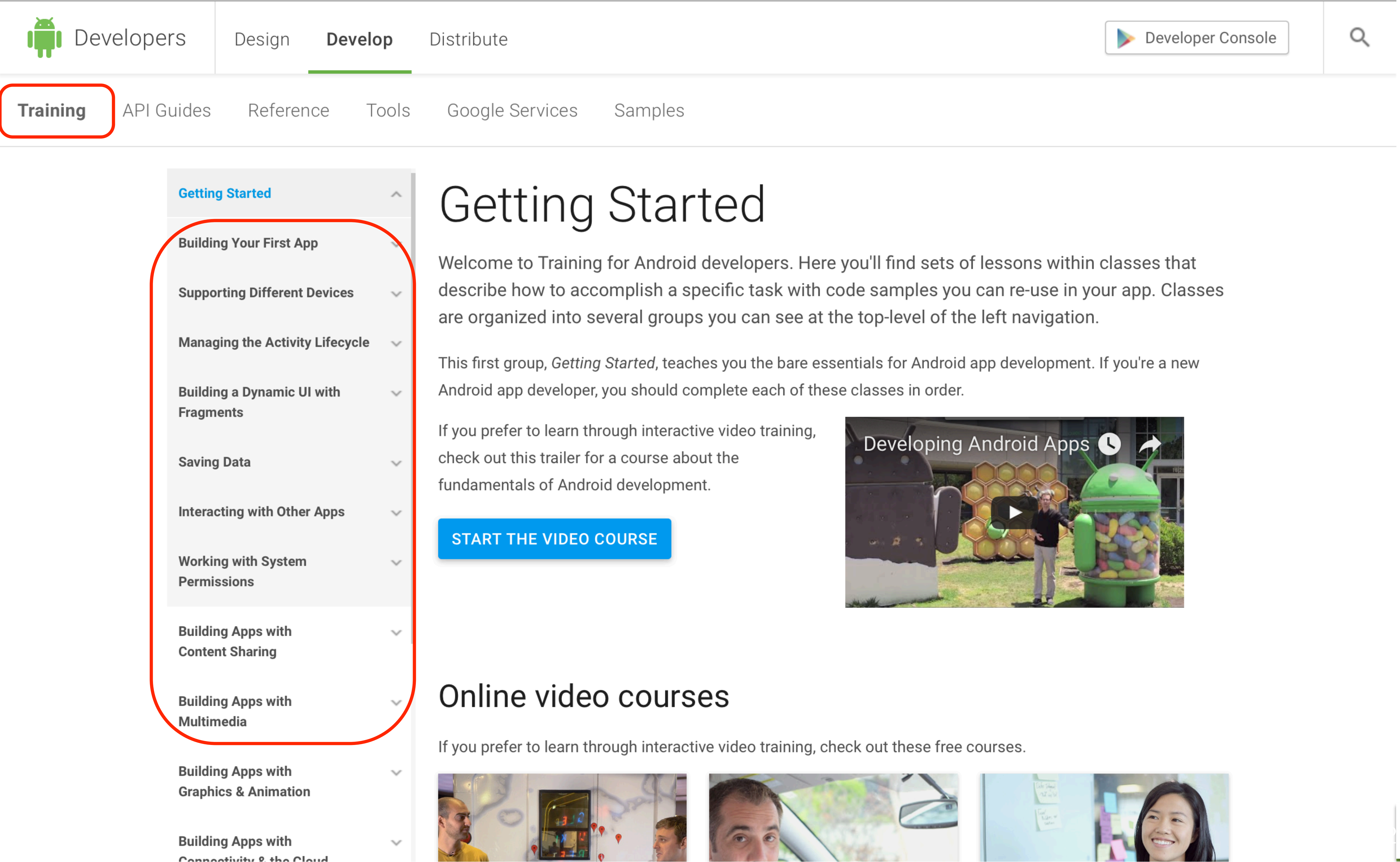


Get Started with Android Studio

Everything you need to build incredible app experiences on phones and tablets, Wear, TV, and Auto.

- Set up Android Studio
- Build your first app
- Learn about Android
- Sample projects

Latest



Developers
Design
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Google Services
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Getting Started
Building Your First App
Supporting Different Devices
Managing the Activity Lifecycle
Building a Dynamic UI with Fragments
Saving Data
Interacting with Other Apps
Working with System Permissions
Building Apps with Content Sharing
Building Apps with Multimedia
Building Apps with Graphics & Animation
Building Apps with Connectivity & the Cloud

Getting Started

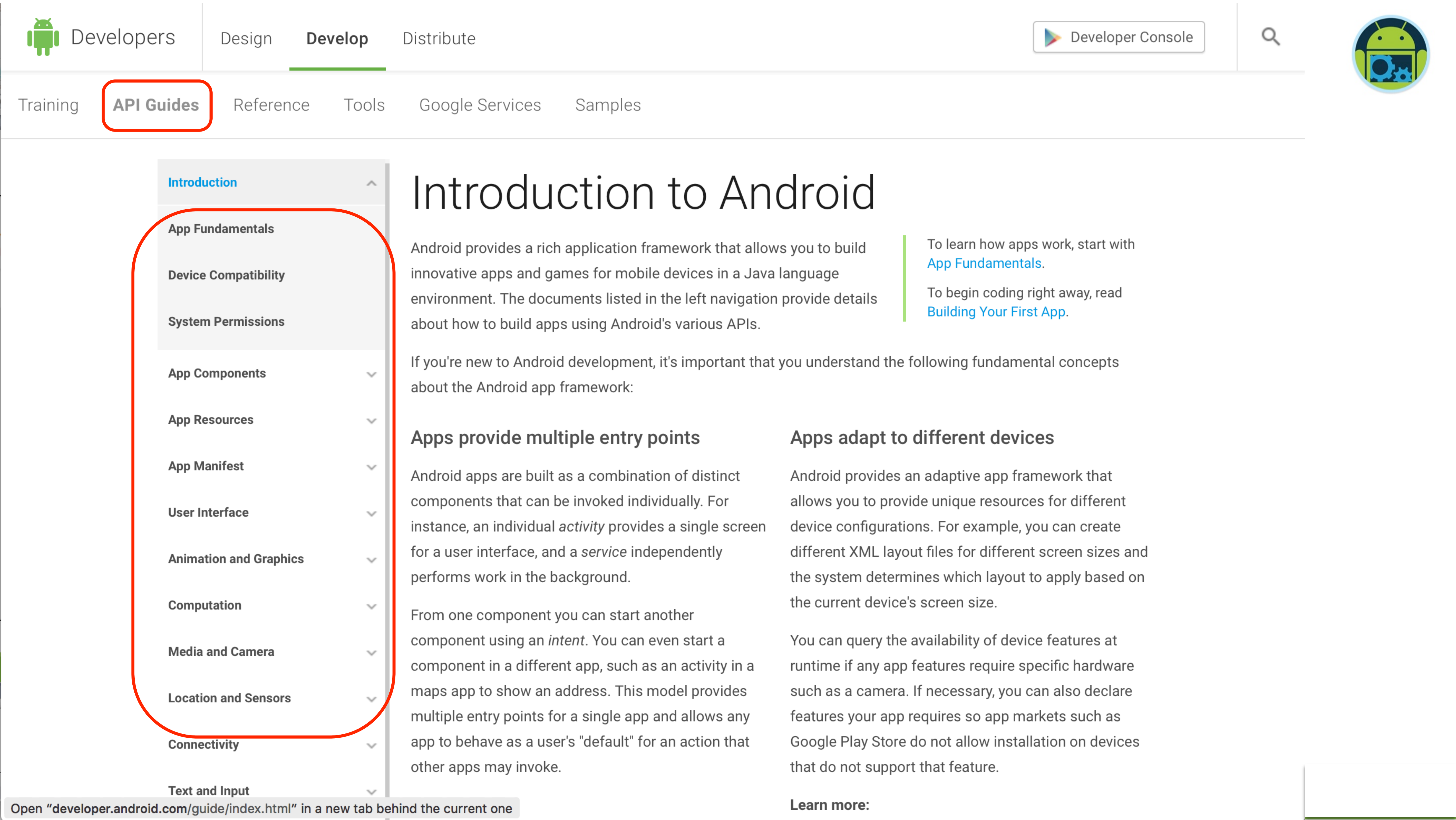
Welcome to Training for Android developers. Here you'll find sets of lessons within classes that describe how to accomplish a specific task with code samples you can re-use in your app. Classes are organized into several groups you can see at the top-level of the left navigation.

This first group, *Getting Started*, teaches you the bare essentials for Android app development. If you're a new Android app developer, you should complete each of these classes in order.

If you prefer to learn through interactive video training, check out this trailer for a course about the fundamentals of Android development.

Online video courses

If you prefer to learn through interactive video training, check out these free courses.



Introduction to Android

Android provides a rich application framework that allows you to build innovative apps and games for mobile devices in a Java language environment. The documents listed in the left navigation provide details about how to build apps using Android's various APIs.

To learn how apps work, start with App Fundamentals.

To begin coding right away, read Building Your First App.

If you're new to Android development, it's important that you understand the following fundamental concepts about the Android app framework:

Apps provide multiple entry points

Android apps are built as a combination of distinct components that can be invoked individually. For instance, an individual *activity* provides a single screen for a user interface, and a *service* independently performs work in the background.

From one component you can start another component using an *intent*. You can even start a component in a different app, such as an activity in a maps app to show an address. This model provides multiple entry points for a single app and allows any app to behave as a user's "default" for an action that other apps may invoke.

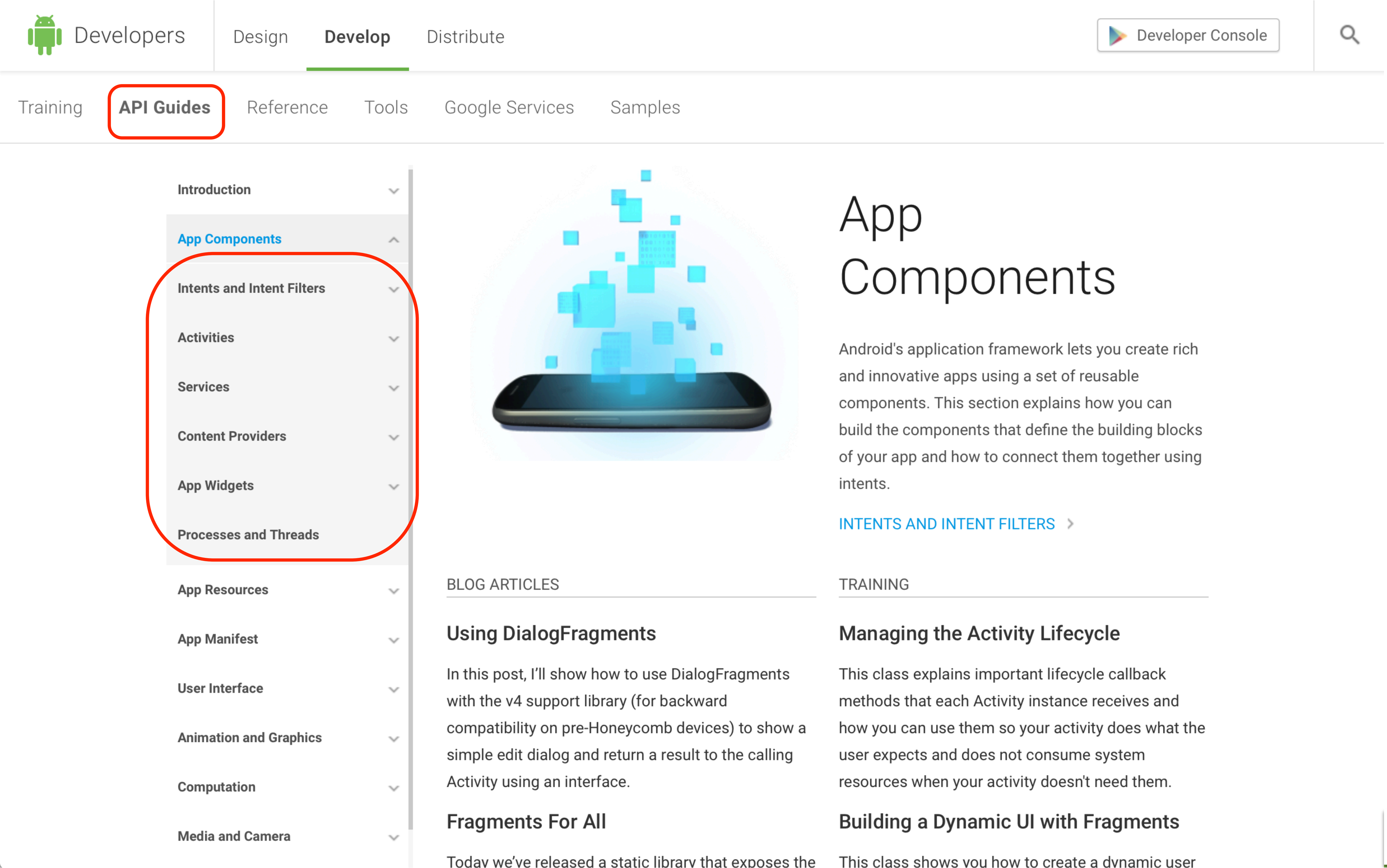
Apps adapt to different devices

Android provides an adaptive app framework that allows you to provide unique resources for different device configurations. For example, you can create different XML layout files for different screen sizes and the system determines which layout to apply based on the current device's screen size.

You can query the availability of device features at runtime if any app features require specific hardware such as a camera. If necessary, you can also declare features your app requires so app markets such as Google Play Store do not allow installation on devices that do not support that feature.

Learn more:

Open "developer.android.com/guide/index.html" in a new tab behind the current one



App Components

Android's application framework lets you create rich and innovative apps using a set of reusable components. This section explains how you can build the components that define the building blocks of your app and how to connect them together using intents.

INTENTS AND INTENT FILTERS

BLOG ARTICLES

Using DialogFragments

In this post, I'll show how to use DialogFragments with the v4 support library (for backward compatibility on pre-Honeycomb devices) to show a simple edit dialog and return a result to the calling Activity using an interface.

Fragments For All

Today we've released a static library that exposes the

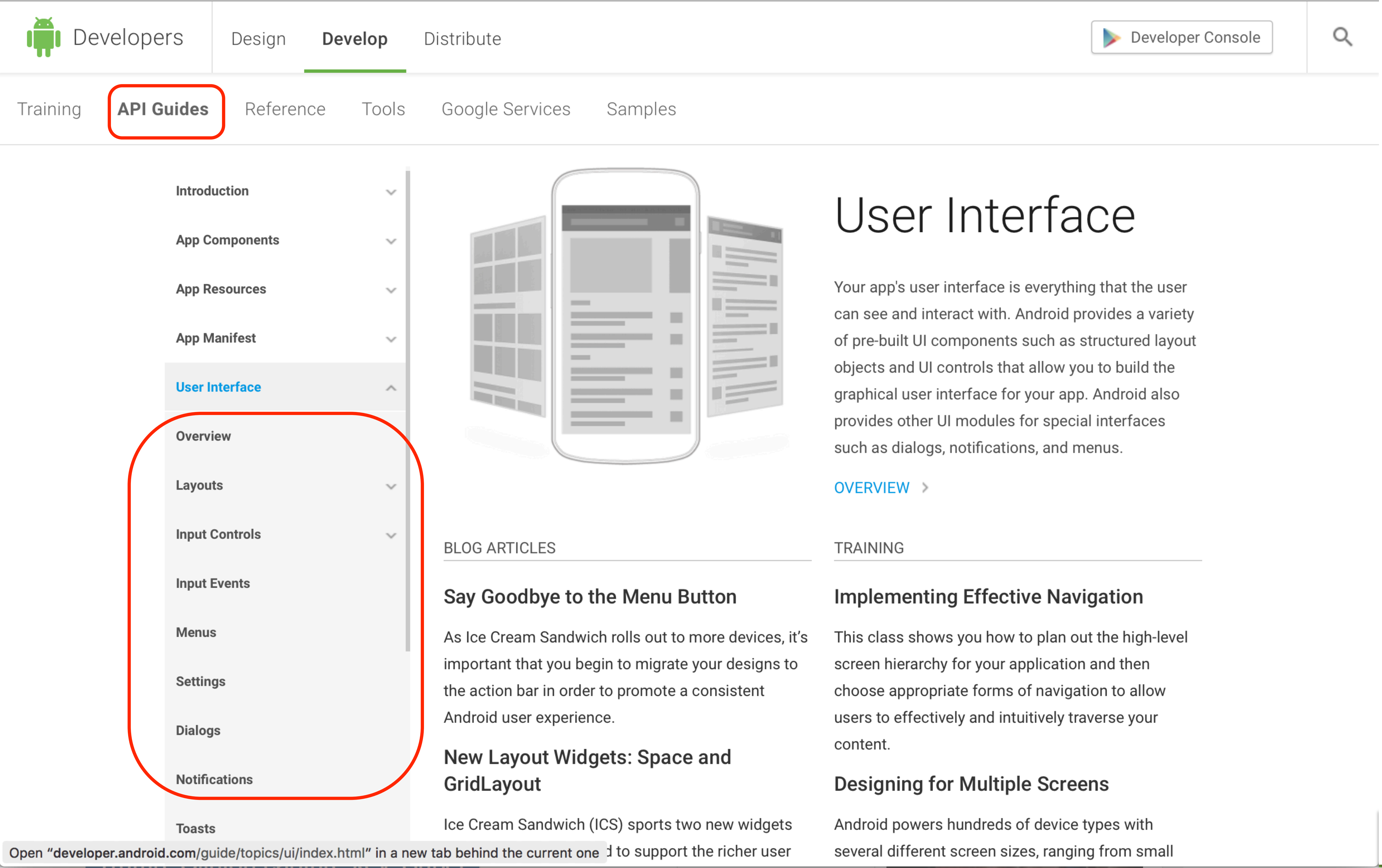
TRAINING

Managing the Activity Lifecycle

This class explains important lifecycle callback methods that each Activity instance receives and how you can use them so your activity does what the user expects and does not consume system resources when your activity doesn't need them.

Building a Dynamic UI with Fragments

This class shows you how to create a dynamic user



User Interface

Your app's user interface is everything that the user can see and interact with. Android provides a variety of pre-built UI components such as structured layout objects and UI controls that allow you to build the graphical user interface for your app. Android also provides other UI modules for special interfaces such as dialogs, notifications, and menus.

OVERVIEW ›

BLOG ARTICLES

Say Goodbye to the Menu Button

As Ice Cream Sandwich rolls out to more devices, it's important that you begin to migrate your designs to the action bar in order to promote a consistent Android user experience.

New Layout Widgets: Space and GridLayout

Ice Cream Sandwich (ICS) sports two new widgets [...]d to support the richer user

TRAINING

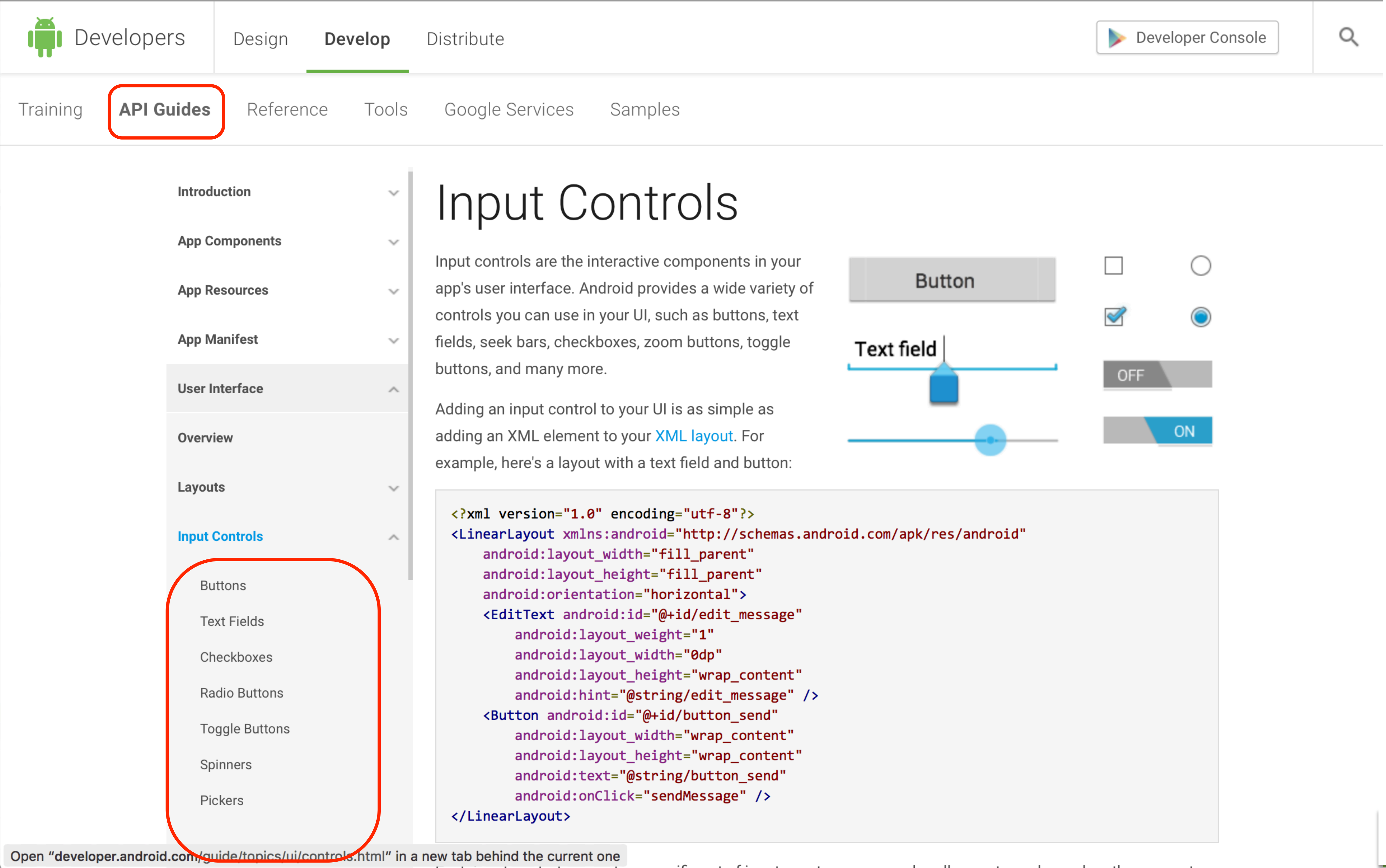
Implementing Effective Navigation

This class shows you how to plan out the high-level screen hierarchy for your application and then choose appropriate forms of navigation to allow users to effectively and intuitively traverse your content.

Designing for Multiple Screens

Android powers hundreds of device types with several different screen sizes, ranging from small

Open "developer.android.com/guide/topics/ui/index.html" in a new tab behind the current one



Input Controls

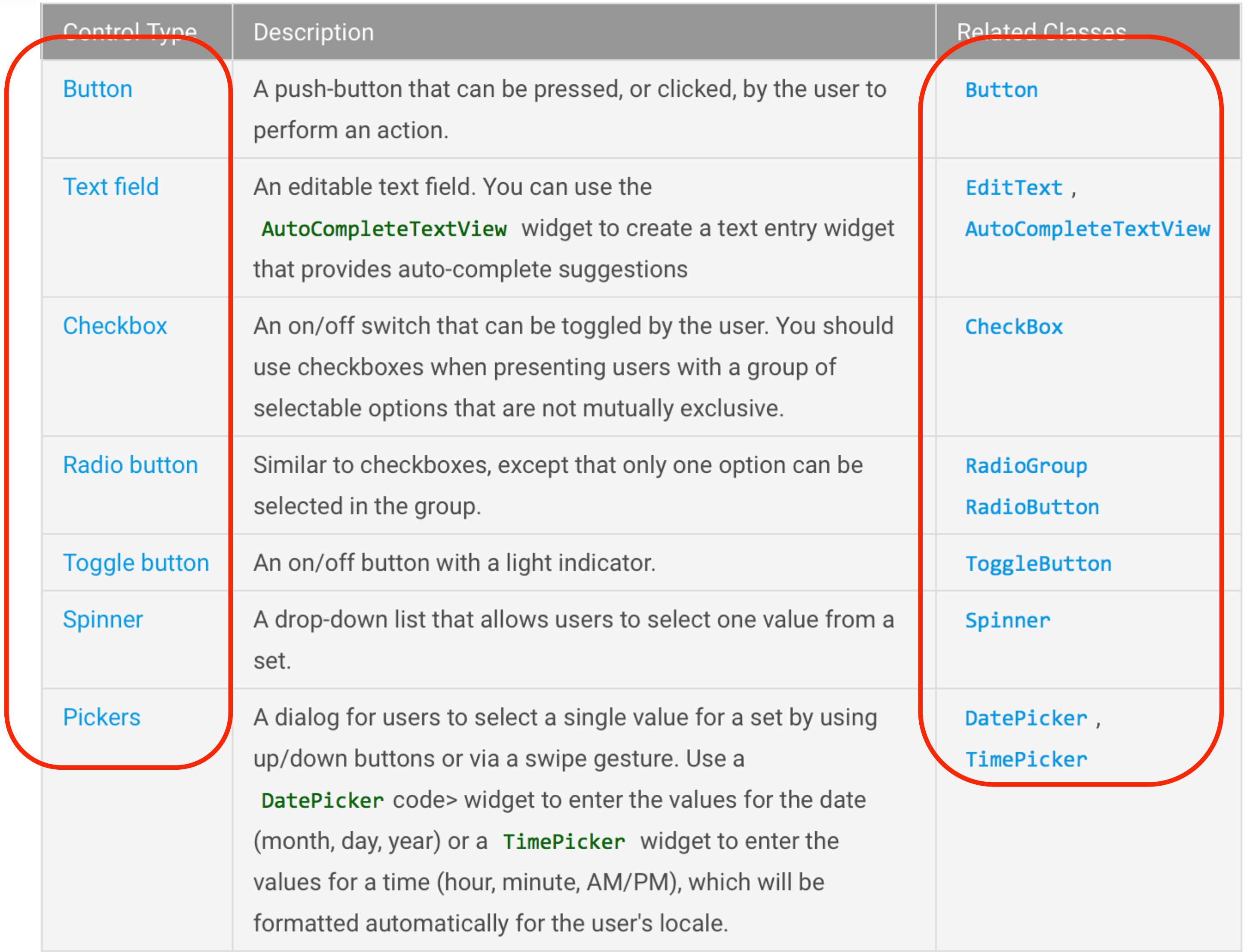
Input controls are the interactive components in your app's user interface. Android provides a wide variety of controls you can use in your UI, such as buttons, text fields, seek bars, checkboxes, zoom buttons, toggle buttons, and many more.

Adding an input control to your UI is as simple as adding an XML element to your XML layout. For example, here's a layout with a text field and button:

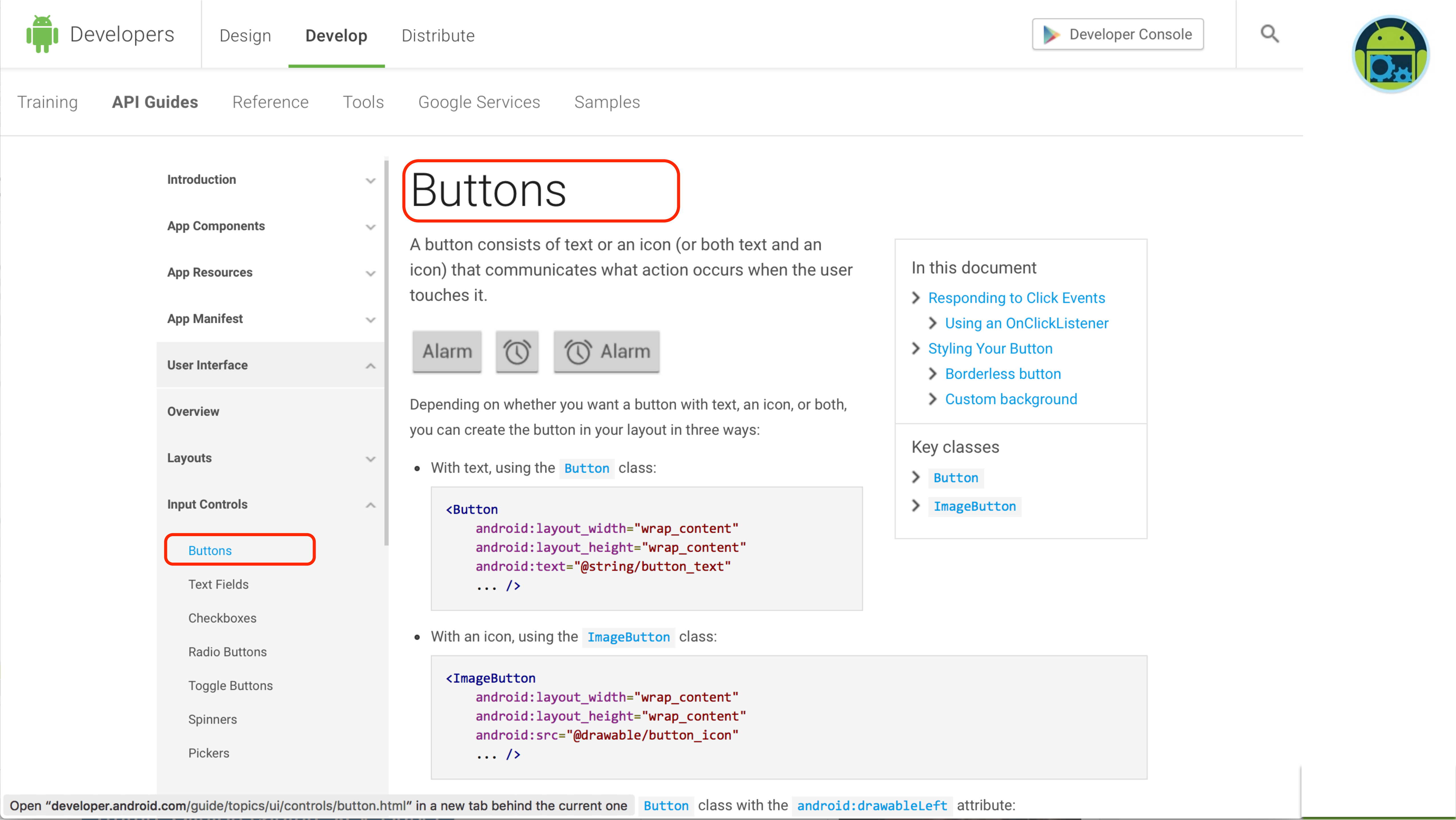
```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:orientation="horizontal">
    <EditText android:id="@+id/edit_message"
        android:layout_weight="1"
        android:layout_width="0dp"
        android:layout_height="wrap_content"
        android:hint="@string/edit_message" />
    <Button android:id="@+id/button_send"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="@string/button_send"
        android:onClick="sendMessage" />
</LinearLayout>
```

Open "developer.android.com/guide/topics/ui/controls.html" in a new tab behind the current one

Common Controls



Control Type	Description	Related Classes
Button	A push-button that can be pressed, or clicked, by the user to perform an action.	`Button`
Text field	An editable text field. You can use the `AutoCompleteTextView` widget to create a text entry widget that provides auto-complete suggestions	`EditText` , `AutoCompleteTextView`
Checkbox	An on/off switch that can be toggled by the user. You should use checkboxes when presenting users with a group of selectable options that are not mutually exclusive.	`CheckBox`
Radio button	Similar to checkboxes, except that only one option can be selected in the group.	`RadioGroup` `RadioButton`
Toggle button	An on/off button with a light indicator.	`ToggleButton`
Spinner	A drop-down list that allows users to select one value from a set.	`Spinner`
Pickers	A dialog for users to select a single value for a set by using up/down buttons or via a swipe gesture. Use a `DatePicker` code> widget to enter the values for the date (month, day, year) or a `TimePicker` widget to enter the values for a time (hour, minute, AM/PM), which will be formatted automatically for the user's locale.	`DatePicker` , `TimePicker`



Buttons

A button consists of text or an icon (or both text and an icon) that communicates what action occurs when the user touches it.

Depending on whether you want a button with text, an icon, or both, you can create the button in your layout in three ways:

- With text, using the `Button` class:

```
<Button
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="@string/button_text"
    ... />
```

- With an icon, using the `ImageButton` class:

```
<ImageButton
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:src="@drawable/button_icon"
    ... />
```

Open "developer.android.com/guide/topics/ui/controls/button.html" in a new tab behind the current one `Button` class with the `android:drawableLeft` attribute:

In this document

- Responding to Click Events
  - Using an OnClickListener
- Styling Your Button
  - Borderless button
  - Custom background

Key classes

- `Button`
- `ImageButton`

Introduction

App Components

App Resources

App Manifest

User Interface

Overview

Layouts

Input Controls

Buttons

Text Fields

Checkboxes

Radio Buttons

Toggle Buttons

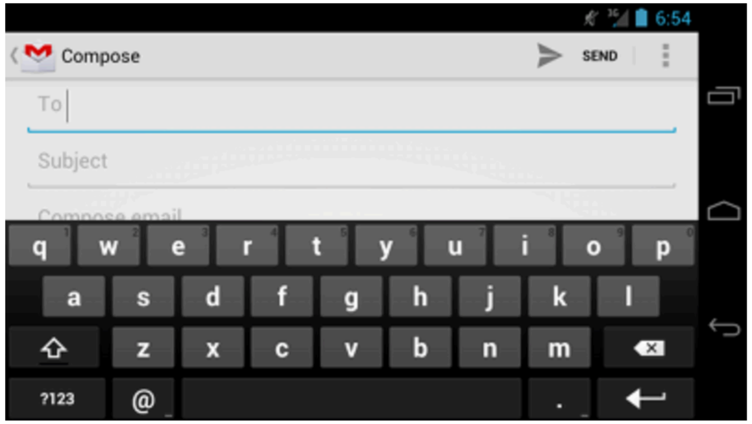
Spinners

Pickers

Text Fields

A text field allows the user to type text into your app. It can be either single line or multi-line. Touching a text field places the cursor and automatically displays the keyboard. In addition to typing, text fields allow for a variety of other activities, such as text selection (cut, copy, paste) and data look-up via auto-completion.

You can add a text field to you layout with the `EditText` object. You should usually do so in your XML layout with a `<EditText>` element.



In this document

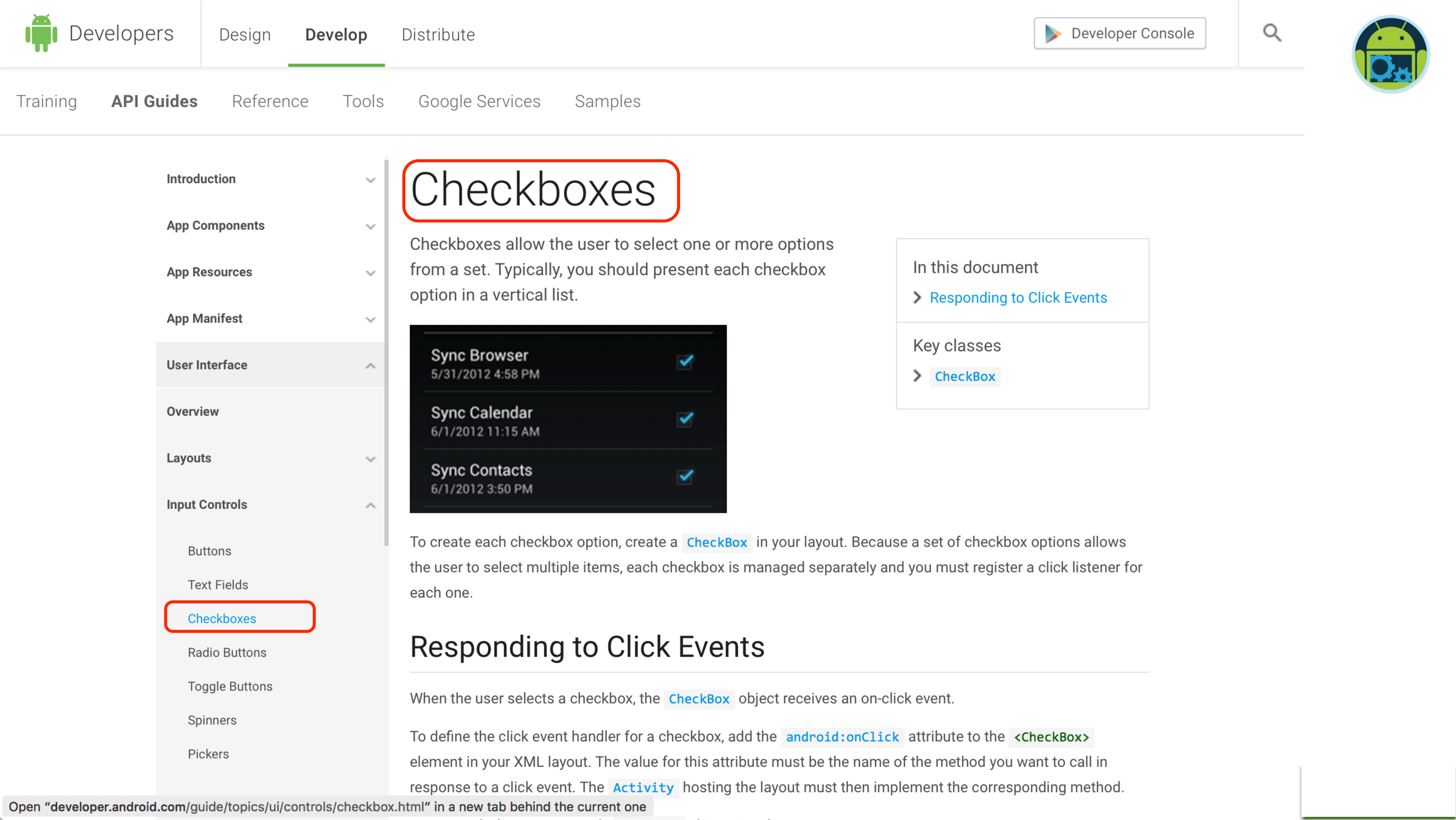
Key classes

- `EditText`
- `AutoCompleteTextView`

Specifying the Keyboard Type

Open "developer.android.com/guide/topics/ui/controls/text.html" in a new tab behind the current one

…put types, such as number,



Checkboxes

Checkboxes allow the user to select one or more options from a set. Typically, you should present each checkbox option in a vertical list.

Sync Browser ☑
5/31/2012 4:58 PM

Sync Calendar ☑
6/1/2012 11:15 AM

Sync Contacts ☑
6/1/2012 3:50 PM

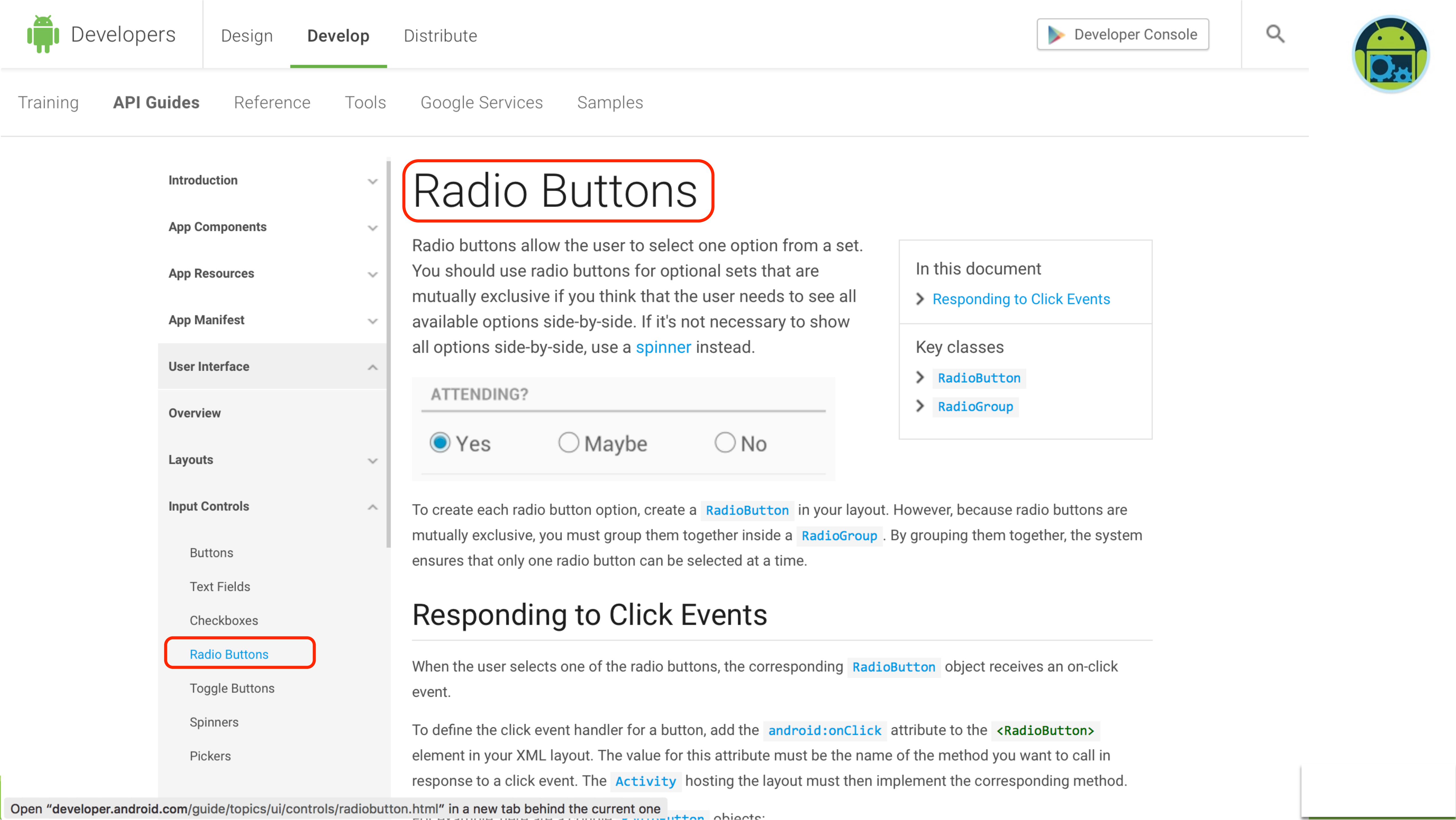
To create each checkbox option, create a `CheckBox` in your layout. Because a set of checkbox options allows the user to select multiple items, each checkbox is managed separately and you must register a click listener for each one.

Responding to Click Events

When the user selects a checkbox, the `CheckBox` object receives an on-click event.

To define the click event handler for a checkbox, add the `android:onClick` attribute to the `<CheckBox>` element in your XML layout. The value for this attribute must be the name of the method you want to call in response to a click event. The `Activity` hosting the layout must then implement the corresponding method.

Open “developer.android.com/guide/topics/ui/controls/checkbox.html” in a new tab behind the current one



Radio Buttons

Radio buttons allow the user to select one option from a set. You should use radio buttons for optional sets that are mutually exclusive if you think that the user needs to see all available options side-by-side. If it's not necessary to show all options side-by-side, use a spinner instead.

○ Yes ○ Maybe ○ No

To create each radio button option, create a `RadioButton` in your layout. However, because radio buttons are mutually exclusive, you must group them together inside a `RadioGroup`. By grouping them together, the system ensures that only one radio button can be selected at a time.

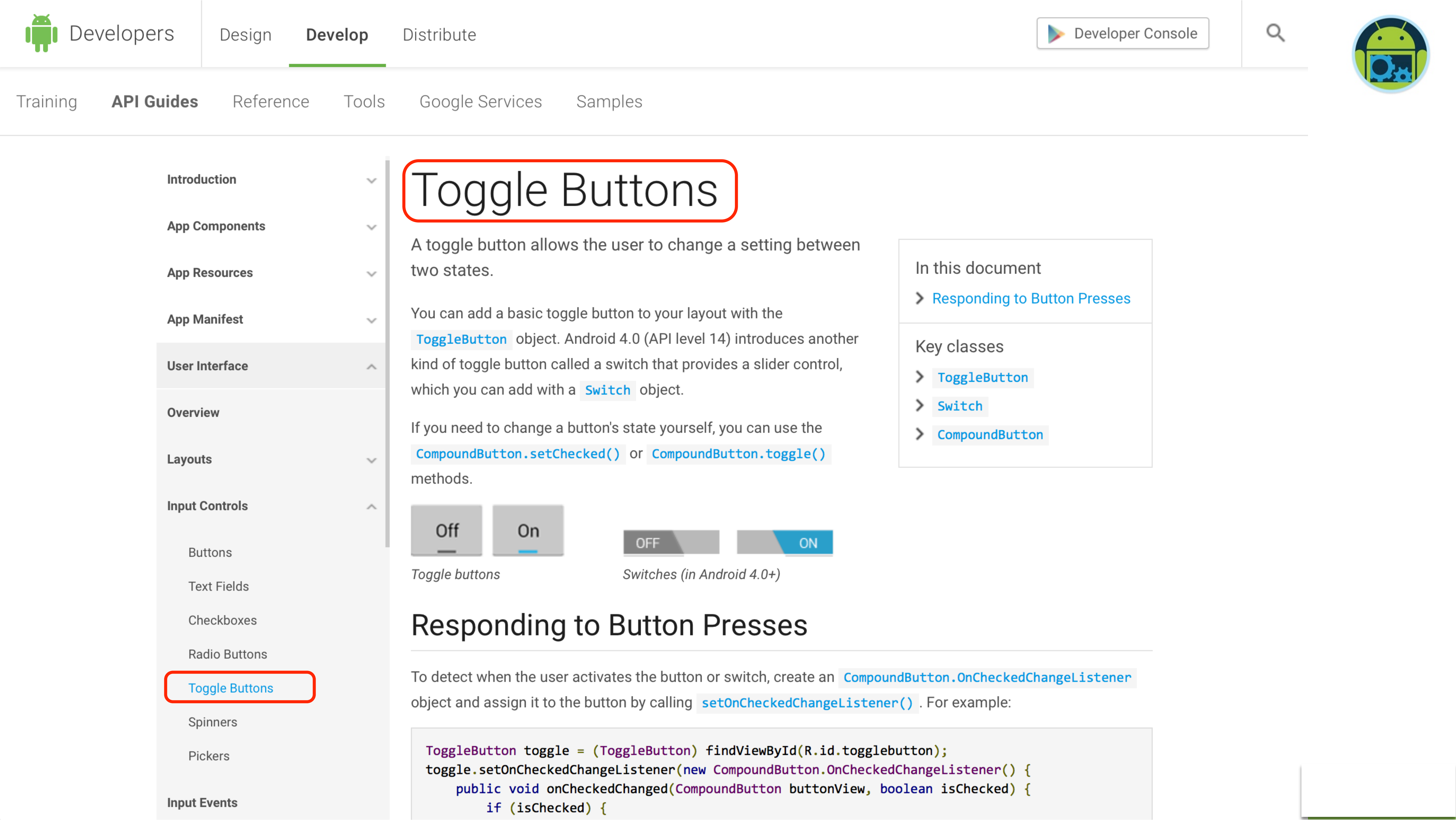
Responding to Click Events

When the user selects one of the radio buttons, the corresponding `RadioButton` object receives an on-click event.

To define the click event handler for a button, add the `android:onClick` attribute to the `<RadioButton>` element in your XML layout. The value for this attribute must be the name of the method you want to call in response to a click event. The `Activity` hosting the layout must then implement the corresponding method.

objects:

Open “developer.android.com/guide/topics/ui/controls/radiobutton.html” in a new tab behind the current one



Toggle Buttons

A toggle button allows the user to change a setting between two states.

You can add a basic toggle button to your layout with the `ToggleButton` object. Android 4.0 (API level 14) introduces another kind of toggle button called a switch that provides a slider control, which you can add with a `Switch` object.

If you need to change a button's state yourself, you can use the `CompoundButton.setChecked()` or `CompoundButton.toggle()` methods.

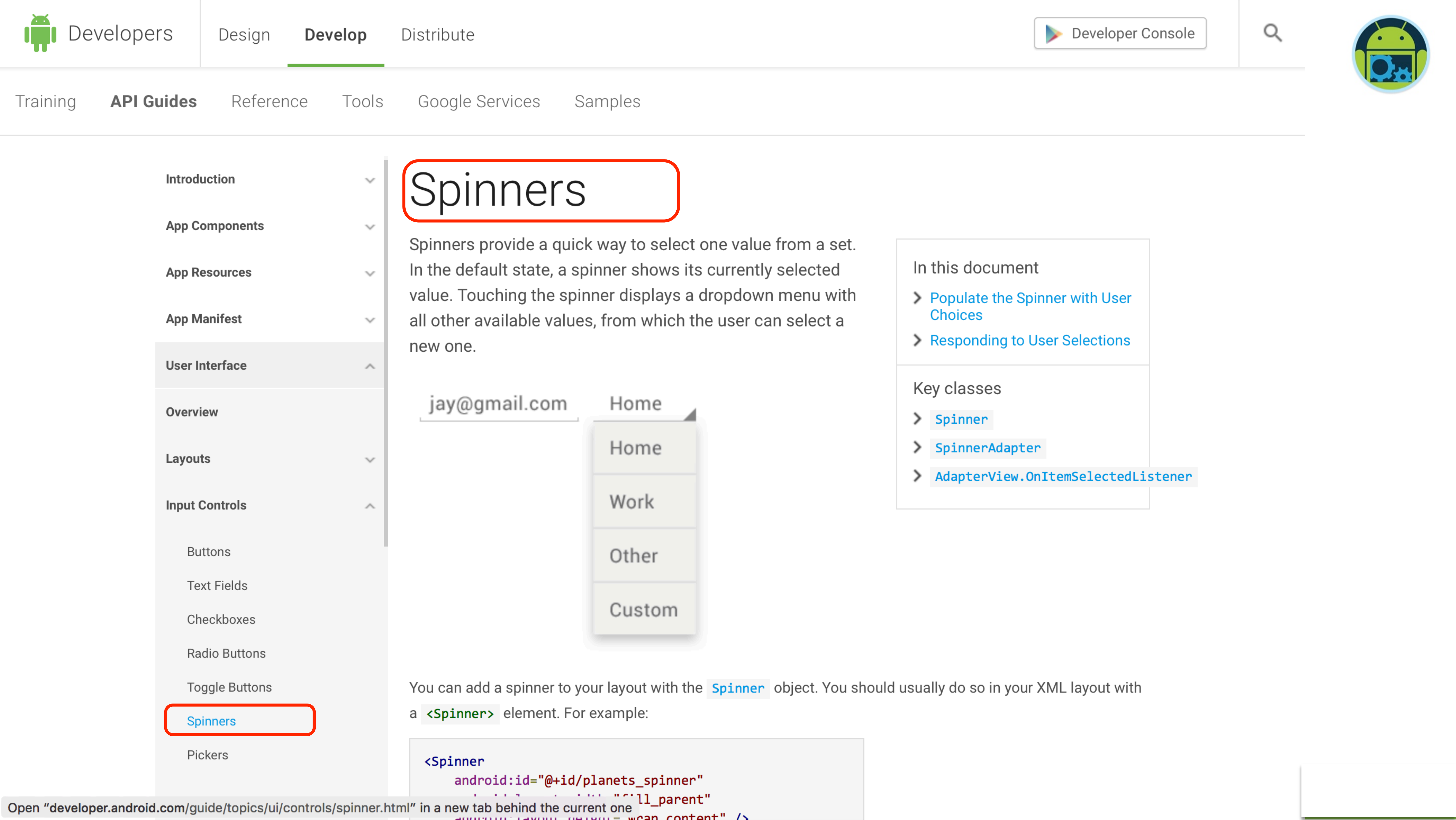
Toggle buttons

Switches (in Android 4.0+)

Responding to Button Presses

To detect when the user activates the button or switch, create an `CompoundButton.OnCheckedChangeListener` object and assign it to the button by calling `setOnCheckedChangeListener()`. For example:

```
ToggleButton toggle = (ToggleButton) findViewById(R.id.togglebutton);
toggle.setOnCheckedChangeListener(new CompoundButton.OnCheckedChangeListener() {
    public void onCheckedChanged(CompoundButton buttonView, boolean isChecked) {
        if (isChecked) {
```



Introduction
App Components
App Resources
App Manifest
User Interface
Overview
Layouts
Input Controls
Buttons
Text Fields
Checkboxes
Radio Buttons
Toggle Buttons
Spinners
Pickers

Spinners

Spinners provide a quick way to select one value from a set. In the default state, a spinner shows its currently selected value. Touching the spinner displays a dropdown menu with all other available values, from which the user can select a new one.

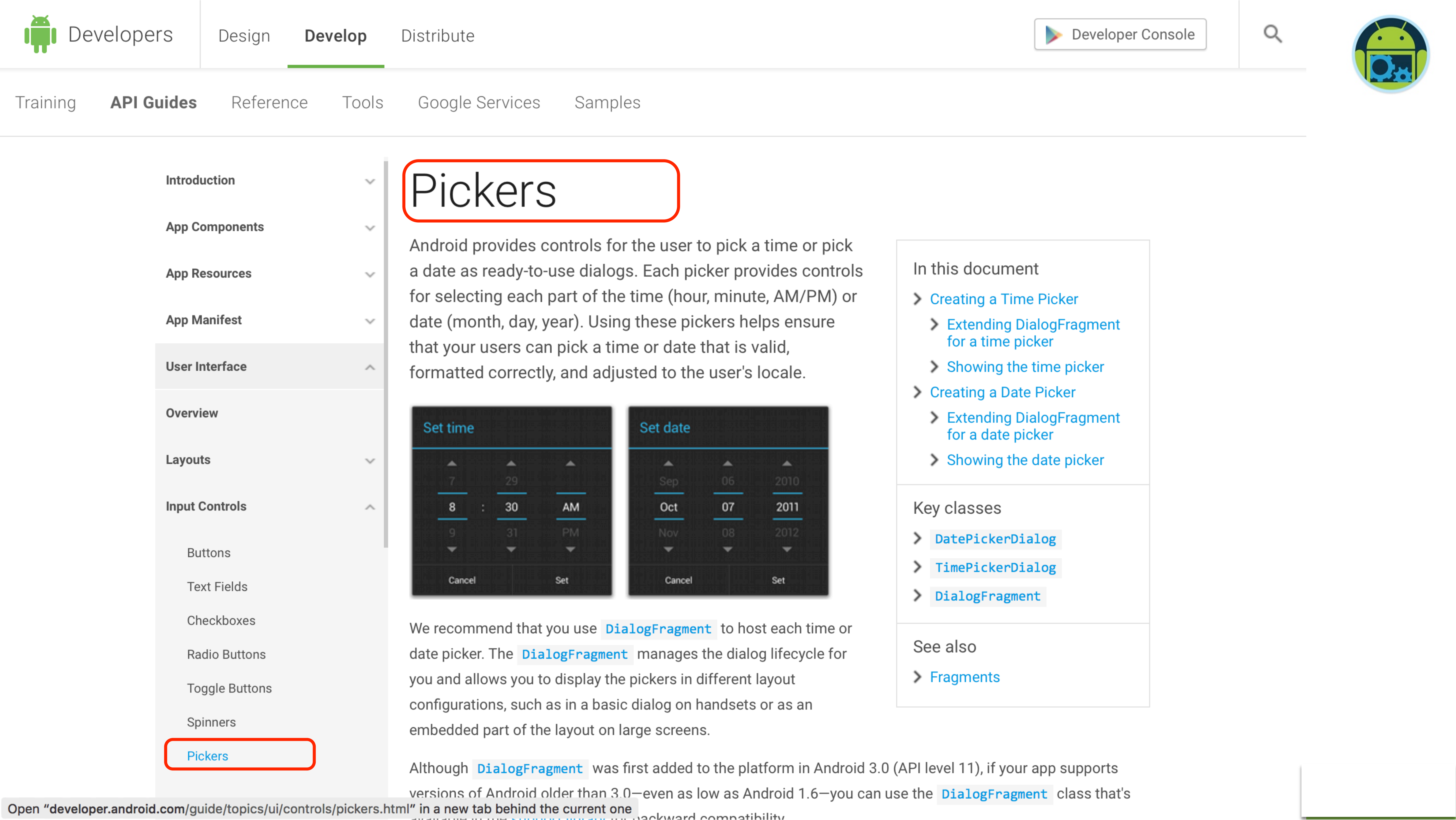
Key classes

- `Spinner`
- `SpinnerAdapter`
- `AdapterView.OnItemSelectedListener`

You can add a spinner to your layout with the `Spinner` object. You should usually do so in your XML layout with a `<Spinner>` element. For example:

```
<Spinner
    android:id="@+id/planets_spinner"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content" />
```

Open “developer.android.com/guide/topics/ui/controls/spinner.html” in a new tab behind the current one



Pickers

Android provides controls for the user to pick a time or pick a date as ready-to-use dialogs. Each picker provides controls for selecting each part of the time (hour, minute, AM/PM) or date (month, day, year). Using these pickers helps ensure that your users can pick a time or date that is valid, formatted correctly, and adjusted to the user's locale.

Key classes
- DatePickerDialog
- TimePickerDialog
- DialogFragment

See also
- Fragments

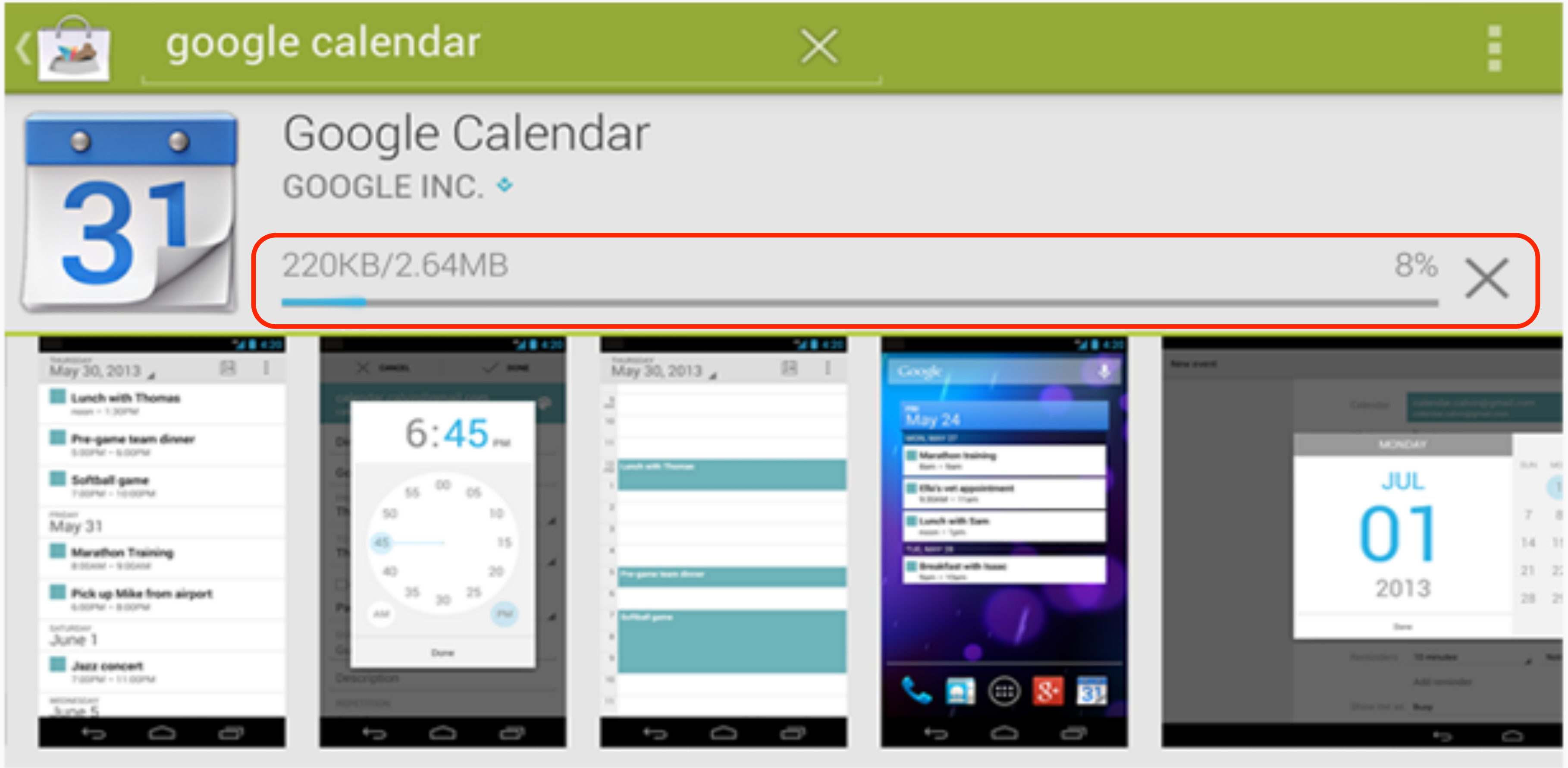
We recommend that you use `DialogFragment` to host each time or date picker. The `DialogFragment` manages the dialog lifecycle for you and allows you to display the pickers in different layout configurations, such as in a basic dialog on handsets or as an embedded part of the layout on large screens.

Although `DialogFragment` was first added to the platform in Android 3.0 (API level 11), if your app supports versions of Android older than 3.0—even as low as Android 1.6—you can use the `DialogFragment` class that's

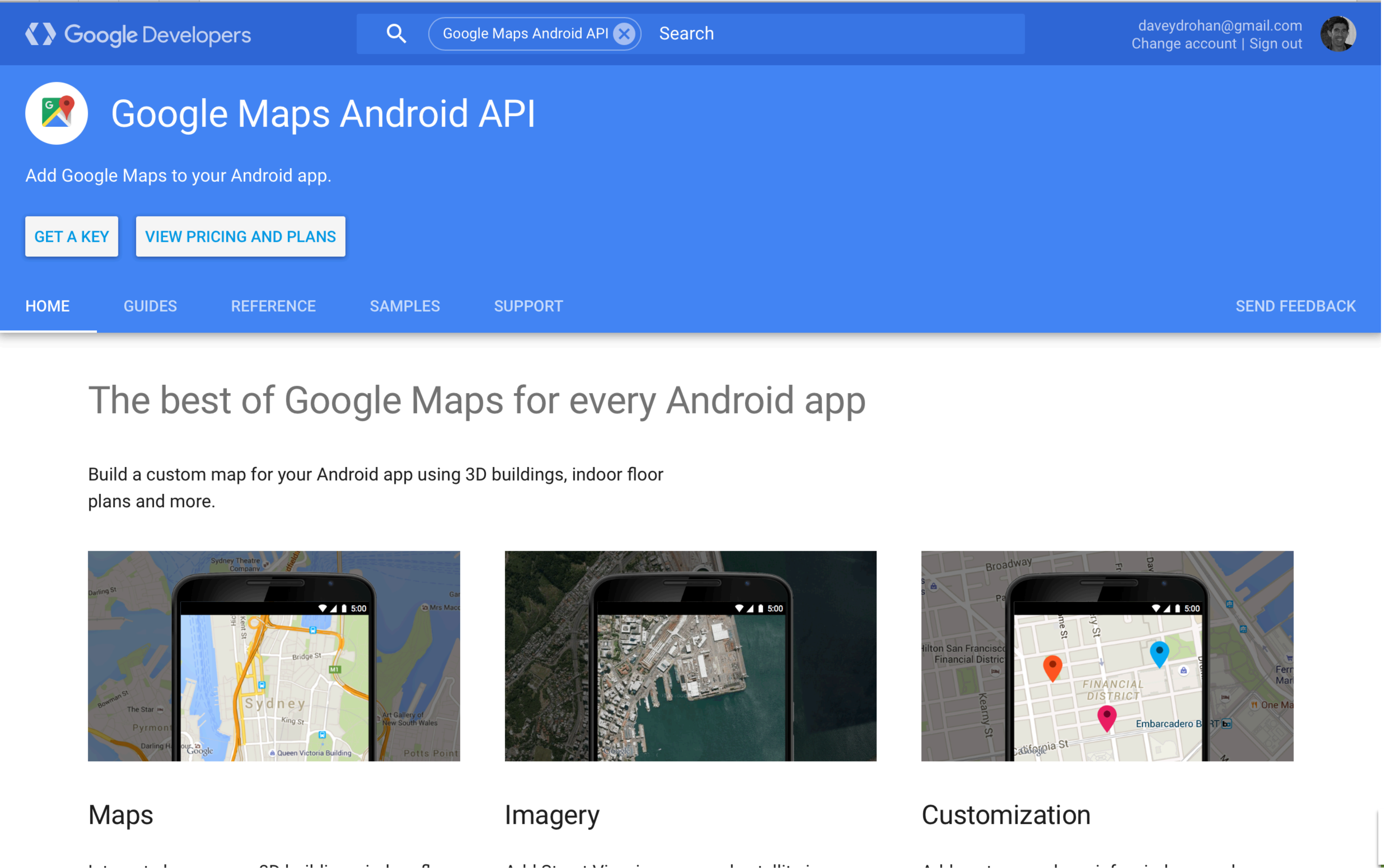
Open "developer.android.com/guide/topics/ui/controls/pickers.html" in a new tab behind the current one

Progress bars

Progress bars are for situations where the percentage completed can be determined. They give users a quick sense of how much longer an operation will take.



A progress bar should always fill from 0% to 100% and never move backwards to a lower value. If multiple operations are happening in sequence, use the progress bar to represent the delay as a whole, so that when the bar reaches 100%, it doesn't return back to 0%.



Google Maps Android API

Add Google Maps to your Android app.

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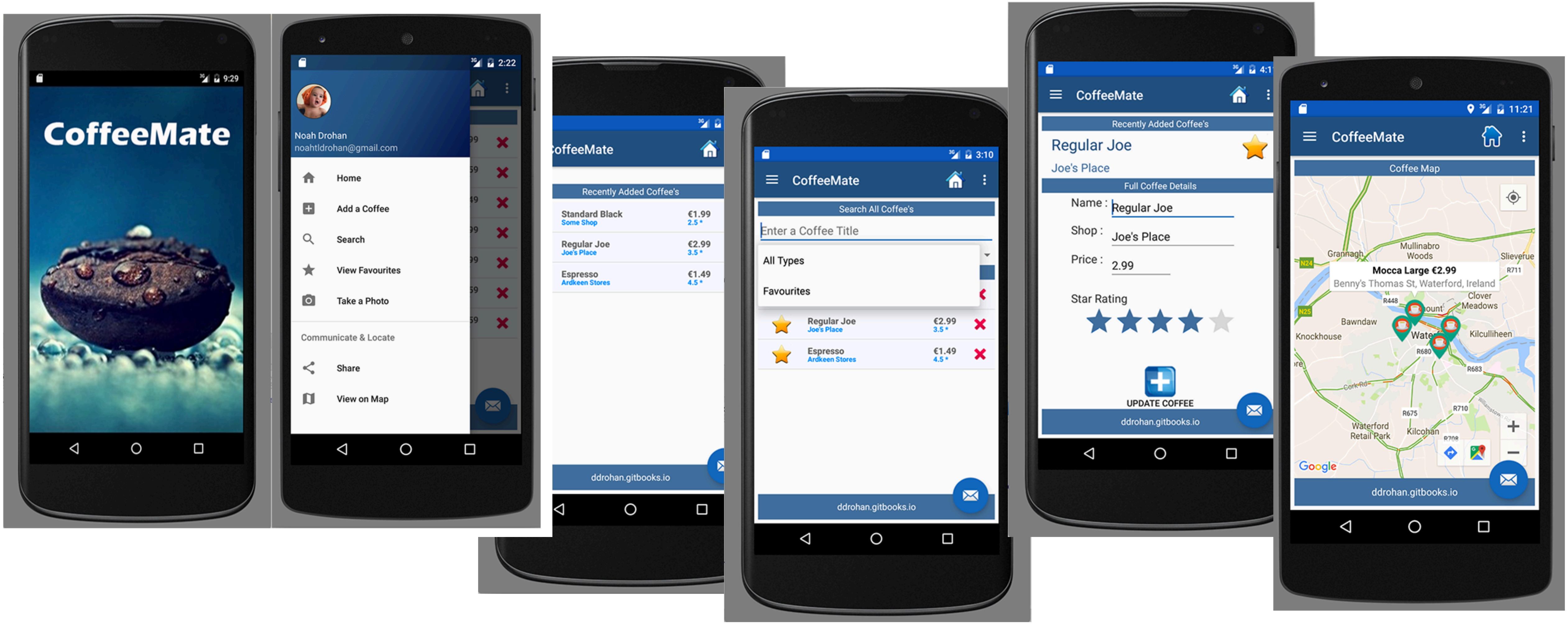
Maps

Imagery

Customization

Ultimate Case Study



offeeMate

Recently Added Coffee's

Standard Black — Some Shop — €1.99 — 2.5 *

Regular Joe — Joe's Place — €2.99 — 3.5 *

Espresso — Ardkeen Stores — €1.49 — 4.5 *

ddrohan.gitbooks.io

Regular Joe — Joe's Place — €2.99 — 3.5 *

Espresso — Ardkeen Stores — €1.49 — 4.5 *

ddrohan.gitbooks.io

Regular Joe

Joe's Place

Full Coffee Details

Name : Regular Joe

Shop : Joe's Place

Price : 2.99

Star Rating

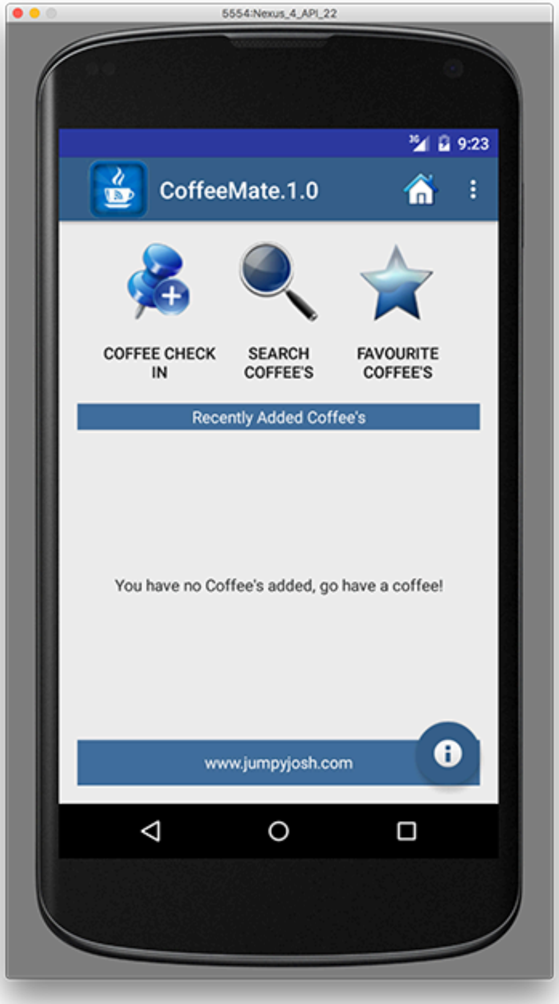
Mocca Large €2.99

Benny's Thomas St, Waterford, Ireland

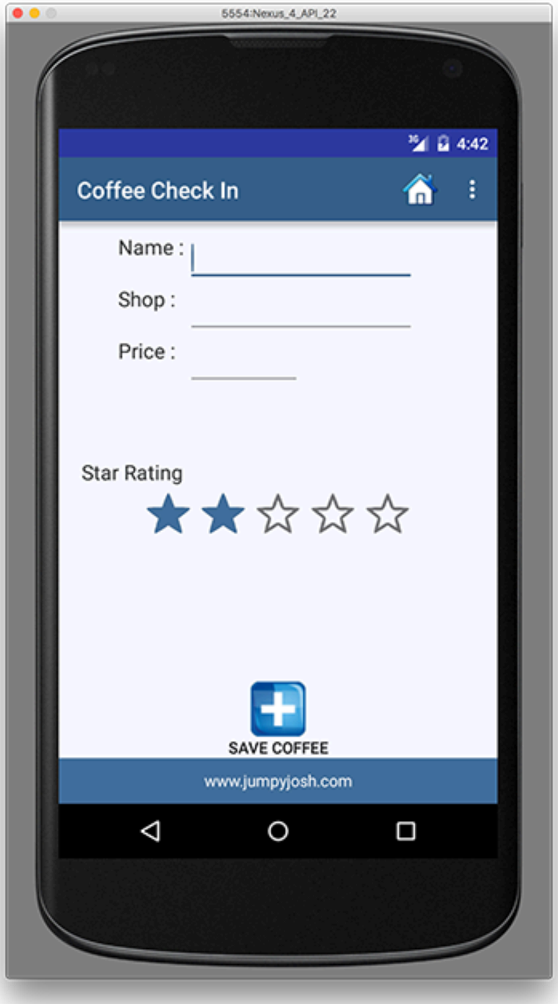
CoffeeMate 1.0

Using Buttons, Multiple Layouts & Menus

CoffeeMate 1.0



You have no Coffee's added, go have a coffee!

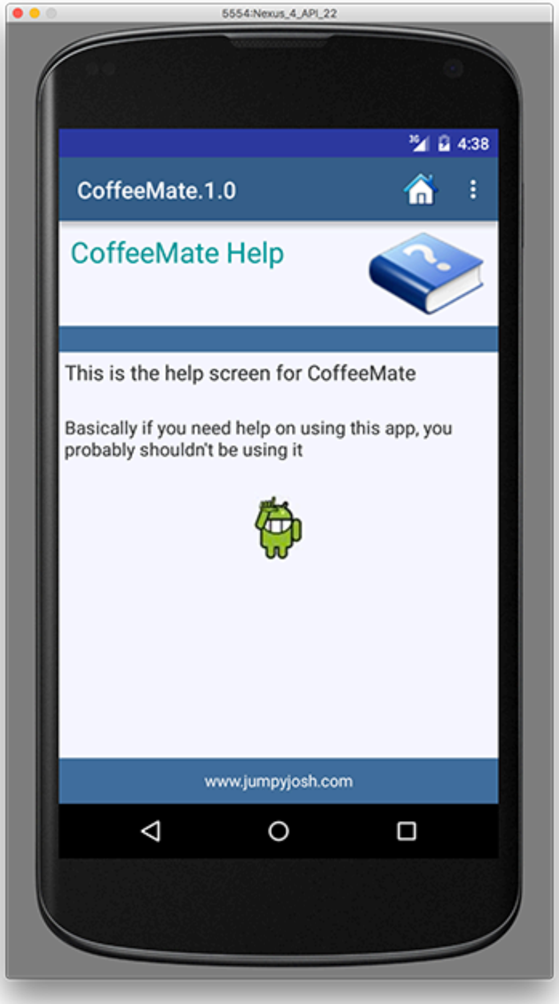


Name :

Shop :

Price :

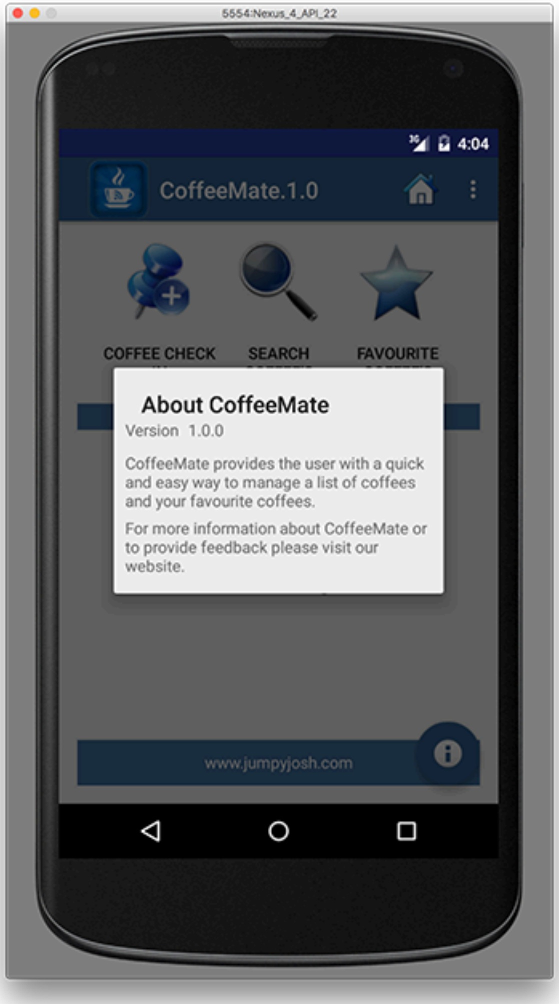
Star Rating



CoffeeMate Help

This is the help screen for CoffeeMate

Basically if you need help on using this app, you probably shouldn't be using it



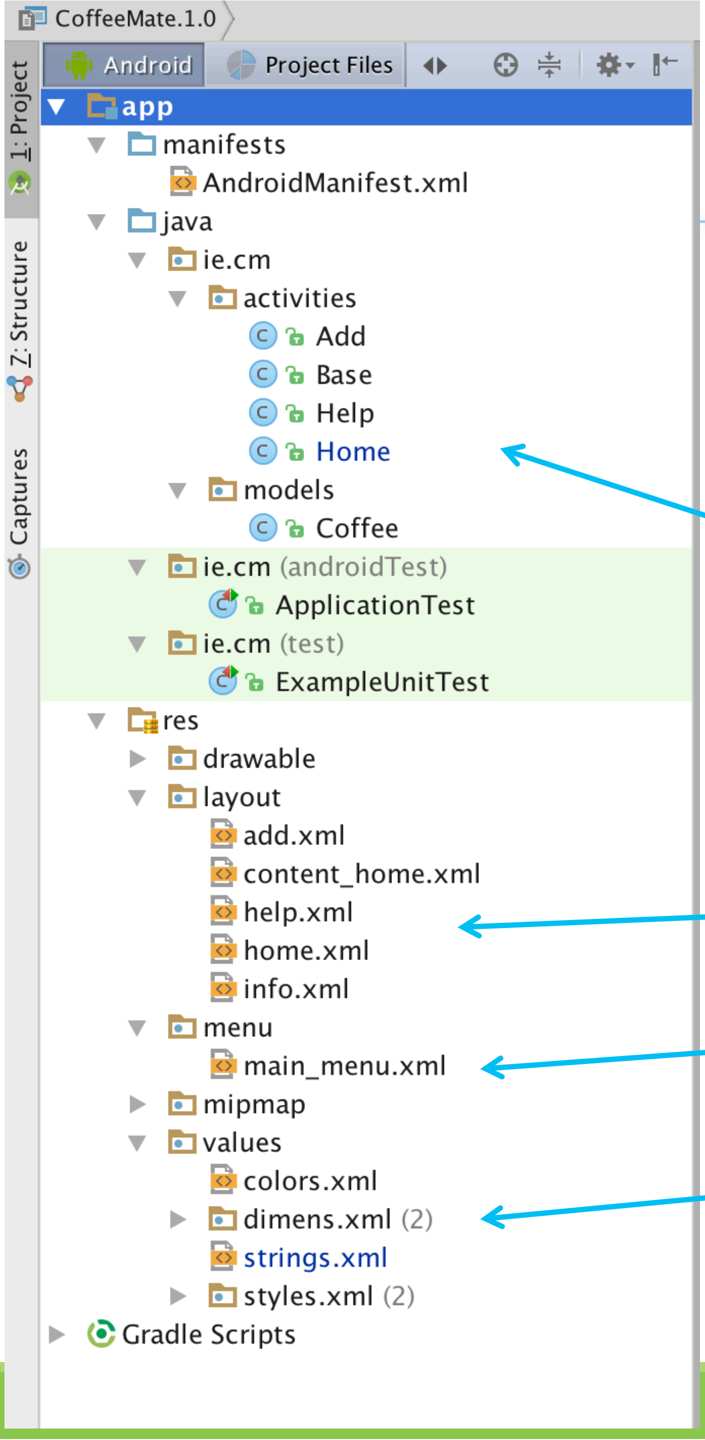
About CoffeeMate

Version 1.0.0

CoffeeMate provides the user with a quick and easy way to manage a list of coffees and your favourite coffees.

For more information about CoffeeMate or to provide feedback please visit our website.

Project Structure – Version 1.0

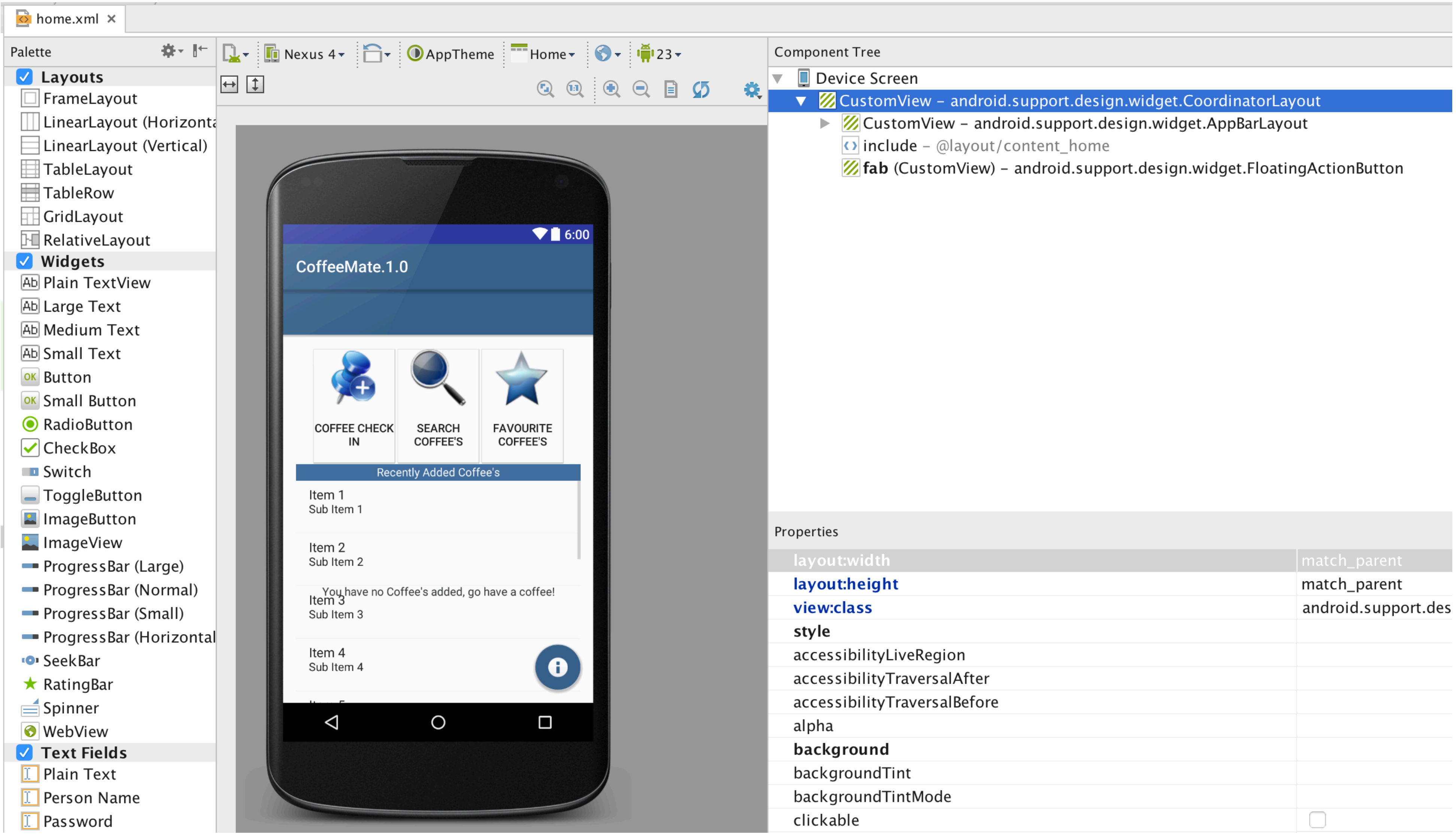


CoffeeMate.1.0

```
▼ app
  ▼ manifests
      AndroidManifest.xml
  ▼ java
    ▼ ie.cm
      ▼ activities
          Add
          Base
          Help
          Home
      ▼ models
          Coffee
    ▼ ie.cm (androidTest)
        ApplicationTest
    ▼ ie.cm (test)
        ExampleUnitTest
  ▼ res
    ▶ drawable
    ▼ layout
        add.xml
        content_home.xml
        help.xml
        home.xml
        info.xml
    ▼ menu
        main_menu.xml
    ▶ mipmap
    ▼ values
        colors.xml
      ▶ dimens.xml (2)
        strings.xml
      ▶ styles.xml (2)
▶ Gradle Scripts
```

- 5 java source files
- 5 xml layouts
- 1 xml file for a menu
- 4 separate xml files for color, string, style & dimension resources

Layout – *home*



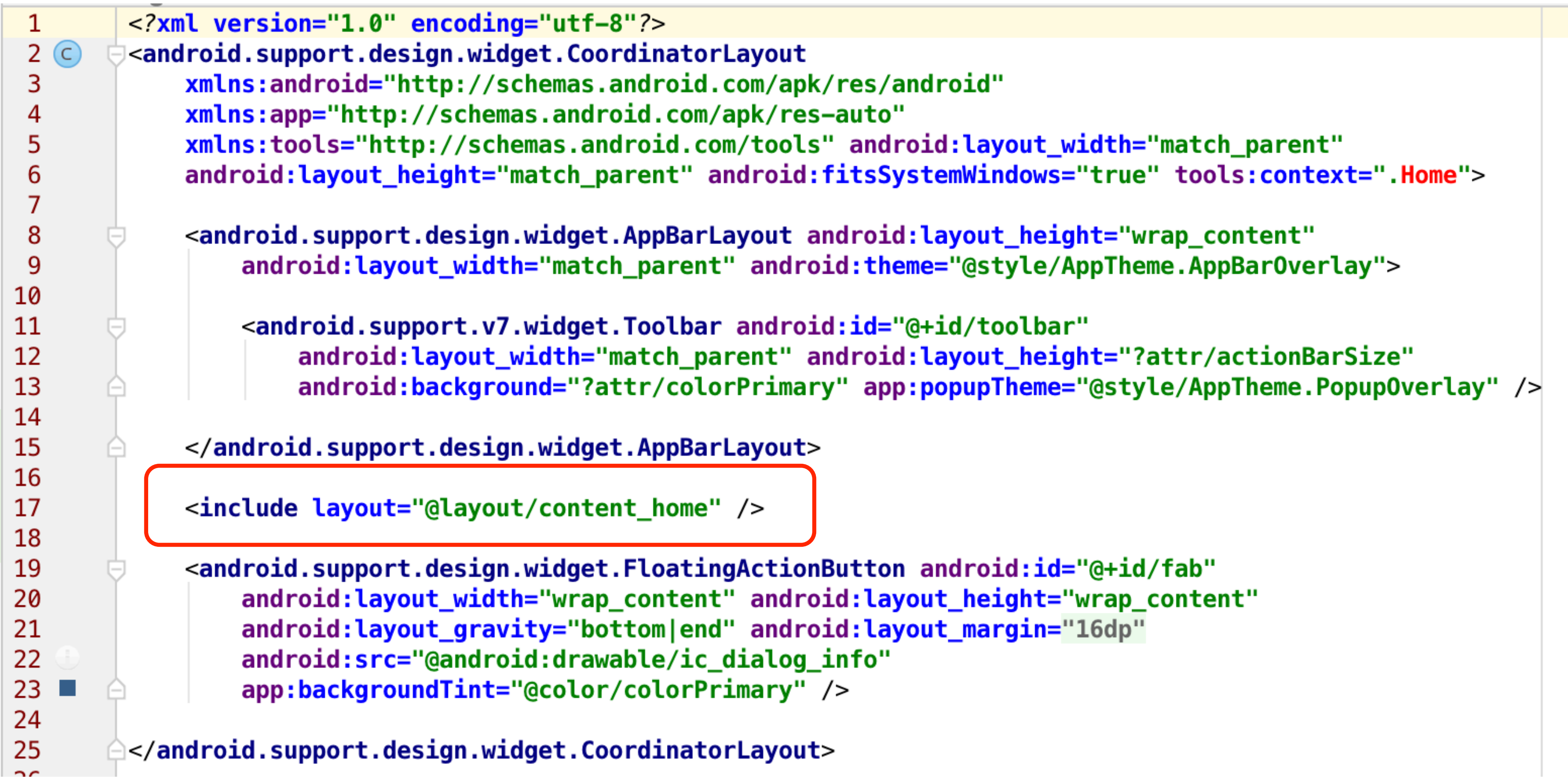
Component Tree

- Device Screen
  - CustomView – android.support.design.widget.CoordinatorLayout
    - CustomView – android.support.design.widget.AppBarLayout
    - include – @layout/content_home
    - fab (CustomView) – android.support.design.widget.FloatingActionButton

Properties

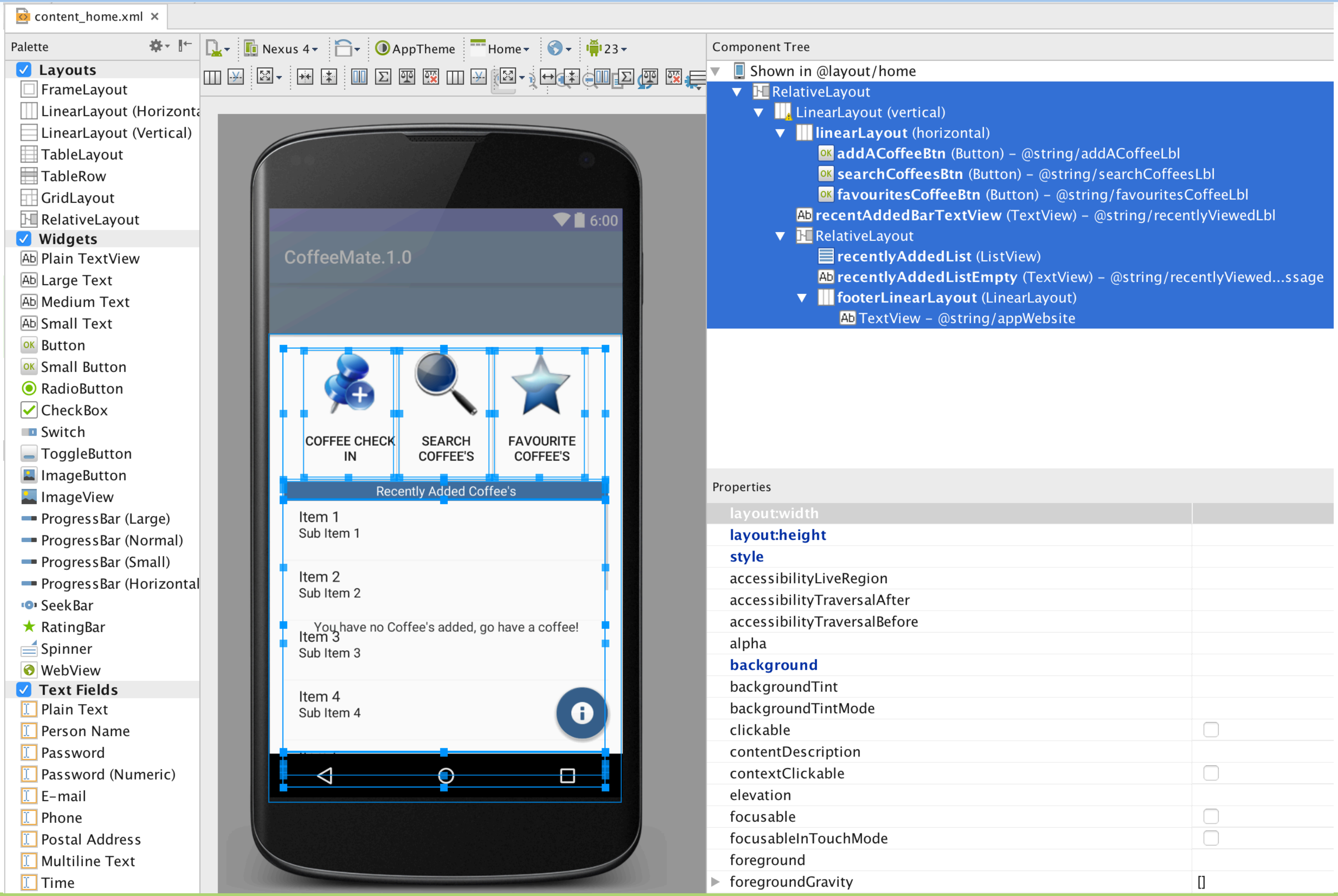
layout:width	match_parent
layout:height	match_parent
view:class	android.support.des
style	
accessibilityLiveRegion	
accessibilityTraversalAfter	
accessibilityTraversalBefore	
alpha	
background	
backgroundTint	
backgroundTintMode	
clickable	□

XML View – *home* *



```xml
<?xml version="1.0" encoding="utf-8"?>
<android.support.design.widget.CoordinatorLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools" android:layout_width="match_parent"
    android:layout_height="match_parent" android:fitsSystemWindows="true" tools:context=".Home">

    <android.support.design.widget.AppBarLayout android:layout_height="wrap_content"
        android:layout_width="match_parent" android:theme="@style/AppTheme.AppBarOverlay">

        <android.support.v7.widget.Toolbar android:id="@+id/toolbar"
            android:layout_width="match_parent" android:layout_height="?attr/actionBarSize"
            android:background="?attr/colorPrimary" app:popupTheme="@style/AppTheme.PopupOverlay" />

    </android.support.design.widget.AppBarLayout>

    <include layout="@layout/content_home" />

    <android.support.design.widget.FloatingActionButton android:id="@+id/fab"
        android:layout_width="wrap_content" android:layout_height="wrap_content"
        android:layout_gravity="bottom|end" android:layout_margin="16dp"
        android:src="@android:drawable/ic_dialog_info"
        app:backgroundTint="@color/colorPrimary" />

</android.support.design.widget.CoordinatorLayout>
```

Layout – *content_home*



Palette

- ☑ **Layouts**
  - FrameLayout
  - LinearLayout (Horizonta
  - LinearLayout (Vertical)
  - TableLayout
  - TableRow
  - GridLayout
  - RelativeLayout
- ☑ **Widgets**
  - Plain TextView
  - Large Text
  - Medium Text
  - Small Text
  - Button
  - Small Button
  - RadioButton
  - CheckBox
  - Switch
  - ToggleButton
  - ImageButton
  - ImageView
  - ProgressBar (Large)
  - ProgressBar (Normal)
  - ProgressBar (Small)
  - ProgressBar (Horizontal
  - SeekBar
  - RatingBar
  - Spinner
  - WebView
- ☑ **Text Fields**
  - Plain Text
  - Person Name
  - Password
  - Password (Numeric)
  - E-mail
  - Phone
  - Postal Address
  - Multiline Text
  - Time

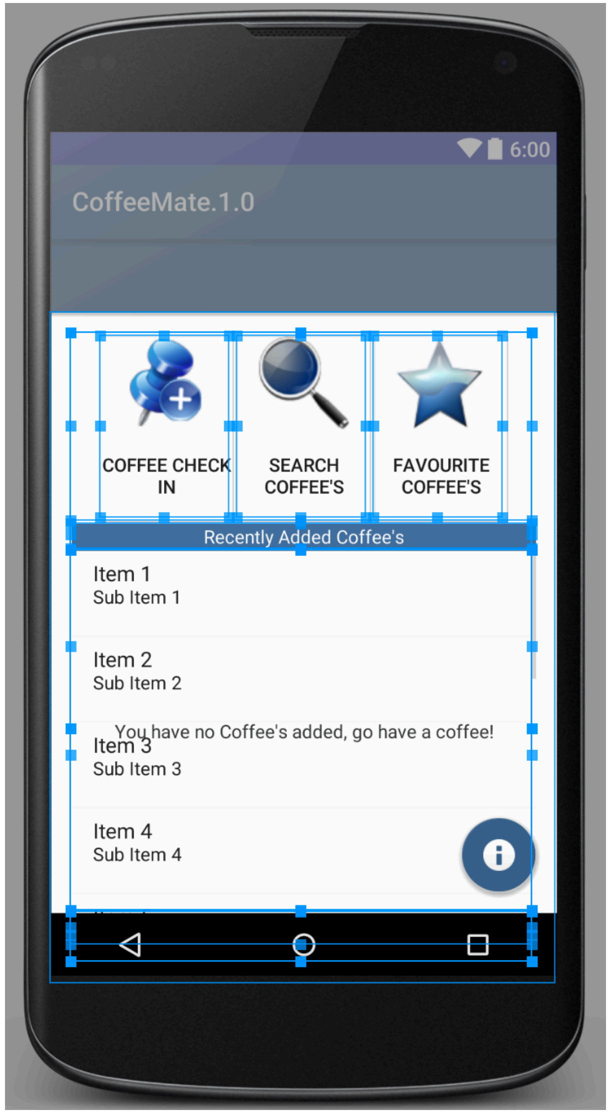
Component Tree

- Shown in @layout/home
  - RelativeLayout
    - LinearLayout (vertical)
      - **linearLayout** (horizontal)
        - **addACoffeeBtn** (Button) – @string/addACoffeeLbl
        - **searchCoffeesBtn** (Button) – @string/searchCoffeesLbl
        - **favouritesCoffeeBtn** (Button) – @string/favouritesCoffeeLbl
      - **recentAddedBarTextView** (TextView) – @string/recentlyViewedLbl
      - RelativeLayout
        - **recentlyAddedList** (ListView)
        - **recentlyAddedListEmpty** (TextView) – @string/recentlyViewed...ssage
        - **footerLinearLayout** (LinearLayout)
          - TextView – @string/appWebsite

Properties

- layout:width
- **layout:height**
- **style**
- accessibilityLiveRegion
- accessibilityTraversalAfter
- accessibilityTraversalBefore
- alpha
- **background**
- backgroundTint
- backgroundTintMode
- clickable □
- contentDescription
- contextClickable □
- elevation
- focusable □
- focusableInTouchMode □
- foreground
- foregroundGravity []

Layout – Outline View *



Recently Added Coffee's

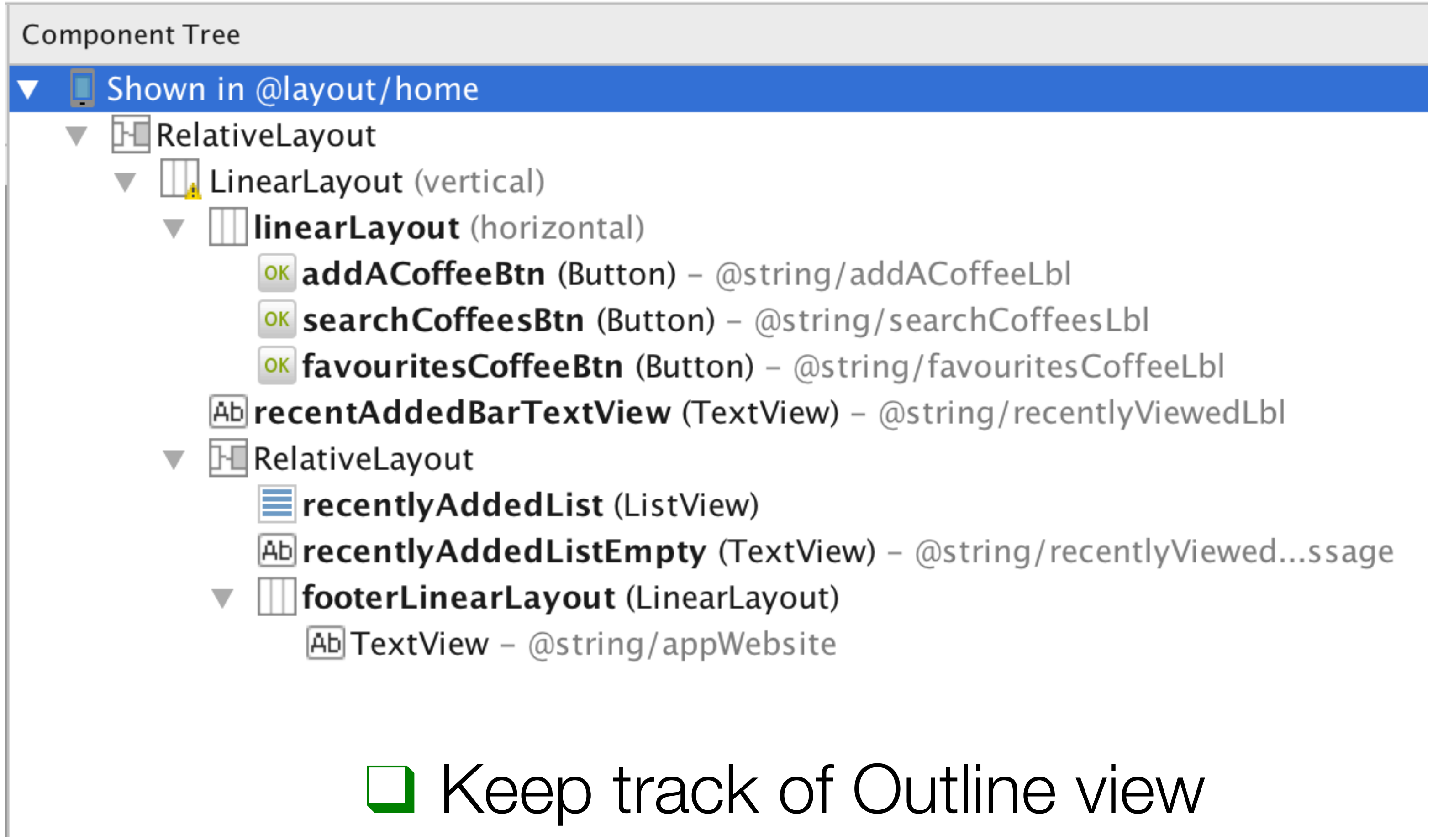
Item 1
Sub Item 1

Item 2
Sub Item 2

You have no Coffee's added, go have a coffee!

Item 3
Sub Item 3

Item 4
Sub Item 4

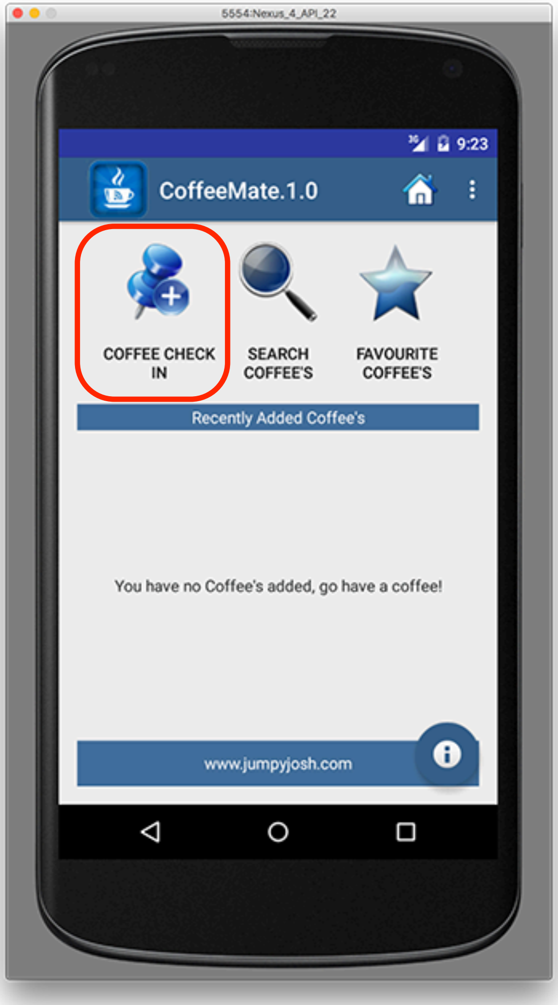


Component Tree

- Shown in @layout/home
  - RelativeLayout
    - LinearLayout (vertical)
      - **linearLayout** (horizontal)
        - OK **addACoffeeBtn** (Button) – @string/addACoffeeLbl
        - OK **searchCoffeesBtn** (Button) – @string/searchCoffeesLbl
        - OK **favouritesCoffeeBtn** (Button) – @string/favouritesCoffeeLbl
      - Ab **recentAddedBarTextView** (TextView) – @string/recentlyViewedLbl
      - RelativeLayout
        - **recentlyAddedList** (ListView)
        - Ab **recentlyAddedListEmpty** (TextView) – @string/recentlyViewed...ssage
        - **footerLinearLayout** (LinearLayout)
          - Ab TextView – @string/appWebsite

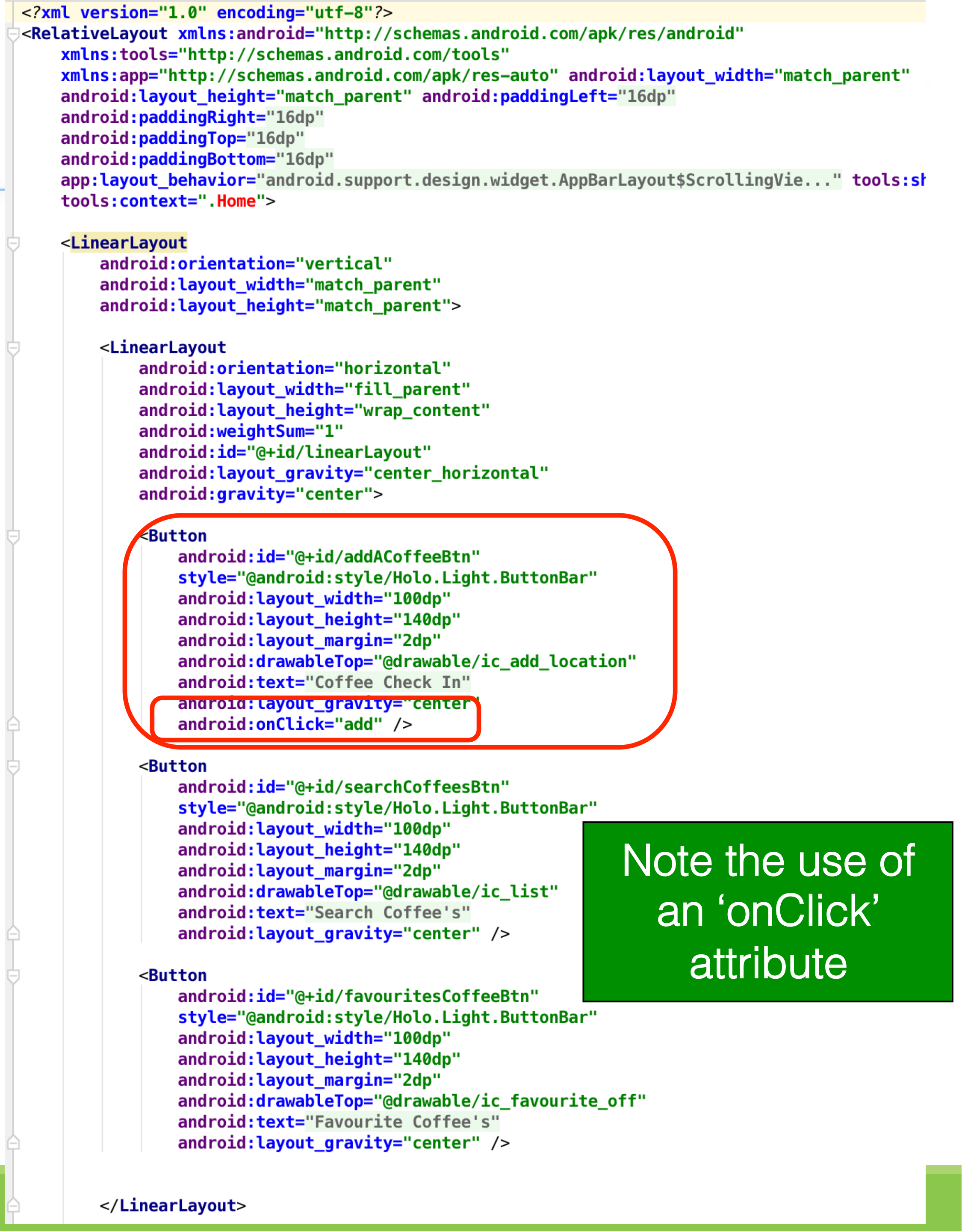
- ❑ Keep track of Outline view
- ❑ Name controls appropriately

XML View - content_home *



This part defines the 3 buttons shown on the layout summary slide. Each button is given an id so that it can be found in Java via ‘findViewById’, then assigned an event handler via setOnClickListener (or onClick)

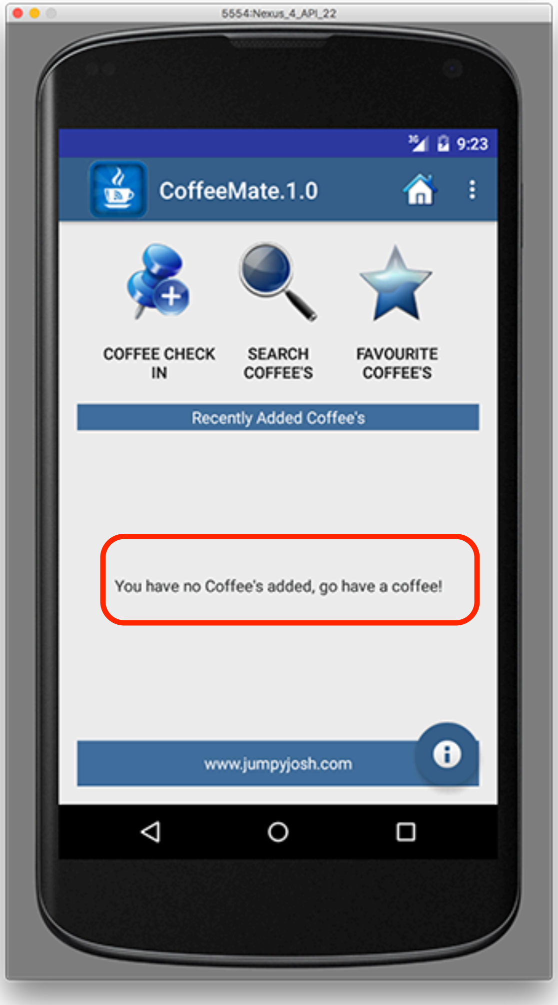
The text (Button label) is taken from strings.xml instead of entered directly here, because the same label will also be used for other widgets later on.



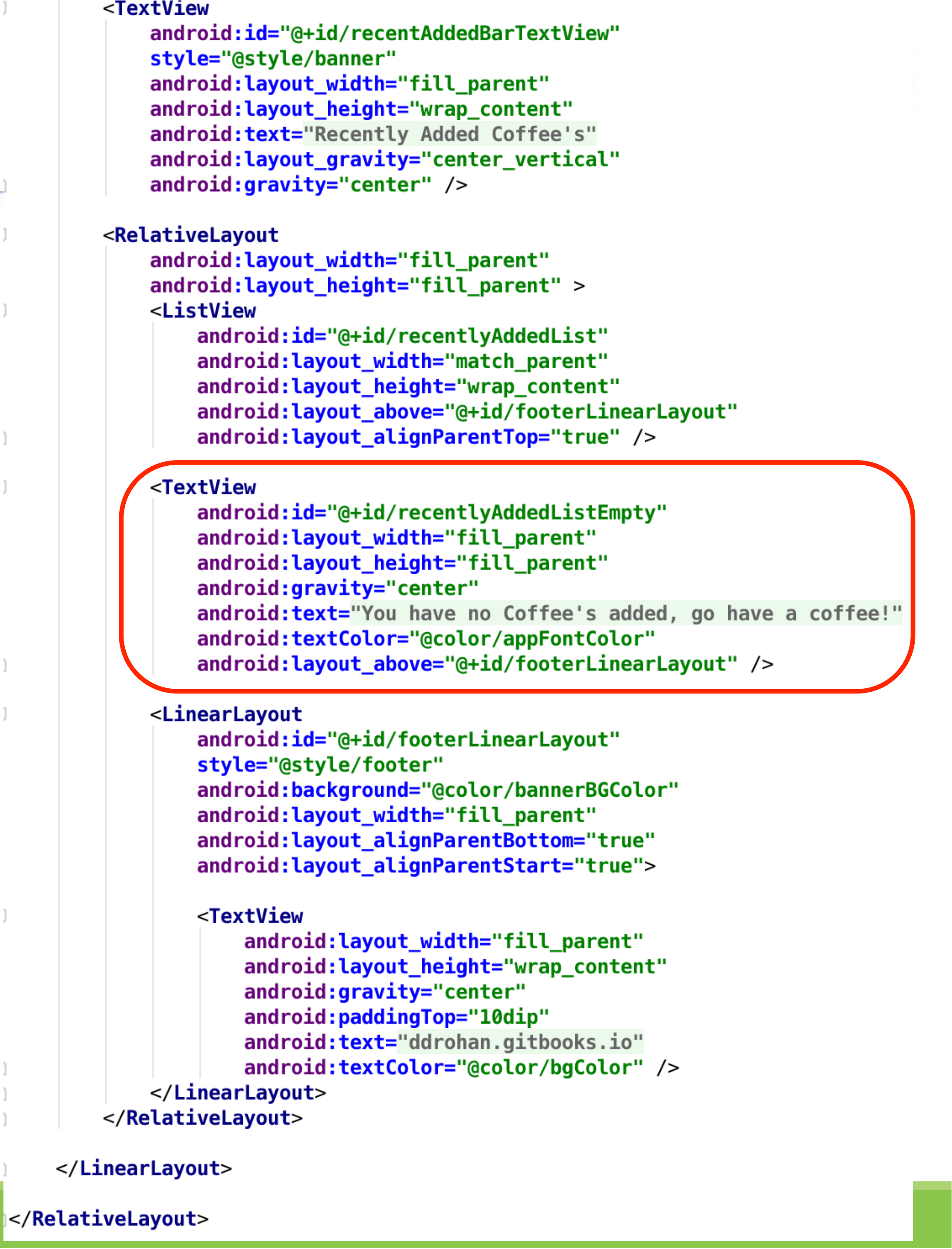
```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    xmlns:app="http://schemas.android.com/apk/res-auto" android:layout_width="match_parent"
    android:layout_height="match_parent" android:paddingLeft="16dp"
    android:paddingRight="16dp"
    android:paddingTop="16dp"
    android:paddingBottom="16dp"
    app:layout_behavior="android.support.design.widget.AppBarLayout$ScrollingVie..." tools:sh
    tools:context=".Home">

    <LinearLayout
        android:orientation="vertical"
        android:layout_width="match_parent"
        android:layout_height="match_parent">

        <LinearLayout
            android:orientation="horizontal"
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            android:weightSum="1"
            android:id="@+id/linearLayout"
            android:layout_gravity="center_horizontal"
            android:gravity="center">

            <Button
                android:id="@+id/addACoffeeBtn"
                style="@android:style/Holo.Light.ButtonBar"
                android:layout_width="100dp"
                android:layout_height="140dp"
                android:layout_margin="2dp"
                android:drawableTop="@drawable/ic_add_location"
                android:text="Coffee Check In"
                android:layout_gravity="center"
                android:onClick="add" />

            <Button
                android:id="@+id/searchCoffeesBtn"
                style="@android:style/Holo.Light.ButtonBar"
                android:layout_width="100dp"
                android:layout_height="140dp"
                android:layout_margin="2dp"
                android:drawableTop="@drawable/ic_list"
                android:text="Search Coffee's"
                android:layout_gravity="center" />

            <Button
                android:id="@+id/favouritesCoffeeBtn"
                style="@android:style/Holo.Light.ButtonBar"
                android:layout_width="100dp"
                android:layout_height="140dp"
                android:layout_margin="2dp"
                android:drawableTop="@drawable/ic_favourite_off"
                android:text="Favourite Coffee's"
                android:layout_gravity="center" />


        </LinearLayout>
```

Note the use of an ‘onClick’ attribute

XML View - content_home *

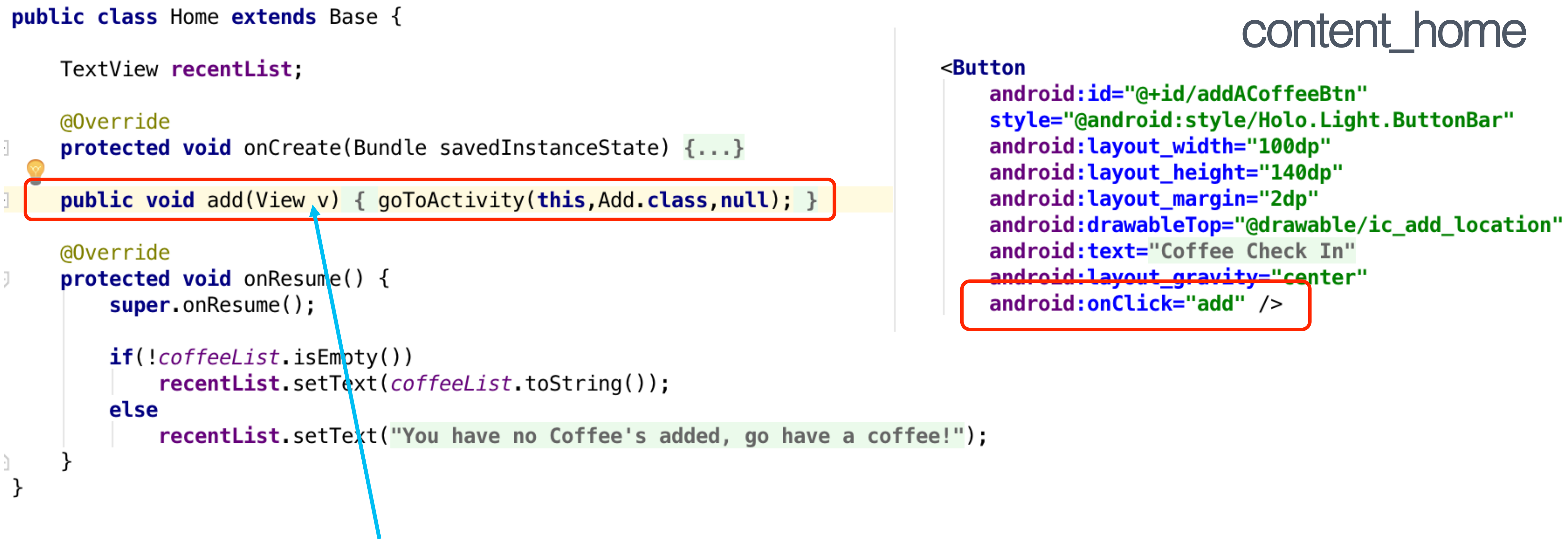


The add and help screens are built and designed in a similar manner



```
        <TextView
            android:id="@+id/recentAddedBarTextView"
            style="@style/banner"
            android:layout_width="fill_parent"
            android:layout_height="wrap_content"
            android:text="Recently Added Coffee's"
            android:layout_gravity="center_vertical"
            android:gravity="center" />

        <RelativeLayout
            android:layout_width="fill_parent"
            android:layout_height="fill_parent" >
            <ListView
                android:id="@+id/recentlyAddedList"
                android:layout_width="match_parent"
                android:layout_height="wrap_content"
                android:layout_above="@+id/footerLinearLayout"
                android:layout_alignParentTop="true" />

            <TextView
                android:id="@+id/recentlyAddedListEmpty"
                android:layout_width="fill_parent"
                android:layout_height="fill_parent"
                android:gravity="center"
                android:text="You have no Coffee's added, go have a coffee!"
                android:textColor="@color/appFontColor"
                android:layout_above="@+id/footerLinearLayout" />

            <LinearLayout
                android:id="@+id/footerLinearLayout"
                style="@style/footer"
                android:background="@color/bannerBGColor"
                android:layout_width="fill_parent"
                android:layout_alignParentBottom="true"
                android:layout_alignParentStart="true">

                <TextView
                    android:layout_width="fill_parent"
                    android:layout_height="wrap_content"
                    android:gravity="center"
                    android:paddingTop="10dip"
                    android:text="ddrohan.gitbooks.io"
                    android:textColor="@color/bgColor" />
            </LinearLayout>
        </RelativeLayout>

    </LinearLayout>

</RelativeLayout>
```

CoffeeMate Event Handler *



```java
public class Home extends Base {

    TextView recentList;

    @Override
    protected void onCreate(Bundle savedInstanceState) {...}

    public void add(View v) { goToActivity(this,Add.class,null); }

    @Override
    protected void onResume() {
        super.onResume();

        if(!coffeeList.isEmpty())
            recentList.setText(coffeeList.toString());
        else
            recentList.setText("You have no Coffee's added, go have a coffee!");
    }
}
```

content_home

```xml
<Button
    android:id="@+id/addACoffeeBtn"
    style="@android:style/Holo.Light.ButtonBar"
    android:layout_width="100dp"
    android:layout_height="140dp"
    android:layout_margin="2dp"
    android:drawableTop="@drawable/ic_add_location"
    android:text="Coffee Check In"
    android:layout_gravity="center"
    android:onClick="add" />
```

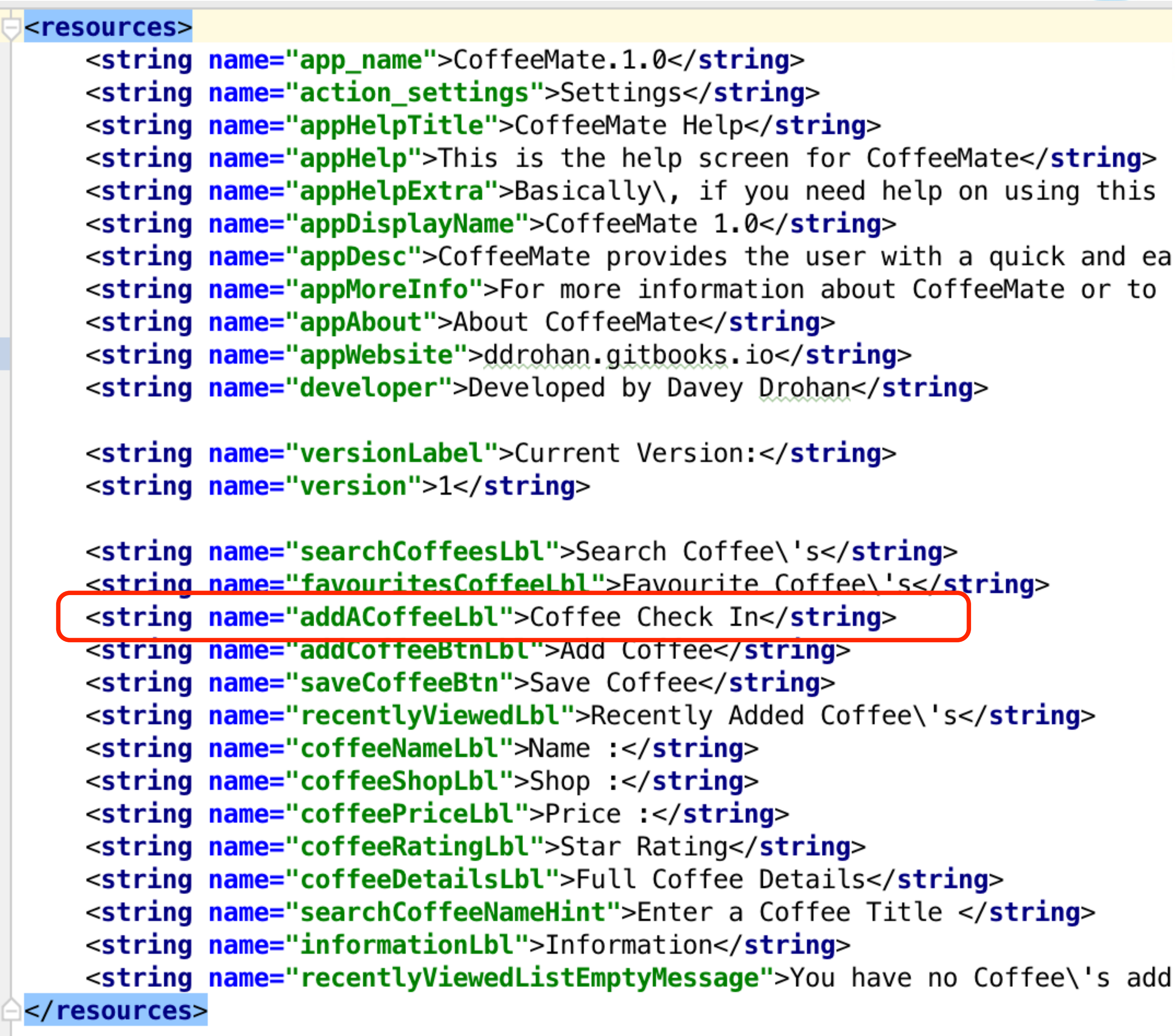
Note the use of a ‘View’ object

strings.xml *

content_home.xml (and the other layouts) refer to these names with @string/appName, @string/addACoffeeLbl etc.

Each string is used as a resource for one or more of the widgets on out layouts.

colors.xml & styles.xml are very similar in terms of content

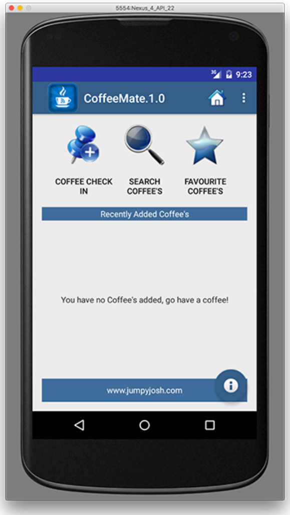


```
<resources>
    <string name="app_name">CoffeeMate.1.0</string>
    <string name="action_settings">Settings</string>
    <string name="appHelpTitle">CoffeeMate Help</string>
    <string name="appHelp">This is the help screen for CoffeeMate</string>
    <string name="appHelpExtra">Basically\, if you need help on using this
    <string name="appDisplayName">CoffeeMate 1.0</string>
    <string name="appDesc">CoffeeMate provides the user with a quick and ea
    <string name="appMoreInfo">For more information about CoffeeMate or to
    <string name="appAbout">About CoffeeMate</string>
    <string name="appWebsite">ddrohan.gitbooks.io</string>
    <string name="developer">Developed by Davey Drohan</string>

    <string name="versionLabel">Current Version:</string>
    <string name="version">1</string>

    <string name="searchCoffeesLbl">Search Coffee\'s</string>
    <string name="favouritesCoffeeLbl">Favourite Coffee\'s</string>
    <string name="addACoffeeLbl">Coffee Check In</string>
    <string name="addCoffeeBtnLbl">Add Coffee</string>
    <string name="saveCoffeeBtn">Save Coffee</string>
    <string name="recentlyViewedLbl">Recently Added Coffee\'s</string>
    <string name="coffeeNameLbl">Name :</string>
    <string name="coffeeShopLbl">Shop :</string>
    <string name="coffeePriceLbl">Price :</string>
    <string name="coffeeRatingLbl">Star Rating</string>
    <string name="coffeeDetailsLbl">Full Coffee Details</string>
    <string name="searchCoffeeNameHint">Enter a Coffee Title </string>
    <string name="informationLbl">Information</string>
    <string name="recentlyViewedListEmptyMessage">You have no Coffee\'s add
</resources>
```

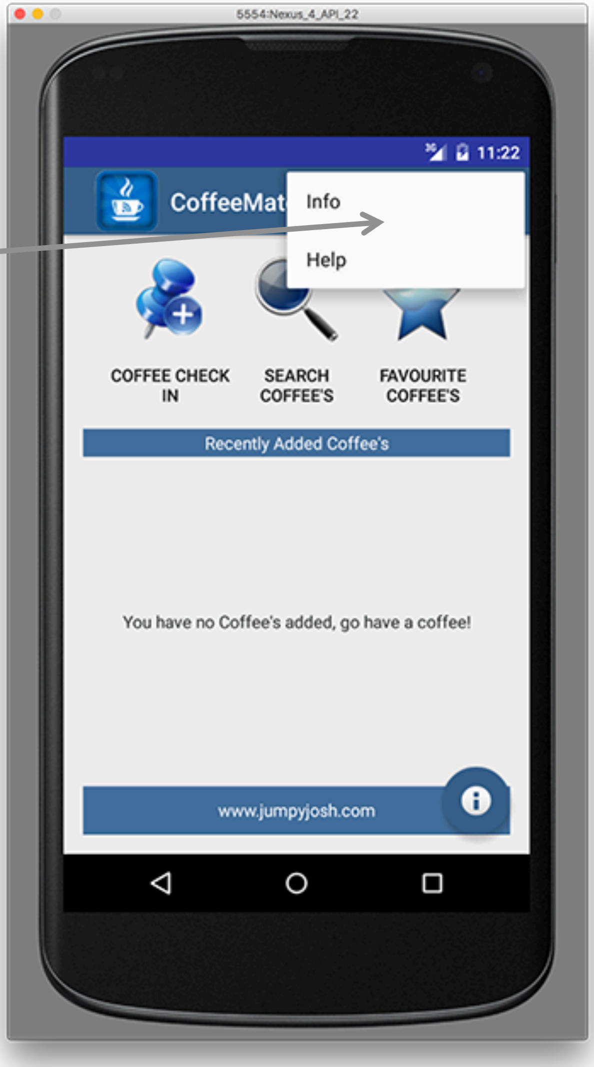
Menus in *CoffeeMate*

Pressing the “Menu” button on the emulator brings up a menu with the following entries

(we’ll modify this slightly in CoffeeMate 2.0)



You have no Coffee's added, go have a coffee!



You have no Coffee's added, go have a coffee!

Menus

- Menus are a common user interface component in many types of applications.
- To provide a familiar and consistent user experience, you should use the Menu APIs to present user actions and other options in your activities.
- Beginning with Android 3.0 (API level 11), Android-powered devices are no longer required to provide a dedicated *Menu* button.
  - instead provide an **action bar** to present common user actions.

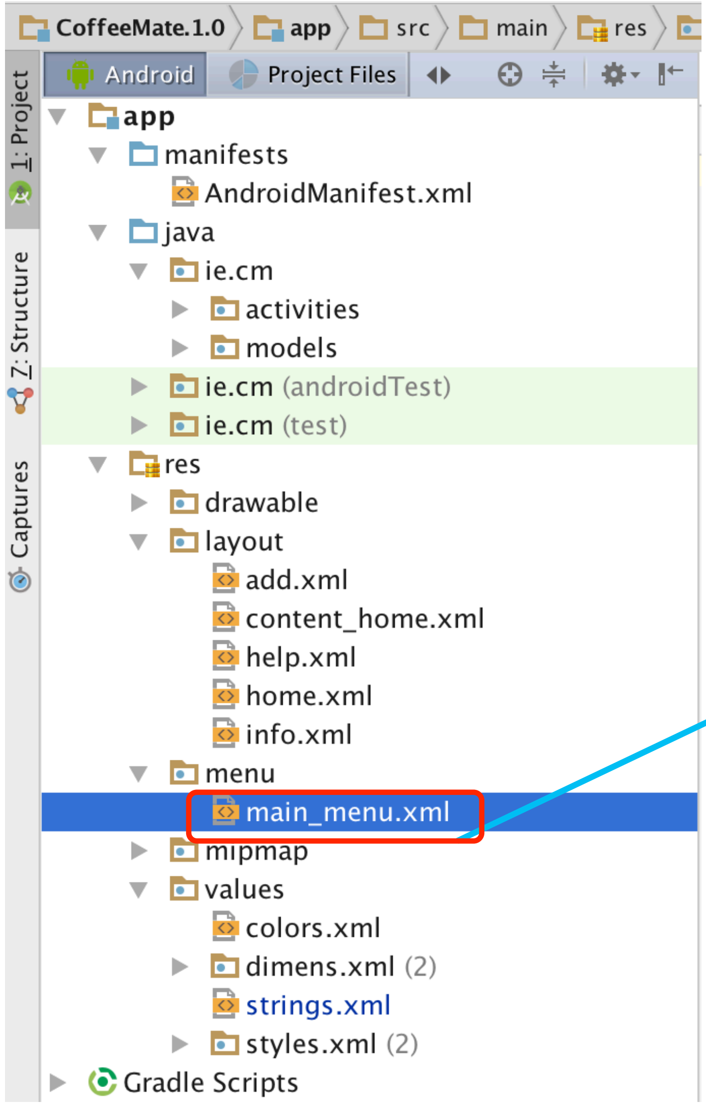
Options Menu & Action Bar

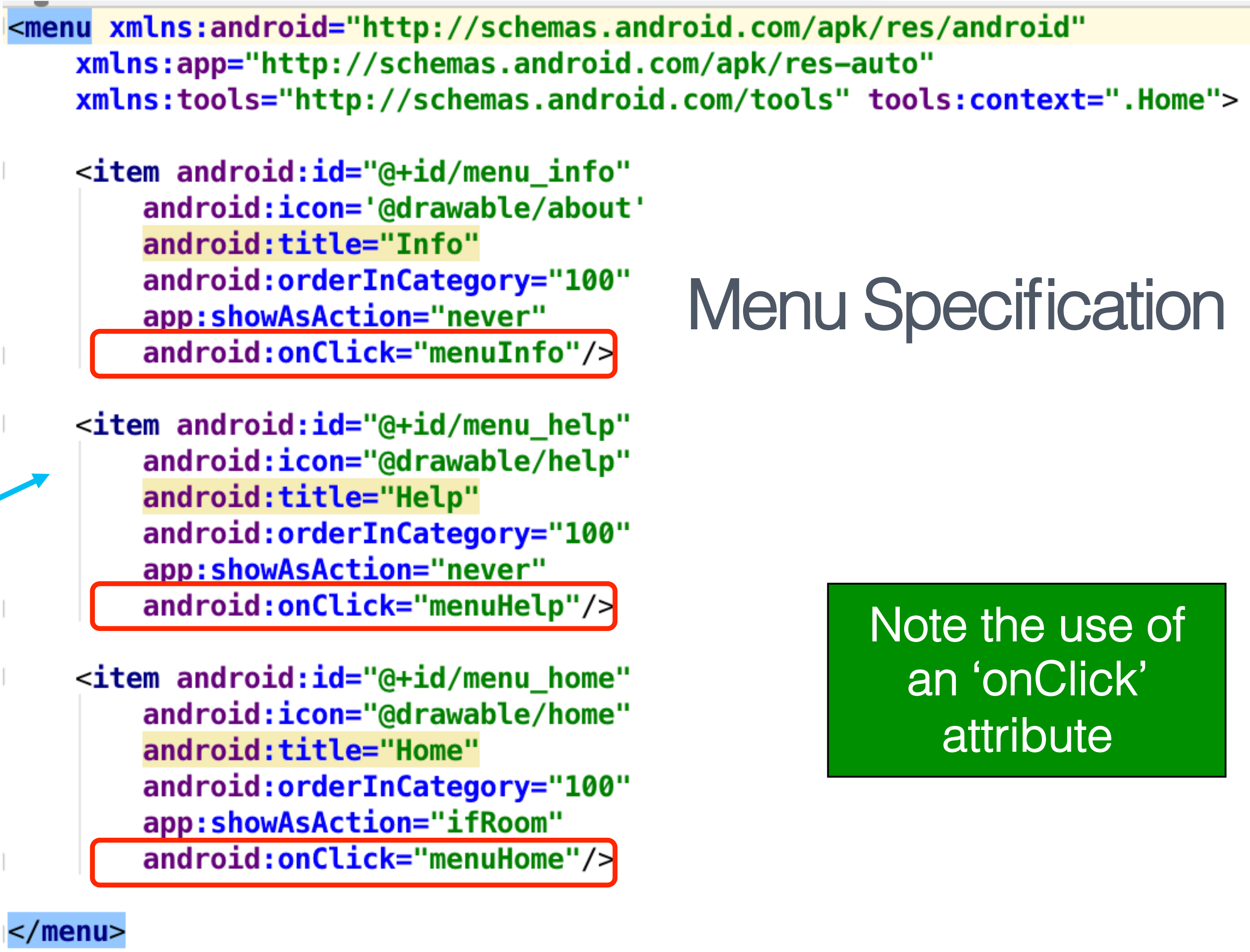
- The options menu is the primary collection of menu items for an activity.
  - It's where you should place actions that have a global impact on the app, such as “Info”, “Help” and “Home” etc.
- If you're developing for Android 2.3 or lower, users can reveal the options menu panel by pressing the *Menu* button.
- On Android 3.0 and higher, items from the options menu are presented by the action bar as a combination of on-screen action items and overflow options.

Enabling/Disabling Menu Items on the fly

- There may be times where you don’t want all your menu options available to the user under certain situations
  - e.g – if you’ve no donations, why let them see the report?
- You can modify the options menu at runtime by overriding the ***`onPrepareOptionsMenu`*** method
  - called each and every time the user presses the *MENU* button.

Menus in *CoffeeMate* *





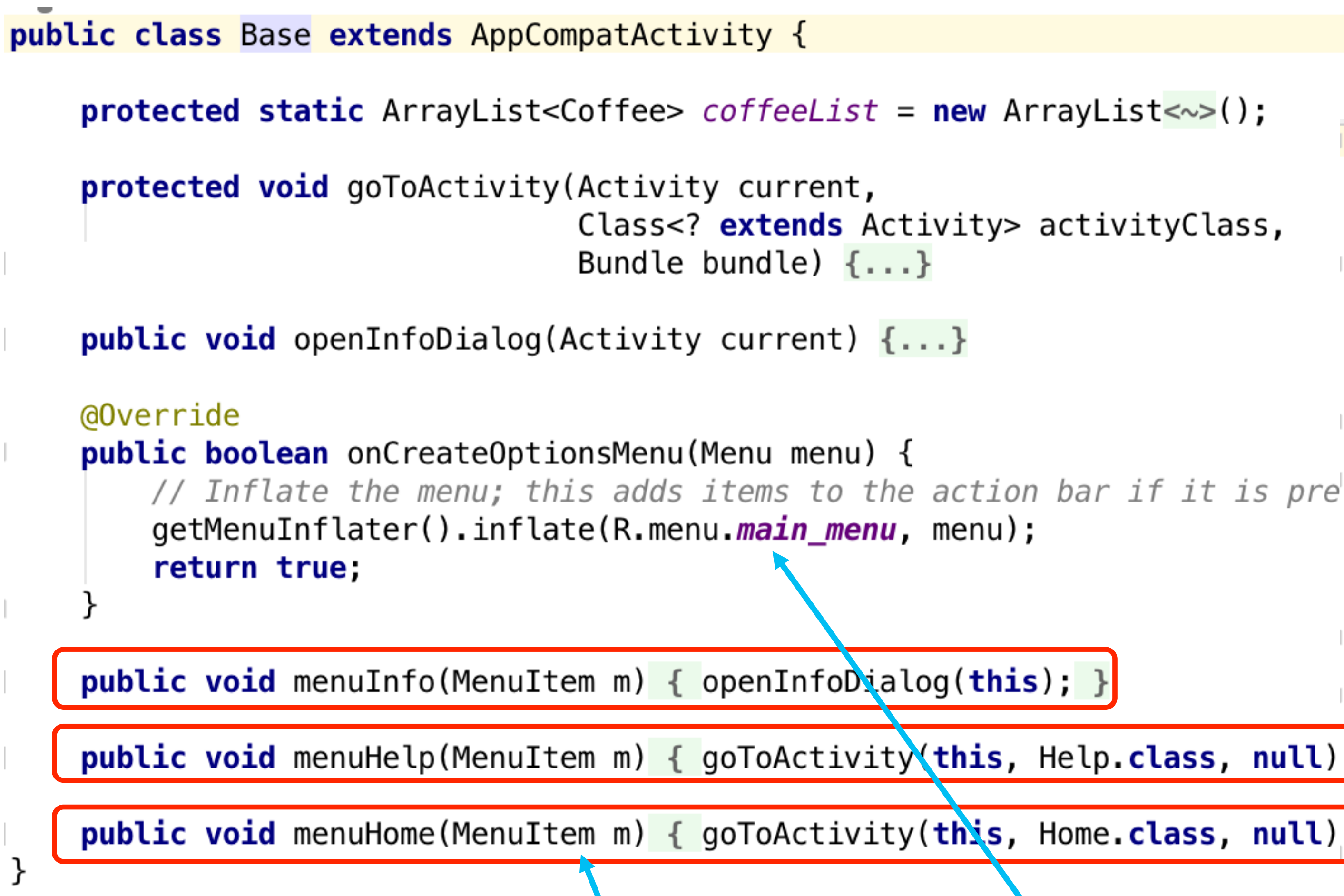
```
<menu xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools" tools:context=".Home">

    <item android:id="@+id/menu_info"
        android:icon='@drawable/about'
        android:title="Info"
        android:orderInCategory="100"
        app:showAsAction="never"
        android:onClick="menuInfo"/>

    <item android:id="@+id/menu_help"
        android:icon="@drawable/help"
        android:title="Help"
        android:orderInCategory="100"
        app:showAsAction="never"
        android:onClick="menuHelp"/>

    <item android:id="@+id/menu_home"
        android:icon="@drawable/home"
        android:title="Home"
        android:orderInCategory="100"
        app:showAsAction="ifRoom"
        android:onClick="menuHome"/>

</menu>
```

Menu Specification

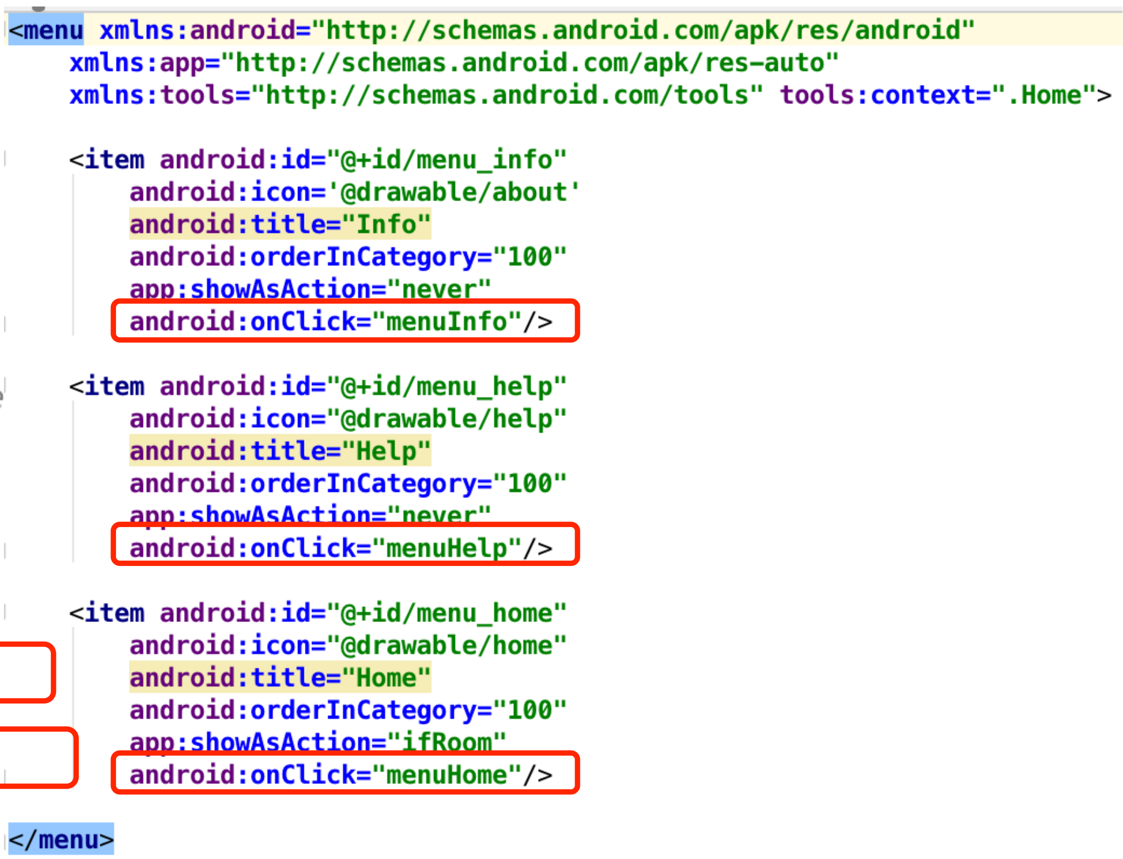
Note the use of an ‘onClick’ attribute

CoffeeMate Menu Event Handler *

Menu Specification



```java
public class Base extends AppCompatActivity {

    protected static ArrayList<Coffee> coffeeList = new ArrayList<~>();

    protected void goToActivity(Activity current,
                                Class<? extends Activity> activityClass,
                                Bundle bundle) {...}

    public void openInfoDialog(Activity current) {...}

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        // Inflate the menu; this adds items to the action bar if it is pre
        getMenuInflater().inflate(R.menu.main_menu, menu);
        return true;
    }

    public void menuInfo(MenuItem m) { openInfoDialog(this); }

    public void menuHelp(MenuItem m) { goToActivity(this, Help.class, null)

    public void menuHome(MenuItem m) { goToActivity(this, Home.class, null)
}
```



```xml
<menu xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools" tools:context=".Home">

    <item android:id="@+id/menu_info"
        android:icon='@drawable/about'
        android:title="Info"
        android:orderInCategory="100"
        app:showAsAction="never"
        android:onClick="menuInfo"/>

    <item android:id="@+id/menu_help"
        android:icon="@drawable/help"
        android:title="Help"
        android:orderInCategory="100"
        app:showAsAction="never"
        android:onClick="menuHelp"/>

    <item android:id="@+id/menu_home"
        android:icon="@drawable/home"
        android:title="Home"
        android:orderInCategory="100"
        app:showAsAction="ifRoom"
        android:onClick="menuHome"/>

</menu>
```

inflate this resource as a ‘Menu’ (creates the menu)

Note the use of a ‘MenuItem’ object

Aside - Why a ‘Base’ Class? *

❑ *Green* Programming – Reduce, Reuse, Recycle

- Reduce the amount of code we need to implement the functionality required (Code Redundancy)
- Reuse common code throughout the app/project where possible/appropriate
- Recycle existing code for use in other apps/projects

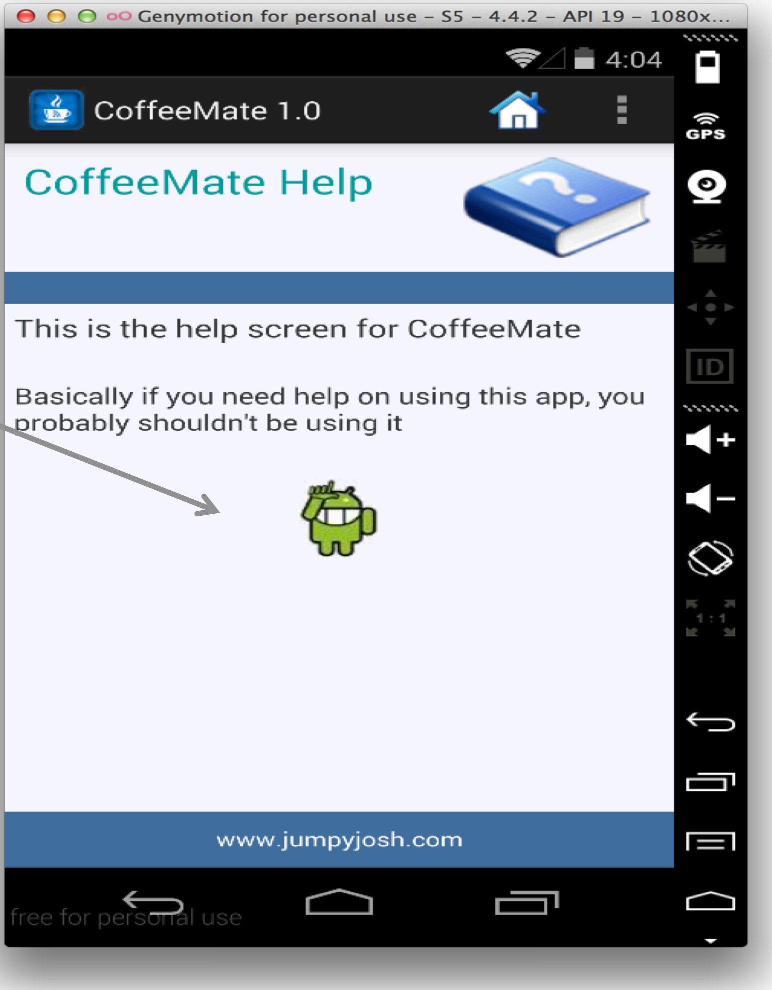
❑ All good for improving Design

CoffeeMate - *Menu* Event Handler ***Alternative***

'Help' Screen launched

check which 'menu item' was selected (by id)

```
@Override
public boolean onMenuItemSelected(int featureId, MenuItem item) {
    switch (item.getItemId()) {
    case R.id.help:
        goToActivity(this,Help.class, null);
        break;
    case R.id.info:
        openInfoDialog(this);
        break;
    case R.id.home:
        goToActivity(this,Home.class, null);
        break;
    }
    return super.onMenuItemSelected(featureId, item);
}
```


Genymotion for personal use – S5 – 4.4.2 – API 19 – 1080x...
4:04
CoffeeMate 1.0
GPS
free for personal use

CoffeeMate Help

This is the help screen for CoffeeMate

Basically if you need help on using this app, you probably shouldn't be using it

www.jumpyjosh.com

Switching Activities - General Approach

- Switch between Activities with Intents when
  - Main screen has buttons and/or menus to navigate to other Activities (your intent)
  - Return to original screen with “back” button (system intent)
- Syntax required to start new Activity
  - Java

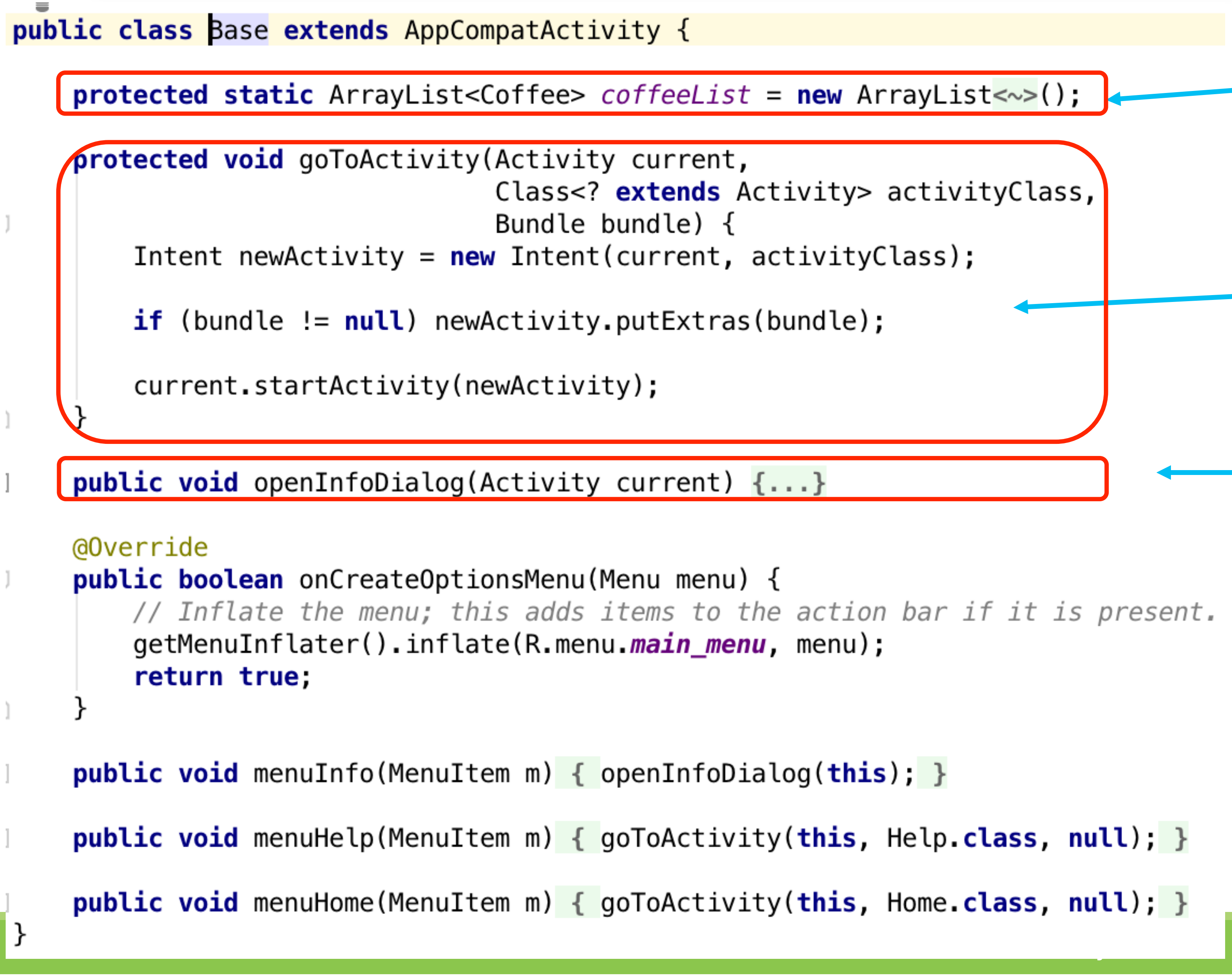
```
Intent goToActivity = new Intent(this,OtherActivity.class);
startActivity(goToActivity);
```

  - XML
    - Requires an entry in AndroidManifest.xml (runtime error otherwise!)

CoffeeMate 1.0

Code
Highlights

class *Base* (our superclass) *



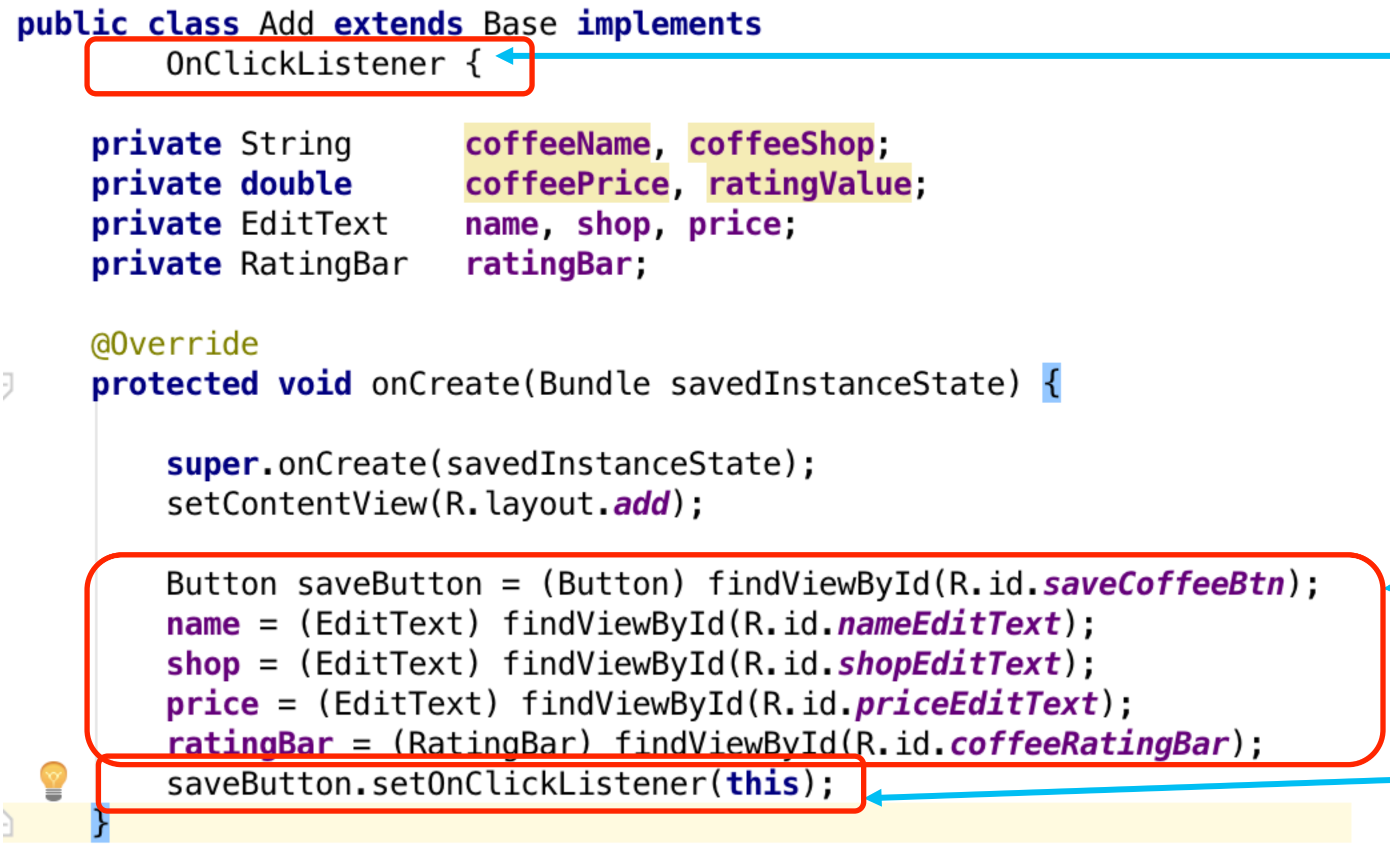
```java
public class Base extends AppCompatActivity {

    protected static ArrayList<Coffee> coffeeList = new ArrayList<~>();

    protected void goToActivity(Activity current,
                                Class<? extends Activity> activityClass,
                                Bundle bundle) {
        Intent newActivity = new Intent(current, activityClass);

        if (bundle != null) newActivity.putExtras(bundle);

        current.startActivity(newActivity);
    }

    public void openInfoDialog(Activity current) {...}

    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        // Inflate the menu; this adds items to the action bar if it is present.
        getMenuInflater().inflate(R.menu.main_menu, menu);
        return true;
    }

    public void menuInfo(MenuItem m) { openInfoDialog(this); }

    public void menuHelp(MenuItem m) { goToActivity(this, Help.class, null); }

    public void menuHome(MenuItem m) { goToActivity(this, Home.class, null); }
}
```

our list of Coffees (available/shared between all our Activities)

If you have never seen wildcards in generics before, this just means that we can pass in <u>any</u> subclass of Activity (as with Help & Home below).

A method to display a Dialog Window in the current Activity

class *Add* (1)



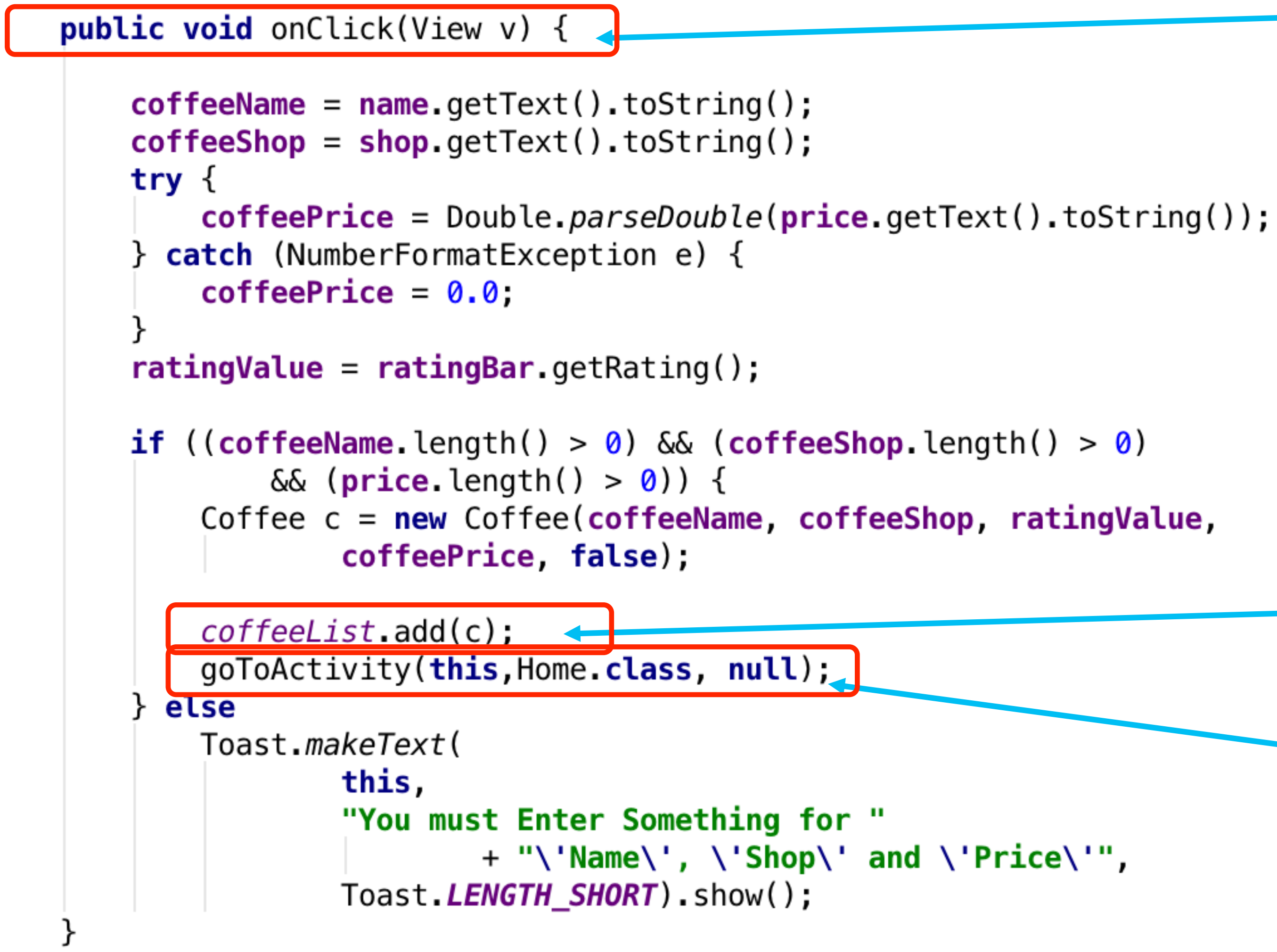
```java
public class Add extends Base implements
        OnClickListener {

    private String      coffeeName, coffeeShop;
    private double      coffeePrice, ratingValue;
    private EditText    name, shop, price;
    private RatingBar   ratingBar;

    @Override
    protected void onCreate(Bundle savedInstanceState) {

        super.onCreate(savedInstanceState);
        setContentView(R.layout.add);

        Button saveButton = (Button) findViewById(R.id.saveCoffeeBtn);
        name = (EditText) findViewById(R.id.nameEditText);
        shop = (EditText) findViewById(R.id.shopEditText);
        price = (EditText) findViewById(R.id.priceEditText);
        ratingBar = (RatingBar) findViewById(R.id.coffeeRatingBar);
        saveButton.setOnClickListener(this);
    }
```

Our Listener Interface

Binding to our Widgets

Attaching the Listener to the button

class *Add* (2)



```java
public void onClick(View v) {

    coffeeName = name.getText().toString();
    coffeeShop = shop.getText().toString();
    try {
        coffeePrice = Double.parseDouble(price.getText().toString());
    } catch (NumberFormatException e) {
        coffeePrice = 0.0;
    }
    ratingValue = ratingBar.getRating();

    if ((coffeeName.length() > 0) && (coffeeShop.length() > 0)
            && (price.length() > 0)) {
        Coffee c = new Coffee(coffeeName, coffeeShop, ratingValue,
                coffeePrice, false);

        coffeeList.add(c);
        goToActivity(this,Home.class, null);
    } else
        Toast.makeText(
                this,
                "You must Enter Something for "
                        + "\'Name\', \'Shop\' and \'Price\'",
                Toast.LENGTH_SHORT).show();
}
```

Our Event Handler Code

Adding the Coffee to our List

Returning to our ‘Home’ Activity

Questions?

Appendix

Android Components

Content Providers (1)

- A component that stores and retrieves data and make it accessible to all applications.
  - uses a standard interface (URI) to fulfill requests for data from other applications & it's one way to share data across applications.
    - e.g. `android.provider.Contacts.Phones.CONTENT_URI`
  - Android ships with a number of content providers for common data types (audio, video, images, personal contact information, and so on) - SQLite DB
  - Android 4.0 introduces the Calendar Provider.
    - uri – `Calendars.CONTENT_URI;`

Content Providers (2)

- Content providers abstract data storage to other applications, activities, services, etc…
- Roughly SQL based.
- You construct a ContentProvider class that will override methods such as insert(), delete(), and update().
- Then you register your content provider with a URI to handle different types of objects.
  - A Unique Resource Identifier is kind of like a URL
- For example, let’s say we want our content provider to allow other applications to access our database of bicycles and also customers.
- We define methods for inserting, deleting, updating, etc… bicycles and customers.
- Then we publish two URIs:
  - BICYCLES_URI
  - CUSTOMERS_URI
- Maybe more URIs for accessing bicycles indexed by serial number?

Broadcast Receivers

- ❑ A component designed to respond to broadcast Intents.
  - Receives system wide messages and implicit intents
  - can be used to react to changed conditions in the system (external notifications or alarms).
  - An application can register as a broadcast receiver for certain events and can be started if such an event occurs. These events can come from Android itself (e.g., battery low) or from any program running on the system.
- ❑ An Activity or Service provides other applications with access to its functionality by executing an Intent Receiver, a small piece of code that responds to requests for data or services from other activities.

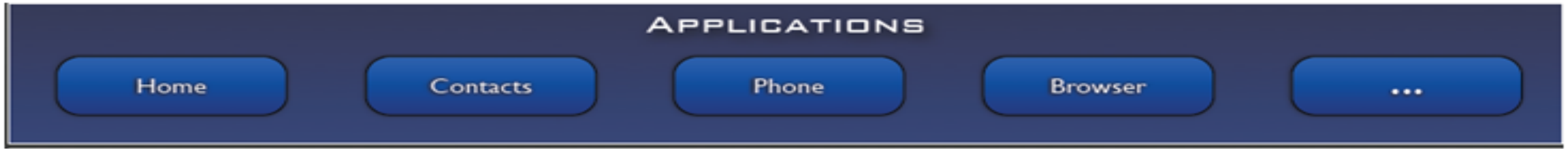
The Layered Framework

slides paraphrase a blog post by Tim Bray (co-inventor of XML and currently employed by Google to work on Android)

http://www.tbray.org/ongoing/When/201x/2010/11/14/What-Android-Is

The Layered Framework (1)

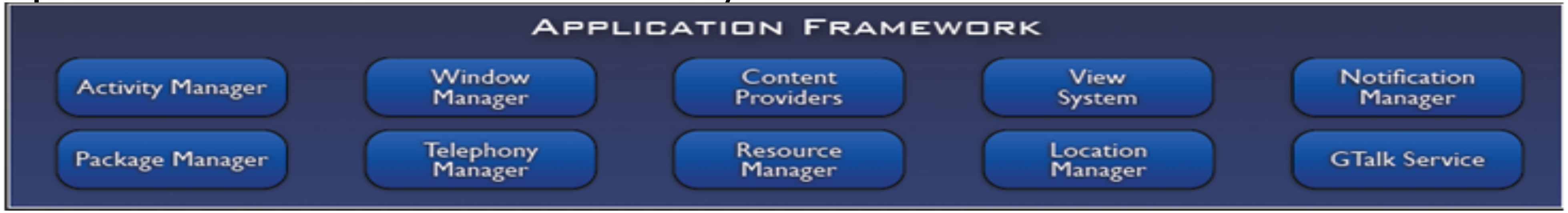
❑ Applications Layer



- Android provides a set of core applications:
  - ✓ Email Client
  - ✓ SMS Program
  - ✓ Calendar
  - ✓ Maps
  - ✓ Browser
  - ✓ Contacts
  - ✓ YOUR APP
  - ✓ Etc
- All applications are written using the Java language. These applications are executed by the Dalvik Virtual Machine (DVM), similar to a Java Virtual Machine but with different bytecodes♪

The Layered Framework (2)

❑ Application Framework Layer



- Enabling and simplifying the reuse of components
  - Developers have full access to the same framework APIs used by the core applications.
  - Users are allowed to replace components.
- These services are used by developers to create Android applications that can be run in the emulator or on a device

- See next slide for more…..

The Layered Framework (3)

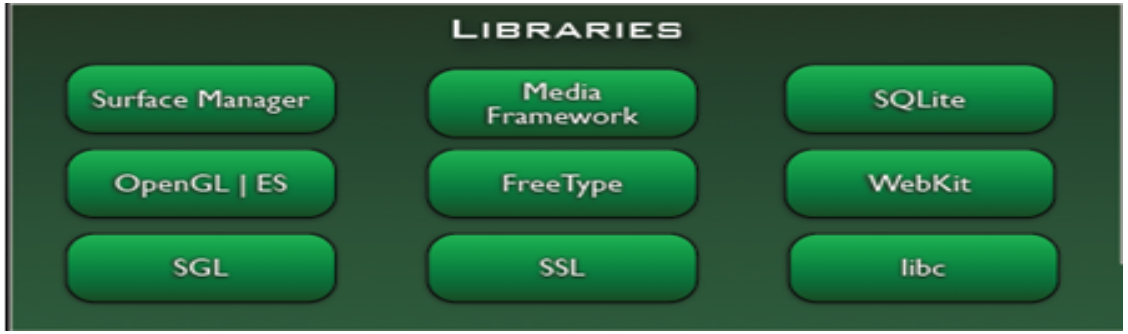
❑ Application Framework Layer Features

Feature♪	**Role♪**
View System♪	Used to build an application, including lists, grids, text boxes, buttons, and embedded web browser♪
Content Provider♪	Enabling applications to access data from other applications or to share their own data♪
Resource Manager♪	Providing access to non-code resources (localized strings, graphics, and layout files)♪
Notification Manager♪	Enabling all applications to display custom alerts in the status bar♪
Activity Manager♪	Managing the lifecycle of applications and providing a common navigation (back) stack♪

We'll be covering the above in more detail later on...

The Layered Framework (4)

❑ Libraries Layer



- Including a set of C/C++ libraries used by components of the Android system
- Exposed to developers through the Android application framework

System C library/libc - a BSD (Berkeley Software Distribution) -derived implementation of the standard C system library (libc), tuned for embedded Linux-based devices

Media Framework/Libraries - based on PacketVideo's OpenCORE; the libraries support playback and recording of many popular audio and video formats, as well as static image files, including MPEG4, H.264, MP3, AAC, AMR, JPG, and PNG

Surface Manager - manages access to the display subsystem and seamlessly composites 2D and 3D graphic layers from multiple applications

WebKit/LibWebCore - a modern web browser engine which powers both the Android browser and an embeddable web view

SGL (Scene Graph Library) - the underlying 2D graphics engine

3D libraries - an implementation based on OpenGL ES 1.0 APIs; the libraries use either hardware 3D acceleration (where available) or the included, highly optimized 3D software rasterizer (shapes->pixels)

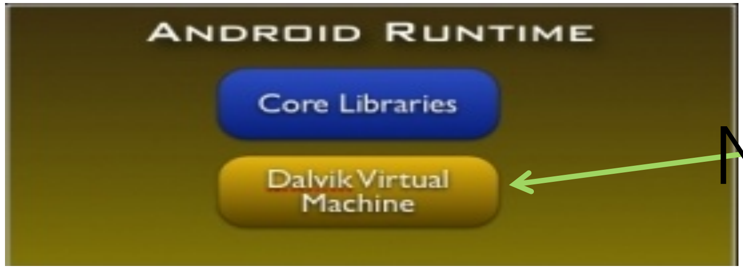
FreeType - bitmap and vector font rendering

SQLite - a powerful and lightweight relational database engine available to all applications

The Layered Framework (5)♪

❑ Core Runtime Libraries

(changing to ART in Kit Kat)



Next Slide

- Providing most of the functionality available in the core libraries of the Java language
- APIs
  - Data Structures
  - Utilities
  - File Access
  - Network Access
  - Graphics
  - Etc

The Layered Framework (6)♪

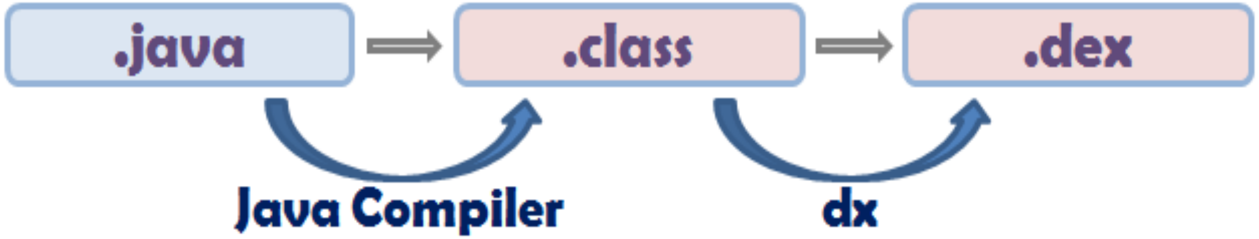
- ❑ Dalvik Virtual Machine (DVM)
  - Provides an environment on which every Android application runs
    - Each Android application runs in its own process, with its own instance of the Dalvik VM.
    - Dalvik has been written such that a device can run multiple VMs efficiently.
- ❑ Android Runtime (ART) 4.4

  (see slide 12)

The Layered Framework (7)♪

❑ Dalvik Virtual Machine (Cont'd)

- ✓ Executing the Dalvik Executable (.dex) format
  - ➢ .dex format is optimized for minimal memory footprint.
  - ➢ Compilation



- ✓ Relying on the Linux Kernel for:
  - ➢ Threading
  - ➢ Low-level memory management

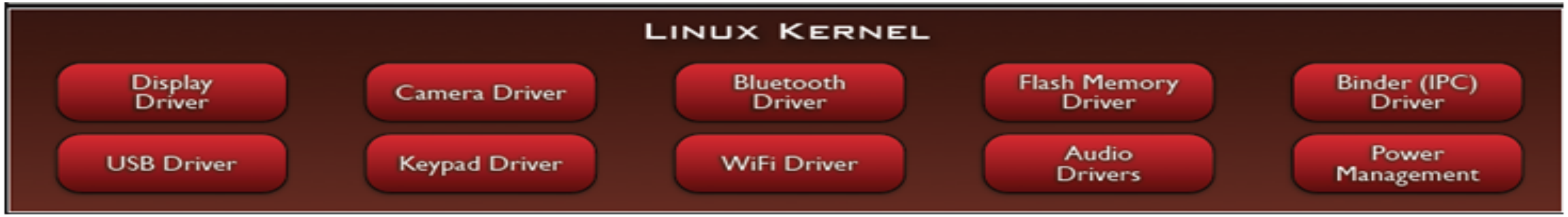
♪

ART – Android Runtime

- Handles app execution in a fundamentally different way from Dalvik.
- Current runtime relies on a JIT compiler to interpret original bytecode
  - In a manner of speaking, apps are only partially compiled by developers
  - resulting code must go through an interpreter on a user's device each and every time it is run == Overhead + Inefficient
  - But the mechanism makes it easy for apps to run on a variety of hardware and architectures.
- ART pre-compiles that bytecode into machine language when *apps are first installed*, turning them into truly native apps.
  - This process is called Ahead-Of-Time (AOT) compilation.
- By removing the need to spin up a new VM or run interpreted code, startup times can be cut down immensely and ongoing execution will become faster.

The Layered Framework (8)

❑ Linux Kernel Layer



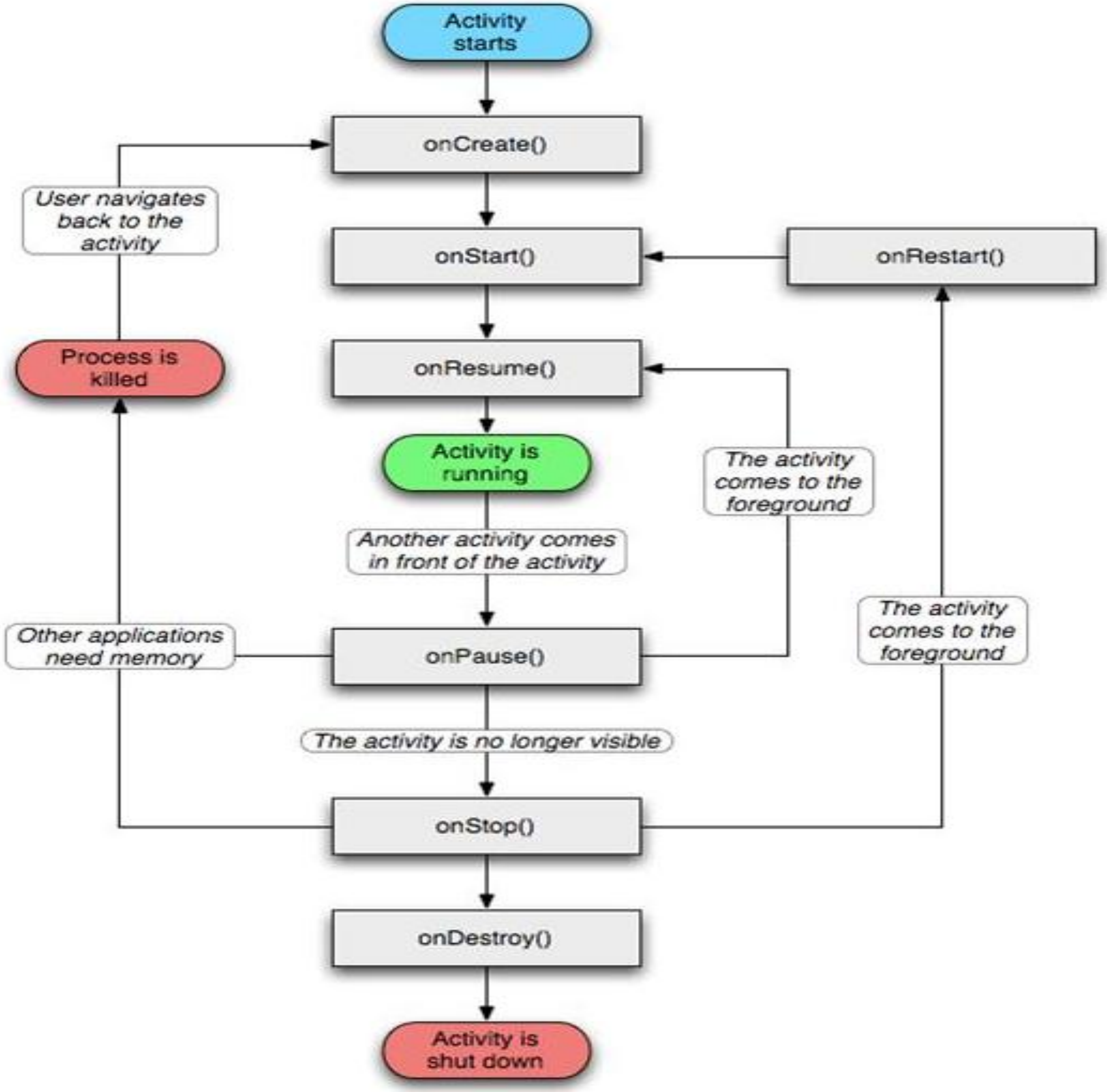
- ❑ At the bottom is the Linux kernel that has been augmented with extensions for Android
  - the extensions deal with power-savings, essentially adapting the Linux kernel to run on mobile devices
- ❑ Relying on Linux Kernel 2.6 for core system services / 3.8 in Kit Kat
  - Memory and Process Management
  - Network Stack
  - Driver Model
  - Security
- ❑ Providing an abstraction layer between the H/W and the rest of the S/W stack

The Application/Activity Lifecycle

The Application/Activity Life Cycle

- Android is designed around the unique requirements of mobile applications.
  - In particular, Android recognizes that resources (memory and battery, for example) are limited on most mobile devices, and provides mechanisms to conserve those resources.
- The mechanisms are evident in the *Android Activity Lifecycle*, which defines the states or events that an activity goes through from the time it is created until it finishes running.

The Activity Life Cycle


Activity starts
onCreate()
User navigates back to the activity
onStart()
onRestart()
Process is killed
onResume()
Activity is running
The activity comes to the foreground
Another activity comes in front of the activity
The activity comes to the foreground
Other applications need memory
onPause()
The activity is no longer visible
onStop()
onDestroy()
Activity is shut down

- ❑ `onStop()` and `onDestroy()` are optional and may never be called
- ❑ If you need persistence, the save needs to happen in `onPause()`

The Activity Life Cycle

- ❑ An activity monitors and reacts to these events by instantiating methods that override the Activity class methods for each event:

❑ onCreate

- Called when an activity is first created. This is the place you normally create your views, open any persistent data files your activity needs to use, and in general initialize your activity.
- When calling onCreate(), the Android framework is passed a Bundle object that contains any activity state saved from when the activity ran before.

❑ onStart

- Called just before an activity becomes visible on the screen. Once onStart() completes, if your activity can become the foreground activity on the screen, control will transfer to onResume().
- If the activity cannot become the foreground activity for some reason, control transfers to the onStop() method.

The Activity Life Cycle

❑ onResume

- Called right after onStart() if your activity is the foreground activity on the screen. At this point your activity is running and interacting with the user. You are receiving keyboard and touch inputs, and the screen is displaying your user interface.
- onResume() is also called if your activity loses the foreground to another activity, and that activity eventually exits, popping your activity back to the foreground. This is where your activity would start (or resume) doing things that are needed to update the user interface.

The Activity Life Cycle

- onPause
  - Called when Android is just about to resume a different activity, giving that activity the foreground. At this point your activity will no longer have access to the screen, so you should stop doing things that consume battery and CPU cycles unnecessarily.
    - If you are running an animation, no one is going to be able to see it, so you might as well suspend it until you get the screen back. Your activity needs to take advantage of this method to store any state that you will need in case your activity gains the foreground again—and it is not guaranteed that your activity will resume.
  - Once you exit this method, Android may kill your activity at any time without returning control to you.

The Activity Life Cycle

- onStop
  - Called when your activity is no longer visible, either because another activity has taken the foreground or because your activity is being destroyed.
- onDestroy
  - The last chance for your activity to do any processing before it is destroyed. Normally you'd get to this point because the activity is done and the framework called its finish method. But as mentioned earlier, the method might be called because Android has decided it needs the resources your activity is consuming.

Questions?