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CMSC436: Programming Handheld Systems

User Interface Classes

Today's Topics

Views & View Events

View Groups, AdapterViews & Layouts

Menus & ActionBar

Dialogs

Android User Interfaces

Activities usually display a user interface

Android provides many classes for constructing user interfaces

View

Key building block for UI components

Occupies a rectangular space on screen

Responsible for drawing itself and for handling events

Some Predefined Views

Button

ToggleButton

Checkbox

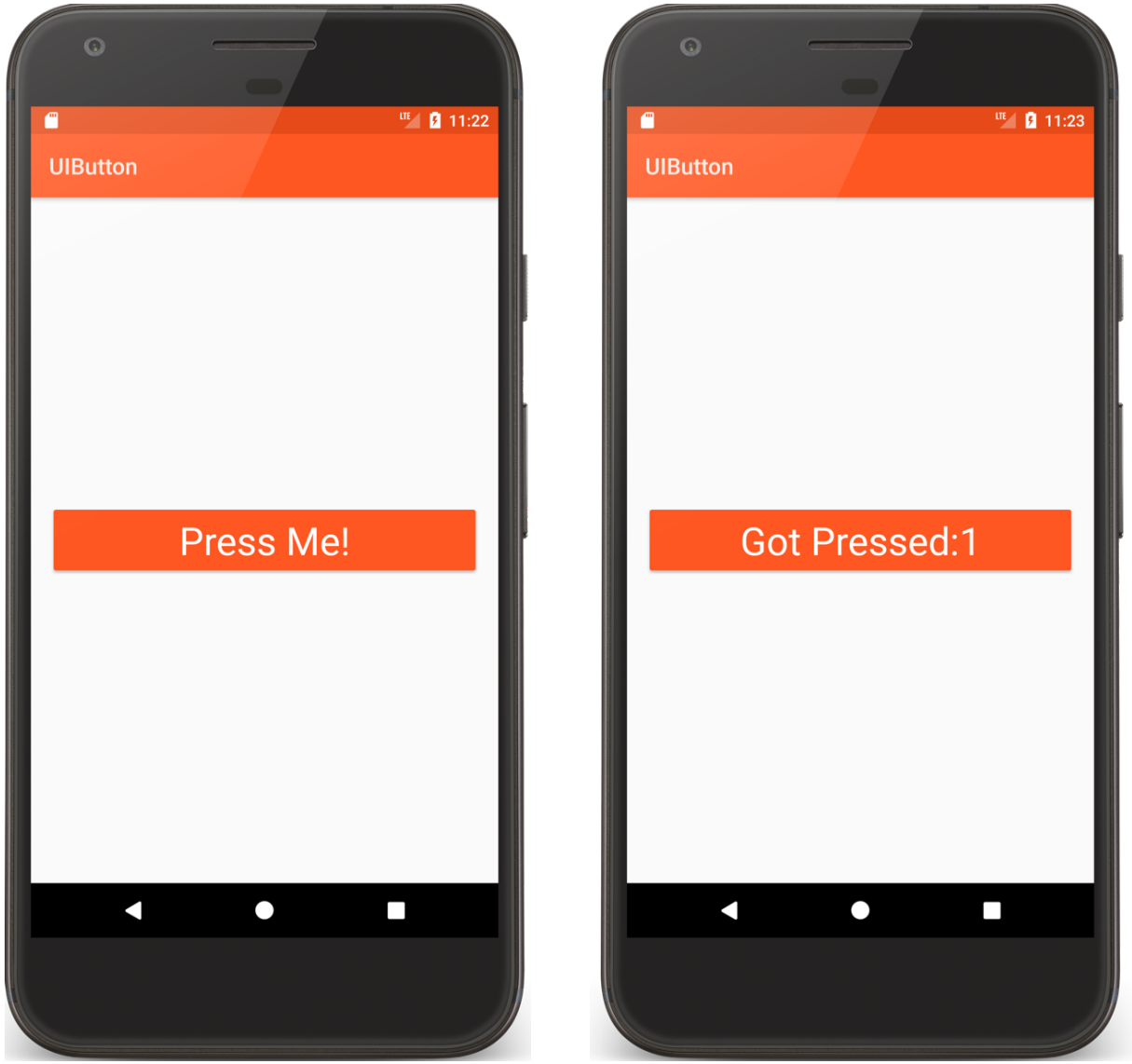
RatingBar

AutoCompleteTextView

Button

View that can be clicked on to perform an action

UIButton



ButtonActivity.kt

```
class ButtonActivity : Activity() {
    companion object {
        private var mCount: Int = 0
    }

    private lateinit var mButton: Button

    public override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.main)

        // Get a reference to the Press Me Button
        mButton = findViewById(R.id.button)
```

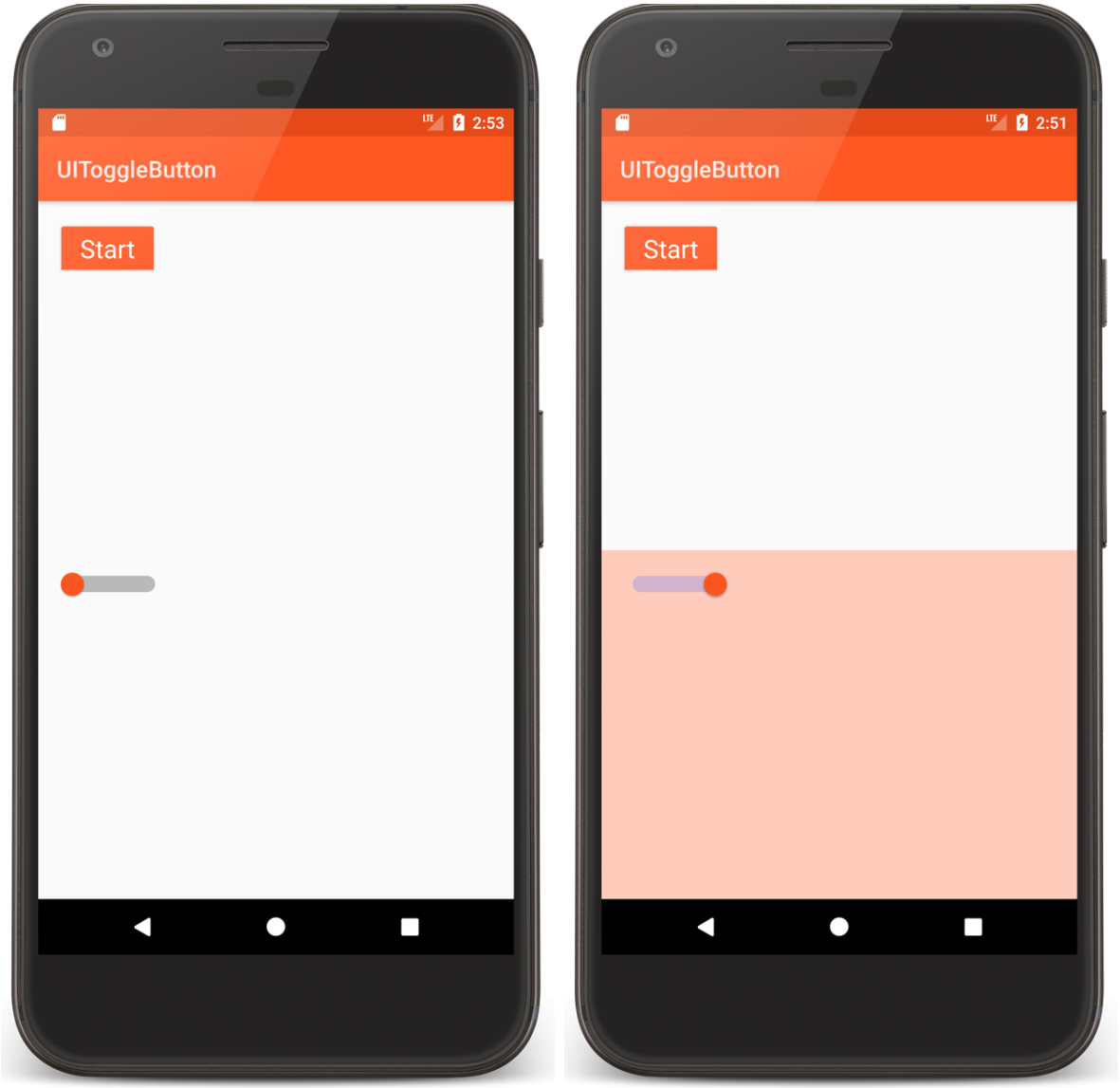
ButtonActivity.kt

```
        // Reset Button Text if restarting
        savedInstanceState?.run {
            mButton.text = getString(R.string.got_pressed_string, mCount)
        }
    }

    // Set an OnClickListener on this Button
    // Called each time the user clicks the Button
    fun processClick(v: View) {

        // Maintain a count of user presses
        // Display count as text on the Button

        (v as Button).text =
                getString(R.string.got_pressed_string, ++mCount)
    }
}
```

ToggleButton

- A 2-state Button
  - Checked/not checked state
  - Light indicator showing state

UIToggleButton



ToggleButtonActivity.kt

```
class ToggleButtonActivity : Activity() {
    public override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.main)

        // Set an setOnCheckedChangeListener on the ToggleButton
        setListener(
            findViewById<ToggleButton>(R.id.togglebutton),
            findViewById<FrameLayout>(R.id.top_frame))

        // Set an OnCheckedChangeListener on the Switch
        setListener(findViewById<Switch>(R.id.switcher),
            findViewById<FrameLayout>(R.id.bottom_frame))
    }
```

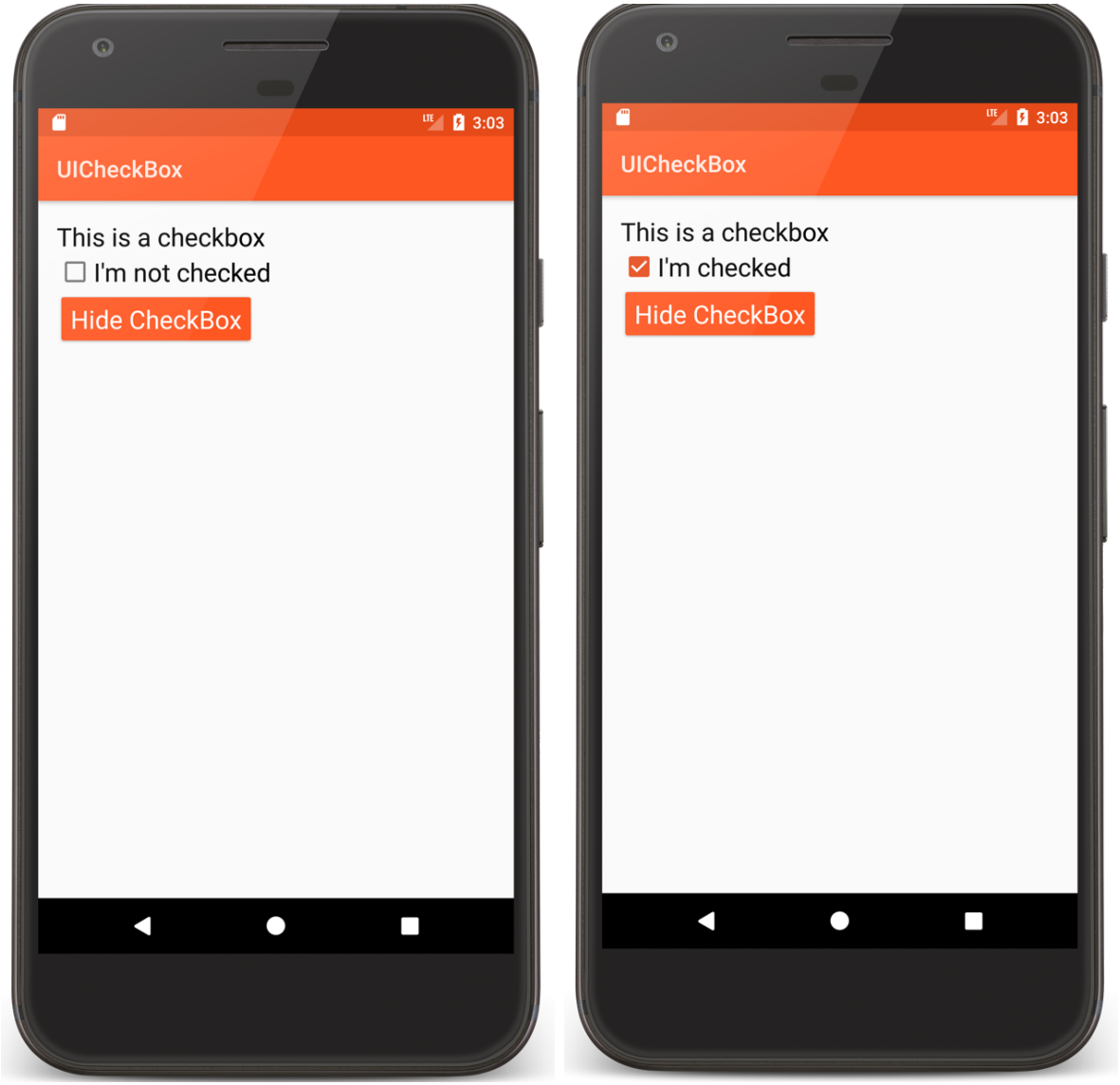
ToggleButtonActivity.kt

```
private fun setListener(button: CompoundButton, background: View) {
    button.setOnCheckedChangeListener { _, isChecked ->
        // Toggle the Background color between a light and dark color
        if (isChecked) {
             background.setBackgroundColor(
                     resources.getColor(R.color.primary_light, null))
        } else {
            background.setBackgroundColor(Color.TRANSPARENT)
        }
    }
}
```

Checkbox

- Another kind of 2-state button
  - Checked/not checked

UICheckbox


3:03
UICheckBox
This is a checkbox
I'm not checked
Hide CheckBox
3:03
UICheckBox
This is a checkbox
I'm checked
Hide CheckBox

main.xml

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
 …
    <CheckBox
         android:id="@+id/checkbox"
           …
         android:onClick="checkBoxClickCallback"
        …/>

    <Button
         android:id="@+id/button"
         …
         android:onClick="buttonClickCallback"
         …/>

</RelativeLayout>
```

CheckBoxActivity.kt

```
// Set with android:onClick
fun checkBoxClickCallback(view: View) {
    setCheckedStateAndText()
}

private fun setCheckedStateAndText() {
    // Check whether CheckBox is currently checked
    // Set CheckBox text accordingly
    if (mCheckBox.isChecked) {
        mCheckBox.text = getString(R.string.im_checked_string)
    } else {
        mCheckBox.text = getString(R.string.im_not_checked_string)
    }
}
```

CheckBoxActivity.kt

```
// Set with android:onClick
fun buttonClickCallback(view: View) {

    // Toggle the CheckBox's visibility state
    // Set the Button text accordingly
    if (mCheckBox.isShown) {
        mCheckBox.visibility = View.INVISIBLE
        mButton.text = getString(R.string.unhide_checkbox_string)
    } else {
        mCheckBox.visibility = View.VISIBLE
        mButton.text = getString(R.string.hide_checkbox_string)
    }
}
```

RatingBar

A view comprising a row of stars

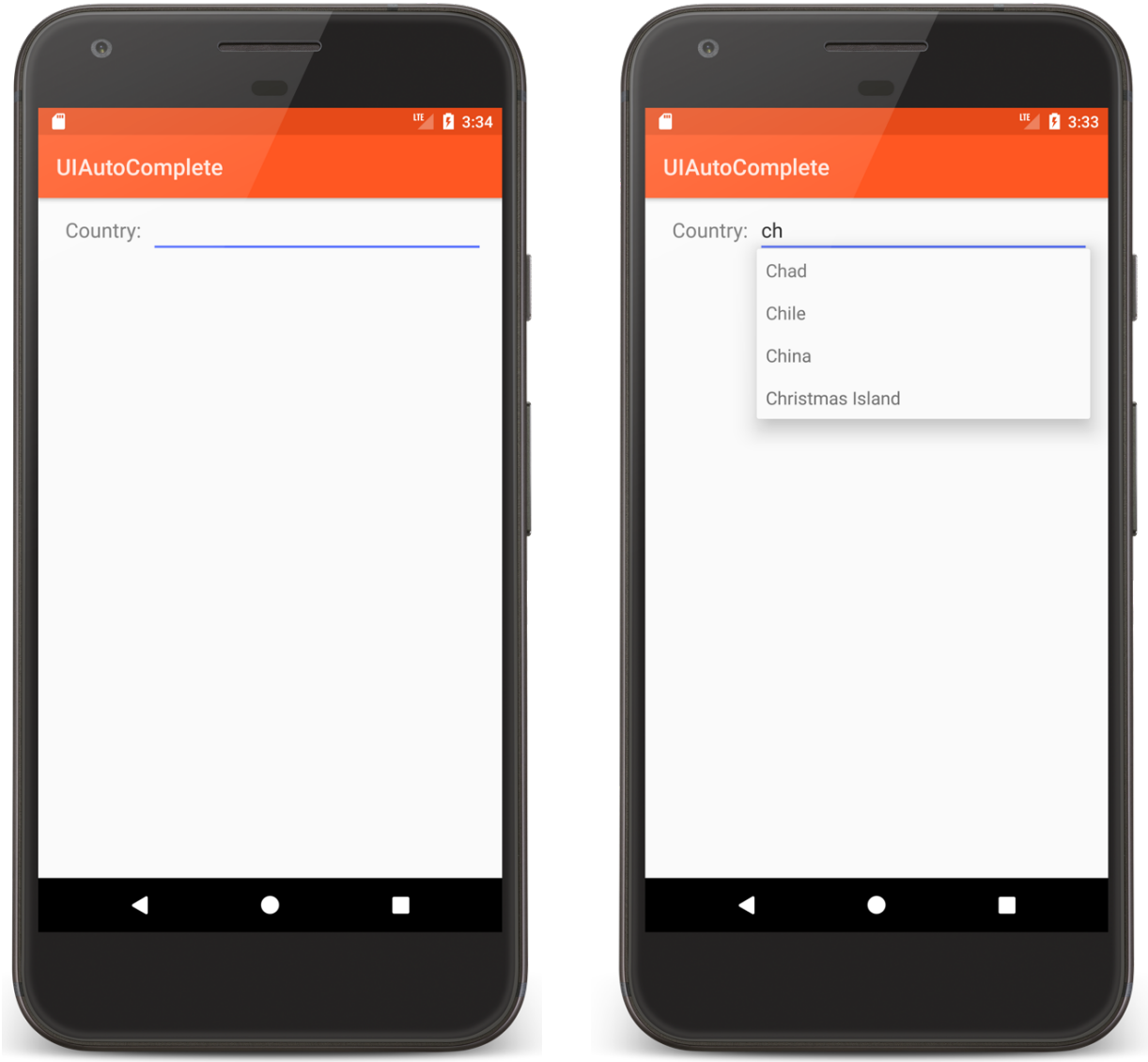
The user can click or drag the stars to highlight some number of them

UIRatingBar

AutoCompleteTextView

An editable text field that provides completion suggestions as the user types in text

UIAutoComplete TextView



Common View Operations

Set visibility: Show or hide View

Set checked state: Checked or not checked

Set listeners: Code that will be executed when specific events occur

Set properties: Opacity, background, rotation

Manage input focus: Allow View to take focus, request focus, etc.

View Event Sources

- User interaction
  - Touch
  - Keyboard/trackball/D-pad
- System control
  - Lifecycle changes

Handling View Events

Will often handle events using listeners

Many Listener interfaces defined by View class

View Listener interfaces

OnClickListener.onClick()

View has been clicked

OnLongClickListener.onLongClick()

View has been pressed & held

View Listener interfaces

OnFocusChangeListener.onFocusChange()

- View has received or lost focus

OnKeyListener.onKey()

- View is about to receive a hardware key press

Displaying Views

Views within a UI are organized as a tree

Displaying/refreshing the UI has multiple steps

- Measure – get dimensions of each View
- Layout – Position each View
- Draw – Draw each view

Handling View Events

Typically, create View subclasses

Then, override View methods

Handling View Events

onMeasure()

Determine the size of this View and its children

onLayout()

Assign a size and position to all View's children

onDraw()

Render View content

Handling View Events

onFocusChanged()

Called when View's focus state has changed

onKeyUp(), onKeyDown()

Called when a hardware key event has occurred

onWindowVisibilityChanged()

Window containing view has changed its visibility status

ViewGroup

An invisible View that contains other Views

Used for grouping & organizing a set of Views

Base class for View containers and Layouts

Some Predefined ViewGroups

RadioGroup

TimePickerFragment

DatePickerFragment

WebView

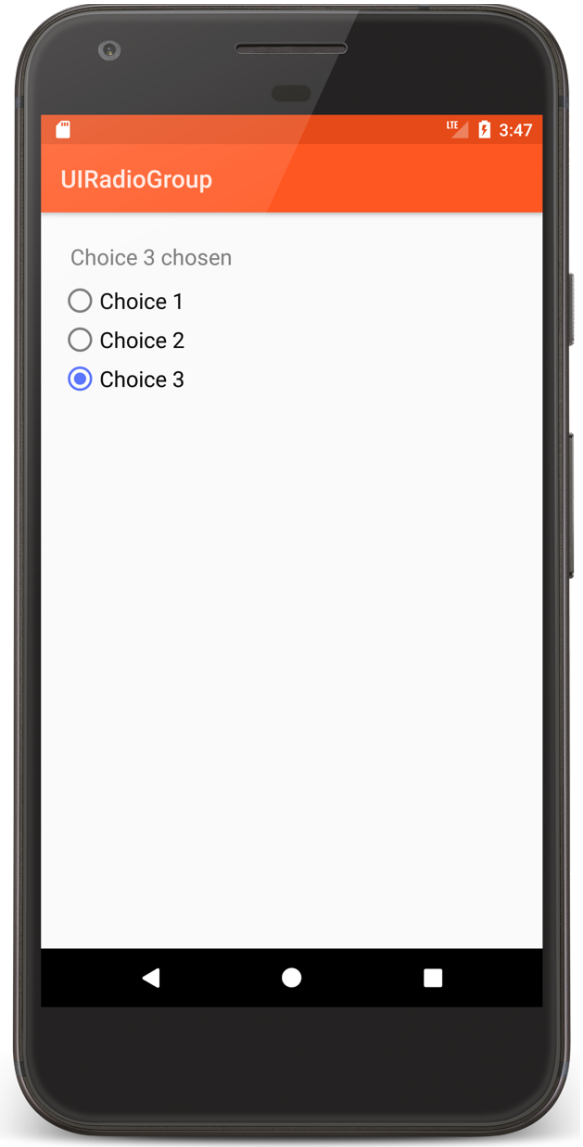
MapView

RadioGroup

A ViewGroup containing a set of Radio Buttons

Only one RadioButton can be selected at any one time

UIRadioGroup



main.xml

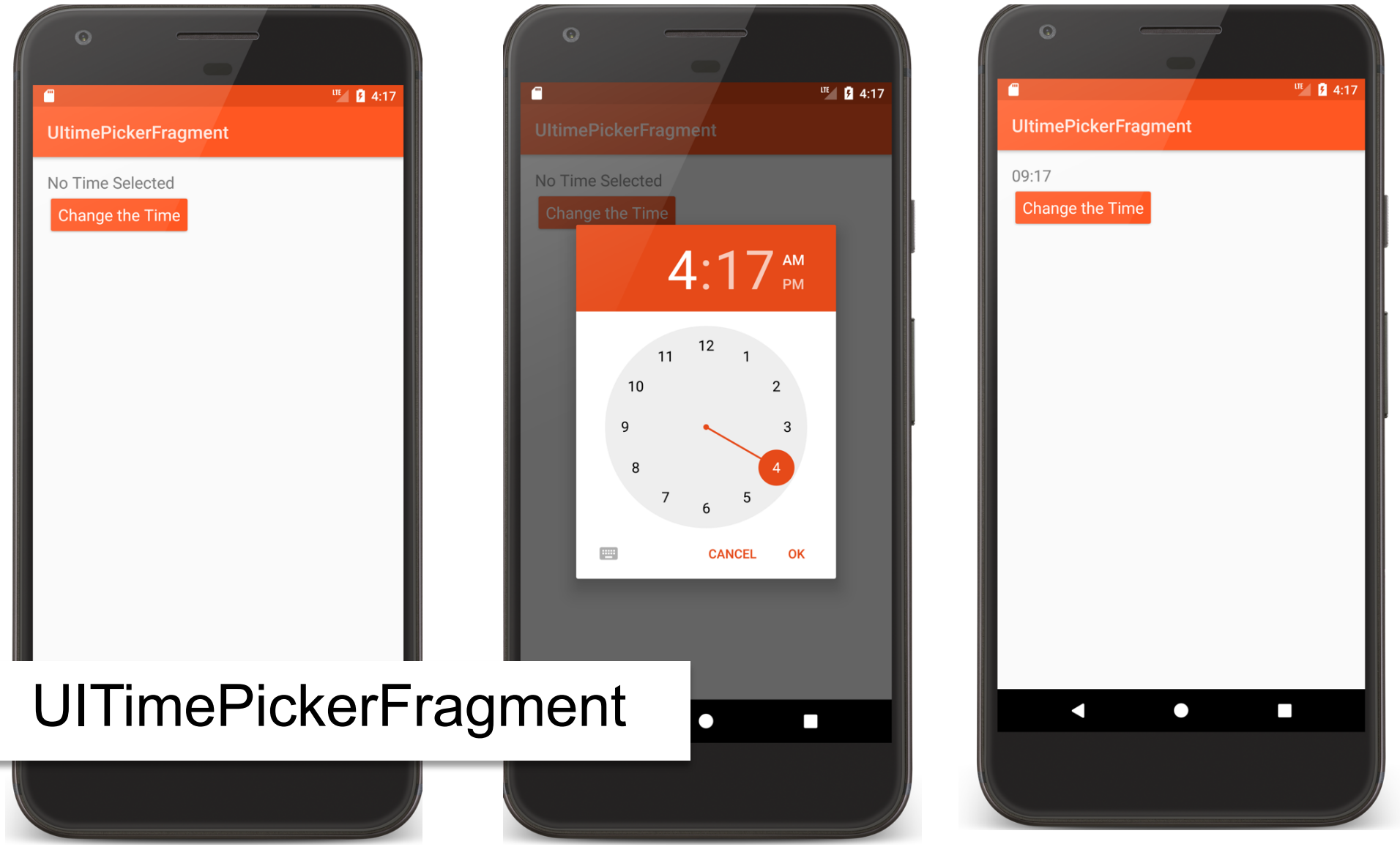
```
<RadioGroup
    android:id="@+id/radio_group"
    …>
     <RadioButton
    android:id="@+id/choice1"
    android:onClick="radioButtonClickCallback"
    …/>
    <RadioButton
    android:id="@+id/choice2"
    android:onClick="radioButtonClickCallback"
    …/>
     <RadioButton
    android:id="@+id/choice3"
    android:onClick="radioButtonClickCallback"
    …/>
</RadioGroup>
```

RadioGroupActivity.kt

```
// Define a generic listener for all three RadioButtons in the RadioGroup
fun radioButtonClickCallback(v: View) {
    val rb = v as RadioButton

// RadioButtons report each click, even if the toggle state doesn't change
    if (rb.isChecked) {
        mTextView.text = getString(R.string.chosen_string, rb.text)
    }
}
```

TimePickerFragment

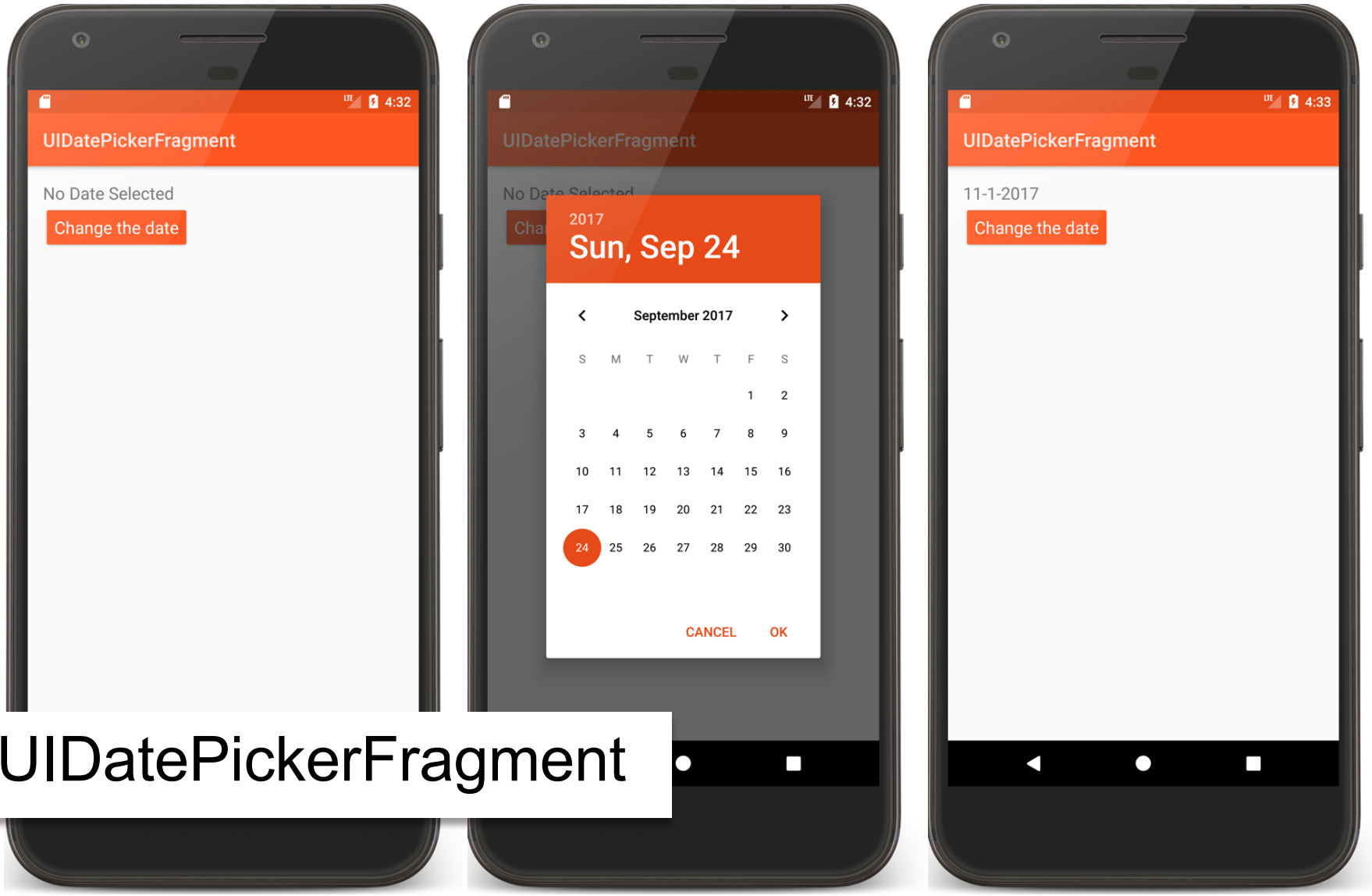
A ViewGroup that allows the user to select a time



UITimePickerFragment

DatePickerFragment

A ViewGroup that allows the user to select a date



UIDatePickerFragment

WebView

A ViewGroup that displays a web page

UIWebView

main.xml

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

    <WebView
        android:id="@+id/webview"
        android:layout_width="match_parent"
        android:layout_height="match_parent" />

</RelativeLayout>
```

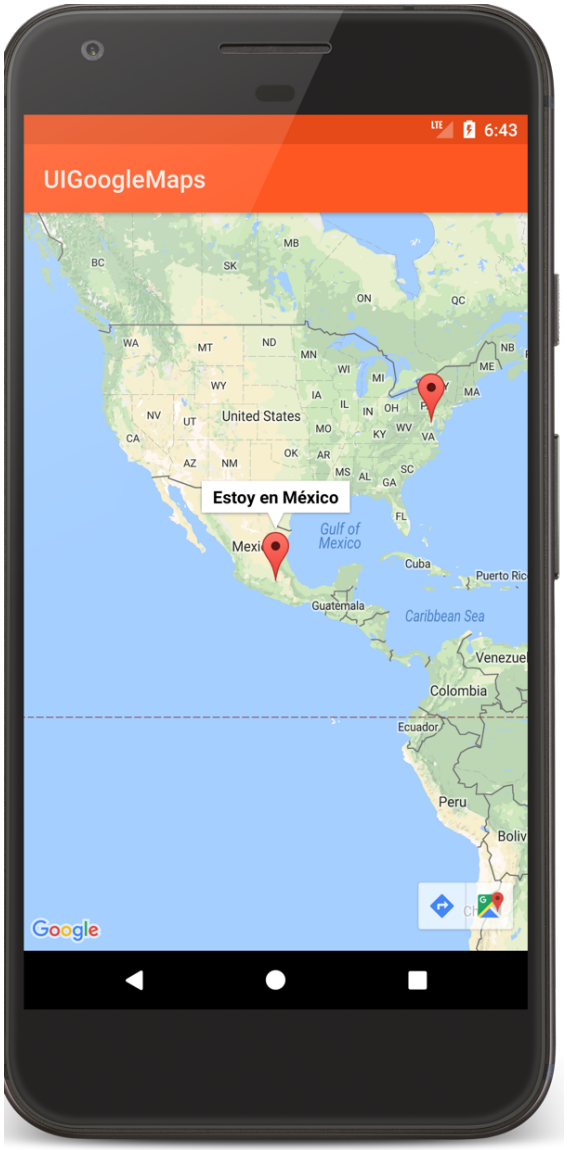
WebViewActivity.kt

```
class WebViewActivity : Activity() {
        …
    public override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.main)

        mWebView = findViewById(R.id.webview)

        // Set a kind of listener on the WebView so the WebView can intercept
        // URL loading requests if it wants to
        mWebView.webViewClient = HelloWebViewClient()

        // Add Zoom controls to WebView
        mWebView.settings.builtInZoomControls = true

        mWebView.loadUrl("https://www.cs.umd.edu/~aporter/Tmp/bee.html")
    }
```

MapView

A ViewGroup that displays a Map

UIGoogleMaps



Adapters & AdapterViews

AdapterViews are Views whose children and data are managed by an Adapter

Interaction pattern

- Adapter manages the data and provides data Views to AdapterView
- AdapterView displays the data Views

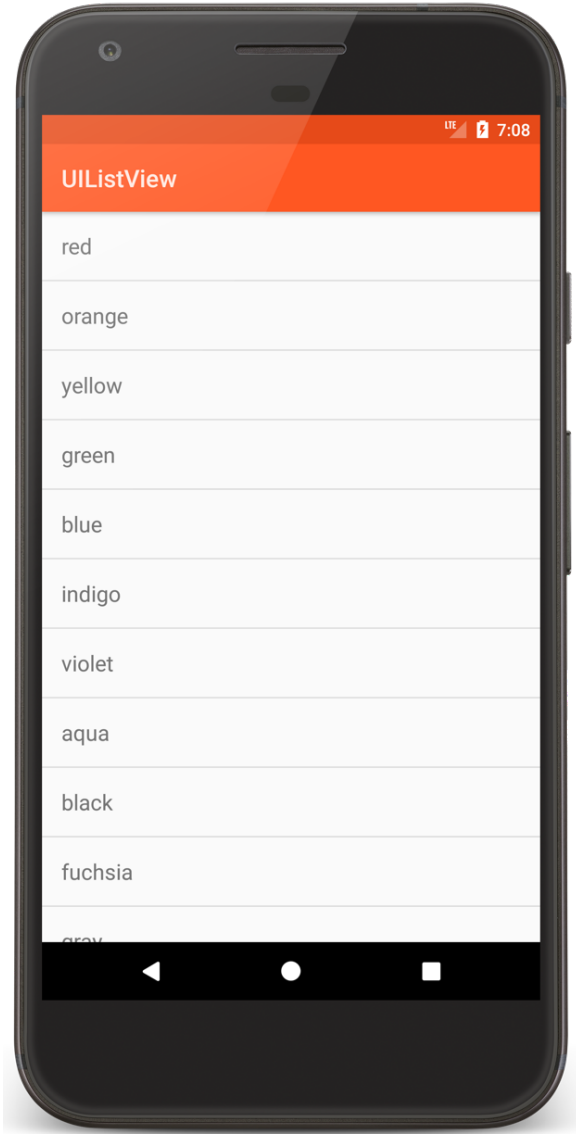
ListView

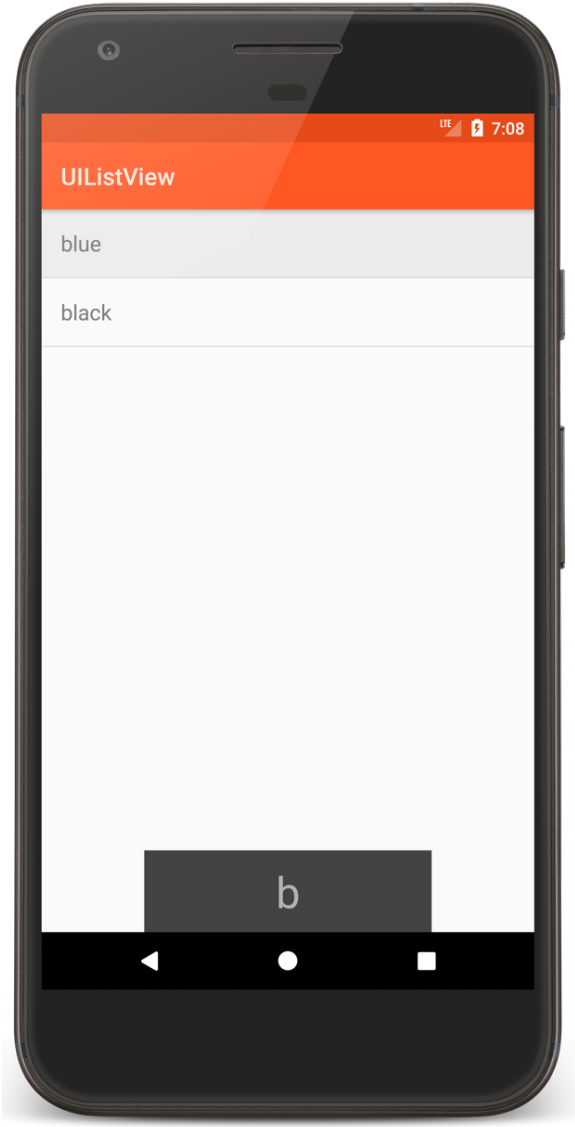
An AdapterView that displays a scrollable list of selectable items

Data items managed by a ListAdapter

ListView can filter the list of items based on text input

UIListView


7:08
UIListView
red
orange
yellow
green
blue
indigo
violet
aqua
black
fuchsia


7:08
UIListView
blue
black
b

list_item.xml

```
<TextView xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:padding="@dimen/activity_margin"
    android:textAppearance="@android:style/TextAppearance.Material.Medium" />
```

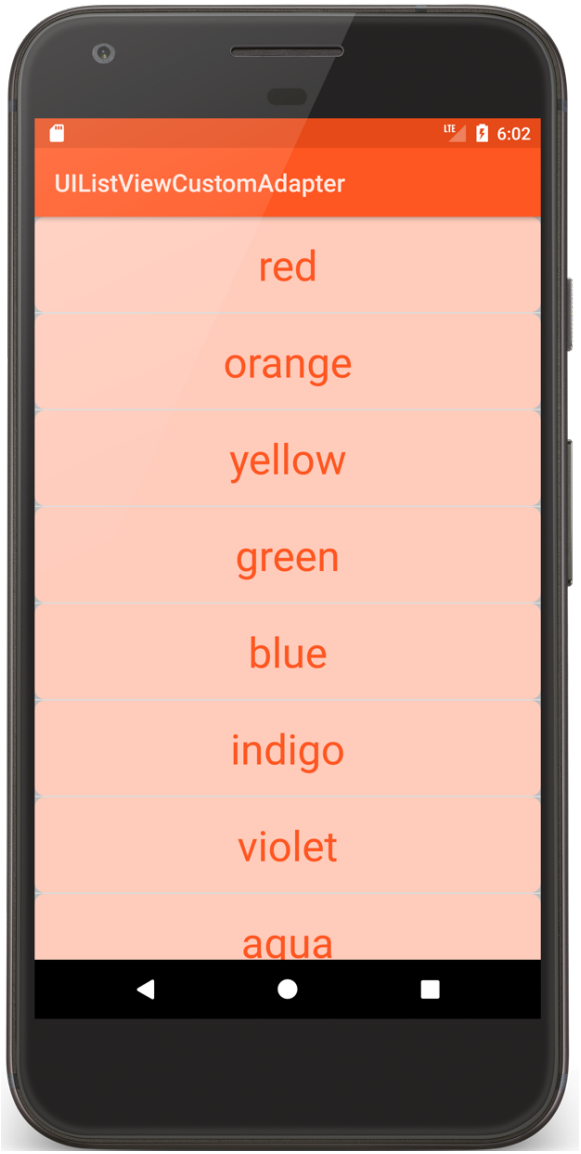
ListViewActivity.kt

```
class ListViewActivity : FragmentActivity() {
    public override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.layout)

        val listView = findViewById<ListView>(R.id.list)


        // Create a new Adapter containing a list of colors
        // Set the adapter on this ListActivity's built-in ListView
        listView.adapter = ArrayAdapter(
            this, R.layout.list_item,
            resources.getStringArray(R.array.colors)
        )
```

ListViewActivity.kt

```
    // Enable filtering when the user types in the virtual keyboard
        listView.isTextFilterEnabled = true

        // Set a setOnItemClickListener on the ListView
        listView.onItemClickListener =
           OnItemClickListener { _, view, _, _ ->
            // Display a Toast message indicting the selected item
            Toast.makeText(
                applicationContext,
                (view as TextView).text, Toast.LENGTH_SHORT
            ).show()
        }
    }
}
```

UIListViewWith CustomAdapter



list_item.xml

```
<TextView xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/text"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:background="@drawable/list_background"
    android:gravity="center"
    android:padding="16dp"
    android:textAppearance=
        "@android:style/TextAppearance.Material.Display1"
    android:textColor="@color/divider">
</TextView>
```

list_background.xml

```
<shape xmlns:android="http://schemas.android.com/apk/res/android"
    android:shape="rectangle">
    <solid android:color="@color/primary_light" />
    <corners android:radius="8dp" />
</shape>
```

ListViewActivity.kt

```
public override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        …


        // Create a new Adapter containing a list of colors
        // Set the adapter on this ListActivity's built-in ListView
        listAdapter = ListViewAdapter(
            this,
            R.layout.list_item,
            resources.getStringArray(R.array.colors)
        )

        …
```

ListViewAdapter.kt

```
class ListViewAdapter(context: Context, resource: Int, objects: Array<String>):
                                        ArrayAdapter<String>(context, resource, objects) {
        …
    override fun getView(position: Int, convertView: View?,
                                                    parent: ViewGroup): View {
        val newView: View
        // Check for recycled View
        if (null == convertView) {
            // Not recycled. Create the View
            newView = mLayoutInflater.inflate(R.layout.list_item, parent, false)
            // Cache View information in ViewHolder Object
            val viewHolder = ViewHolder()
            newView.tag = viewHolder
            viewHolder.textView = newView.findViewById(R.id.text)
        } else {
            newView = convertView
        }
```

ListViewAdapter.kt

```
        // Set the View's data
        // Retrieve the viewHolder Object
        val storedViewHolder = newView.tag as ViewHolder
        //Set the data in the data View
        storedViewHolder.textView.text = getItem(position)
        return newView
    }

    // The ViewHolder class.
    // See: http://developer.android.com/training/improving-layouts/
                                                smooth-scrolling.html#ViewHolder
    internal class ViewHolder {
        lateinit var textView: TextView
    }
}
```

UIRecyclerView

RecyclerViewActivity.kt

```
public override fun onCreate(savedInstanceState: Bundle?) {
        …
    //Set up RecyclerView
    val mRecyclerView = findViewById<RecyclerView>(R.id.list)
    //Set the layout manager
    mRecyclerView.layoutManager = LinearLayoutManager(this)
    // Set up the adapter
    val names = ArrayList<String>()
    Collections.addAll(names, *resources.getStringArray(R.array.colors))
    mRecyclerView.adapter = MyRecyclerViewAdapter(names,
                                                  R.layout.list_item)
}
```

MyRecyclerAdapter.kt

```
internal class MyRecyclerViewAdapter(private val mNames: List<String>,
    private val mRowLayout: Int) :
        RecyclerView.Adapter<MyRecyclerViewAdapter.ViewHolder>() {

   // Create ViewHolder which holds a View to be displayed
   override fun onCreateViewHolder(viewGroup: ViewGroup, i: Int):ViewHolder {
      val v = LayoutInflater.from(viewGroup.context).
                                    inflate(mRowLayout, viewGroup, false)
        return ViewHolder(v)
    }

    // Binding: The process of preparing a child view to display data
    // corresponding to a position within the adapter.
    override fun onBindViewHolder(viewHolder: ViewHolder, i: Int) {
        viewHolder.mName.text = mNames[i]
    }
```

MyRecyclerAdapter.kt

```
override fun getItemCount(): Int {
    return mNames.size
}

class ViewHolder internal constructor(itemView: View) :
     RecyclerView.ViewHolder(itemView),
     View.OnClickListener {
       internal val mName: TextView = itemView.findViewById(R.id.text)
       init {
              itemView.setOnClickListener(this)
       }
       override fun onClick(view: View) {
        // Display a Toast message indicting the selected item
       Toast.makeText(view.context, mName.text, Toast.LENGTH_SHORT).show()
      }
     }
     …
```

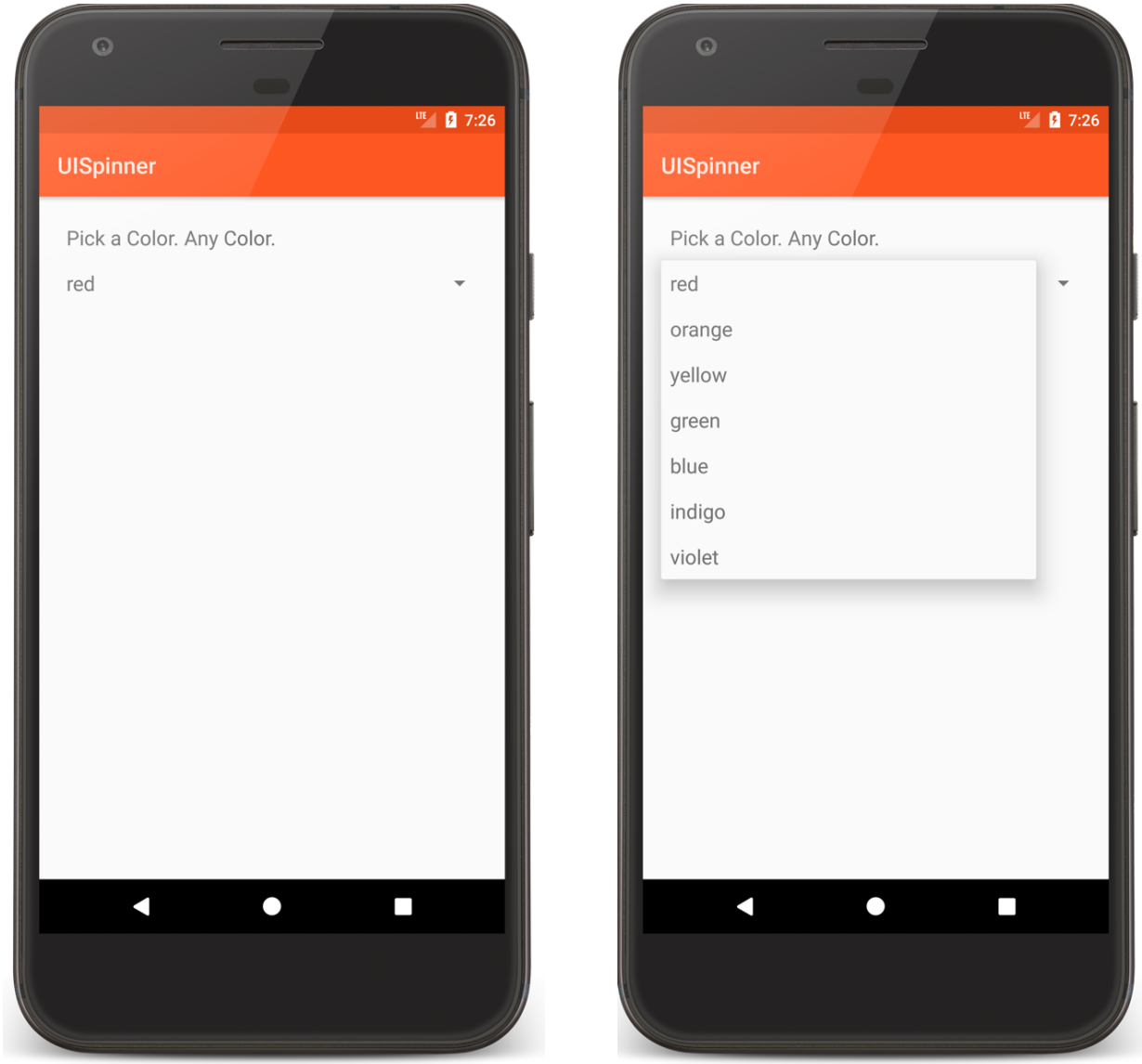
Spinner

An AdapterView that provides a scrollable list of items

User can select one item from the list

Items managed by a SpinnerAdapter

UISpinner


7:26
UISpinner
Pick a Color. Any Color.
red
7:26
UISpinner
Pick a Color. Any Color.
red
orange
yellow
green
blue
indigo
violet

ViewPager

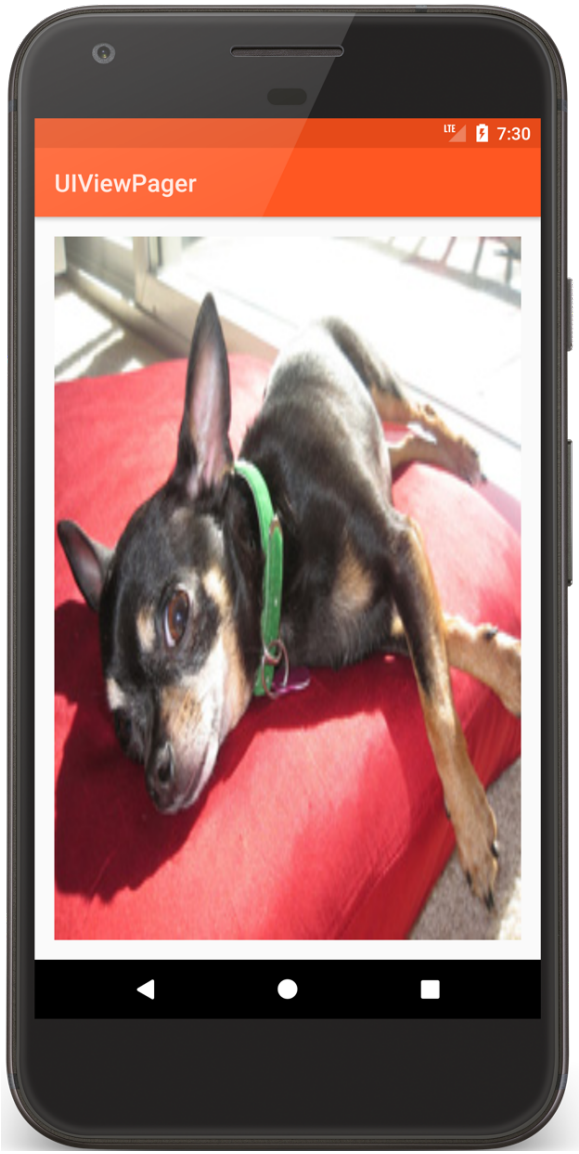
A ViewGroup showing a horizontally scrolling list

Items managed by a PagerAdapter

Two builtin PagerAdapters using Fragments

- FragmentPagerAdapter
- FragmentStatePagerAdapter

UIViewPager



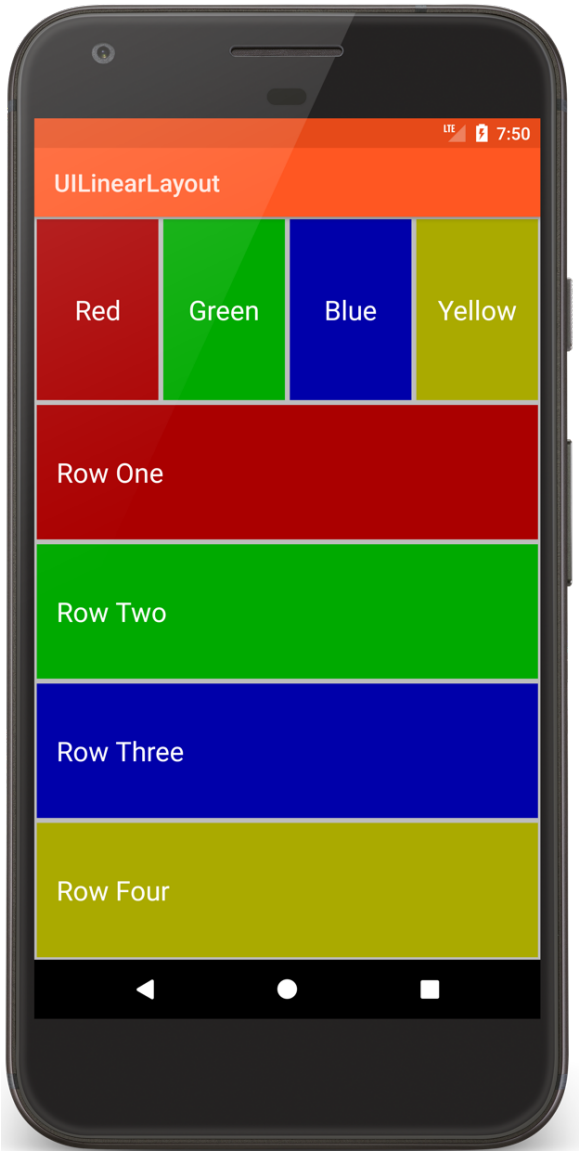
Layouts

A generic Viewgroup that defines a structure/rules for positioning the Views it contains

LinearLayout

Child Views arranged in a single horizontal or vertical row

UILinearLayout



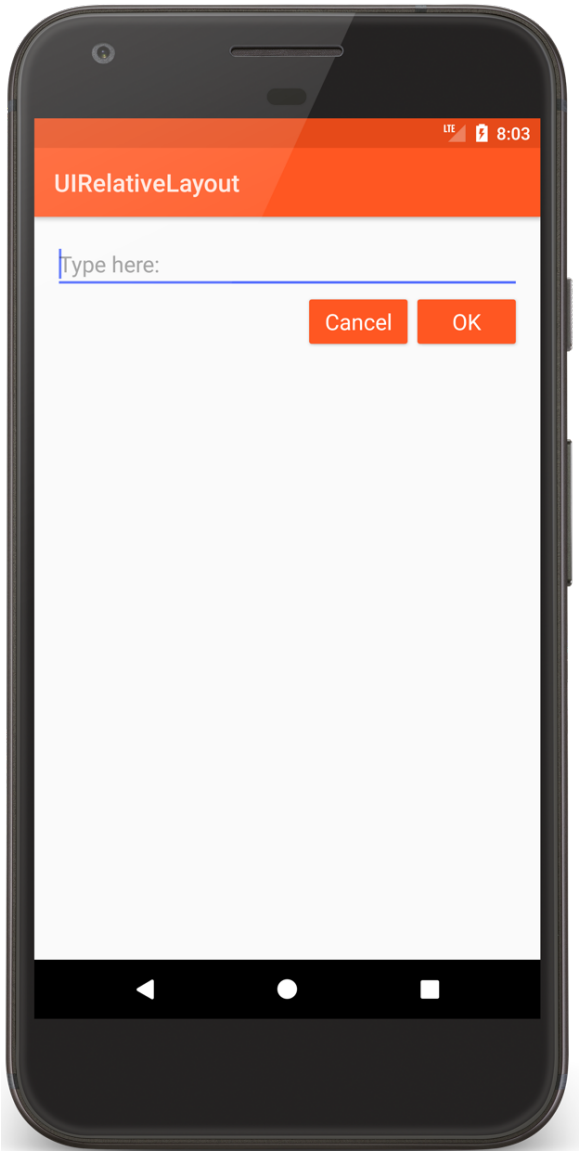
main.xml

```
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:background="@color/divider"
    android:orientation="vertical">
    <!--
     Inner LinearLayout with horizontal orientation
      and layout weight of 1 out of 4
    -->
    <LinearLayout
        android:layout_width="match_parent"
        android:layout_height="0dp"
        android:layout_weight="1"
        android:orientation="horizontal">
        …
```

RelativeLayout

Child Views are positioned relative to each other and to parent View

UIRelativeLayout



main.xml

```
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:padding="@dimen/activity_margin">

    <!-- Note the use of android:hint to put explanatory text in the
         EditText  -->
    <EditText
        android:id="@+id/entry"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:hint="@string/type_here_string"
        android:textAppearance=
                  "@android:style/TextAppearance.Material.Medium"
        android:inputType="textPersonName"
        android:autofillHints="username" />
```

main.xml

```
    <Button
        android:id="@+id/ok_button"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_alignParentEnd="true"
        android:layout_below="@id/entry"
        …/>
    <Button
        android:id="@+id/cancel_button"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_alignTop="@id/ok_button"
        android:layout_toStartOf="@id/ok_button"
        …/>
</RelativeLayout>
```

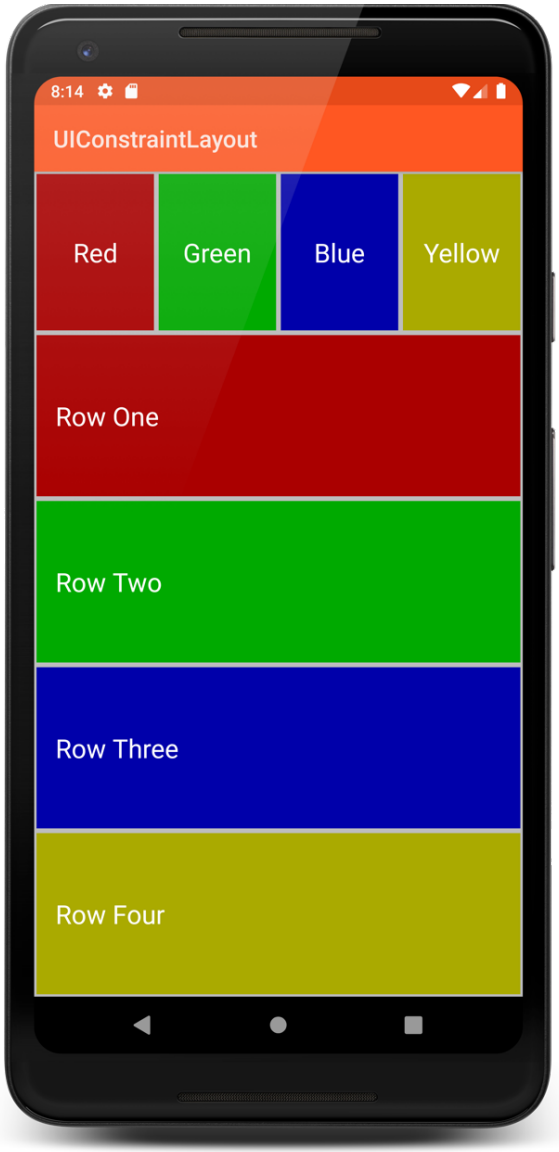
ConstraintLayout

Combines features of LinearLayout and RelativeLayout

Avoids deeply nested layout structures with goal of improving drawing performance

Considered default UI layout for Android going forward

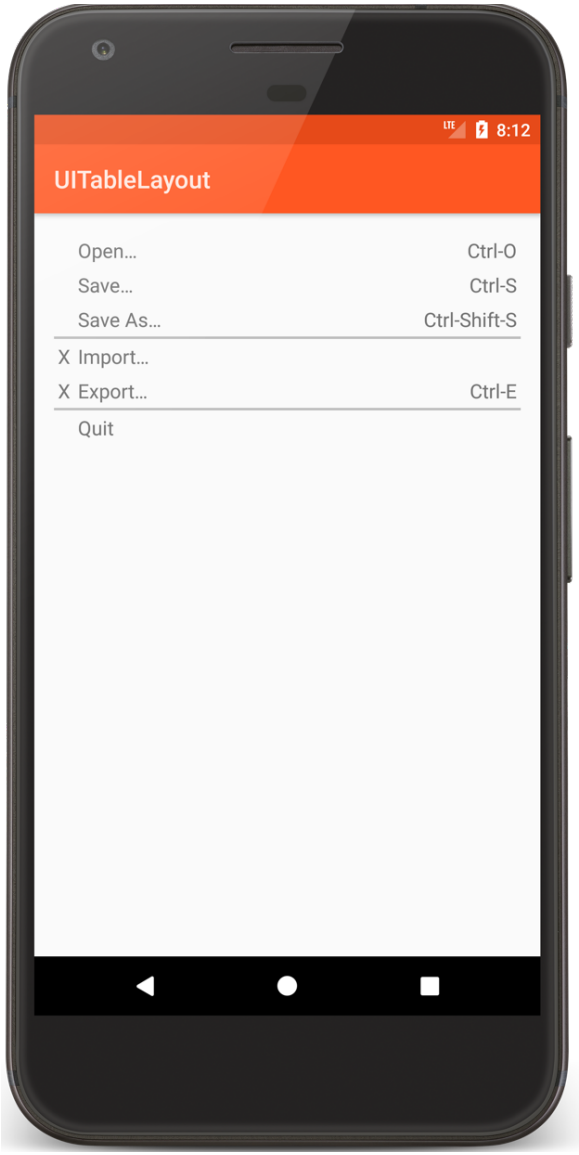
UIConstraintLayout



TableLayout

Child views arranged into rows & columns

UITableLayout



Menus and ActionBar

- Activities support menus
- Activities can
  - Add items to a menu
  - Handle clicks on the menu items

Menu Types

Options

Menu shown when user presses the menu button

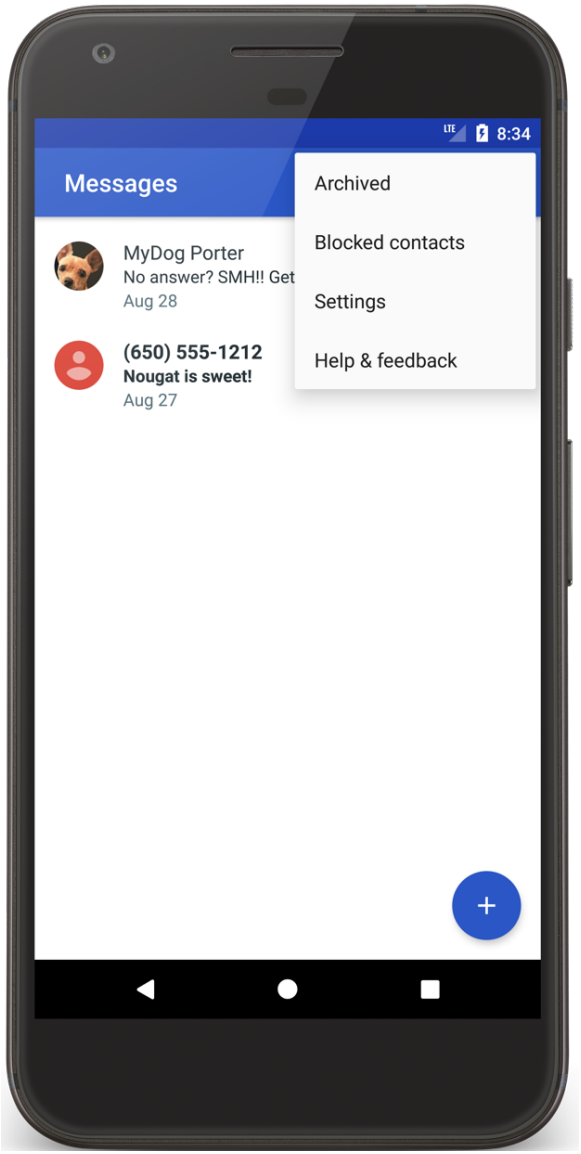
Context

View-specific menu shown when user touches and holds the View

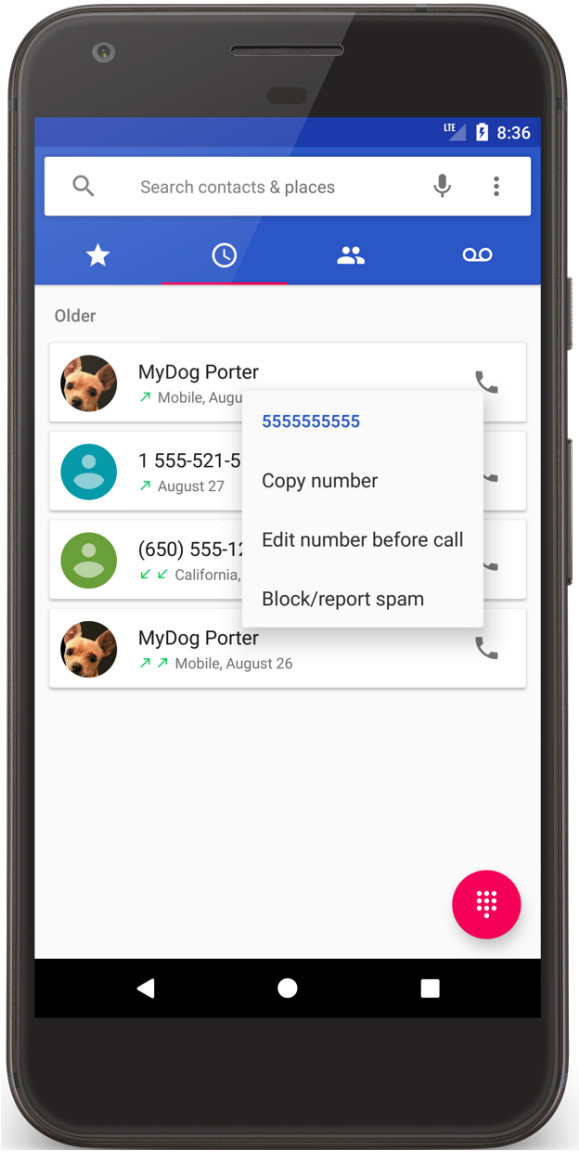
Submenu

A menu activated when user touches a visible menu item

Options Menus



Context Menus



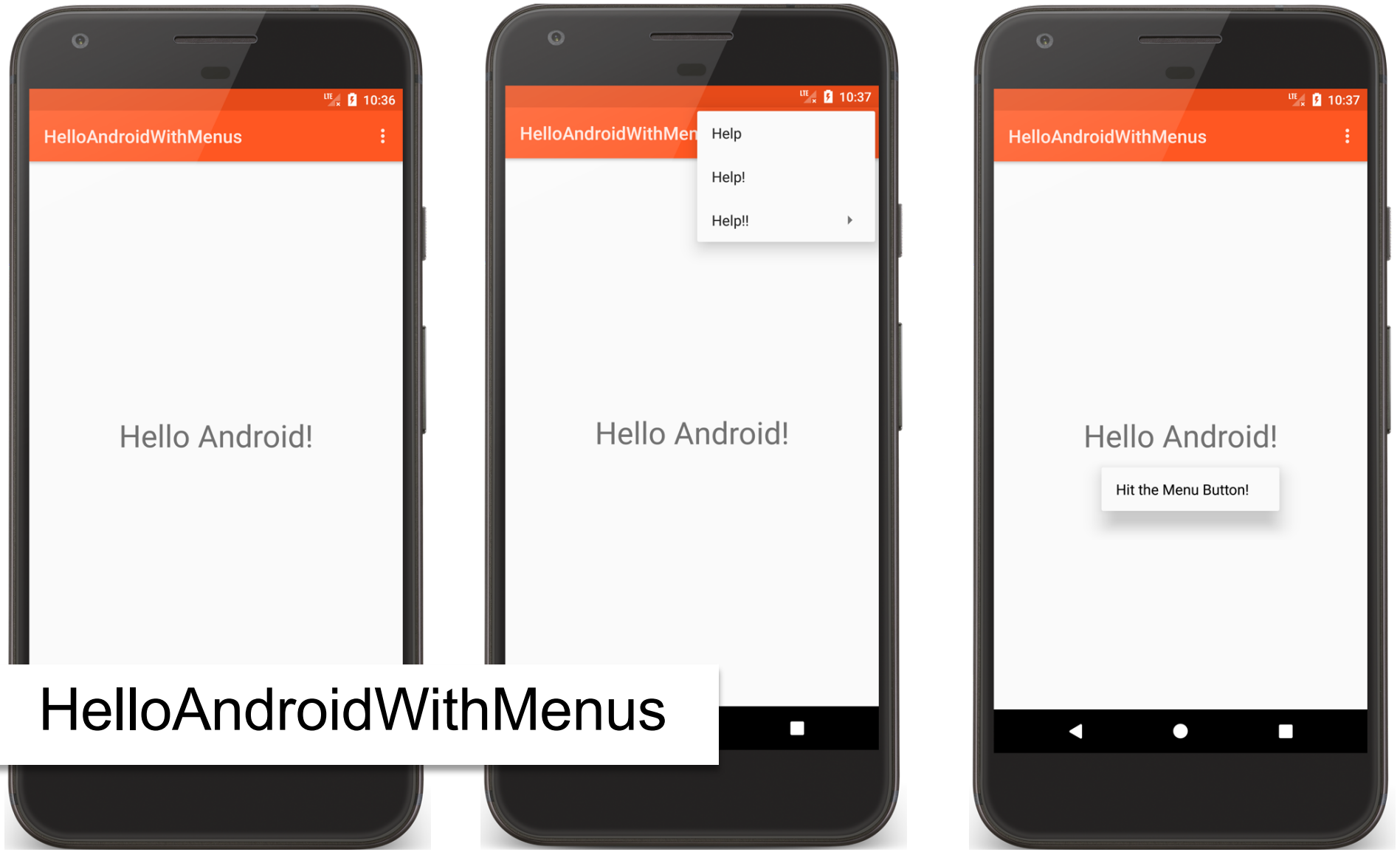
Creating Menus

- Define menu resource in XML file
  - Store in res/menu/filename.xml

Creating Menus

Inflate menu resource using Menu Inflater in onCreate{Options,Context}Menu() methods

Handling item selection in appropriate on{Options,Context}ItemsSelected() methods



HelloAndroidWithMenus

HelloAndroidWithMenuActivity.kt

```
class HelloAndroidWithMenuActivity : Activity() {
    public override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)

        setContentView(R.layout.main)

        // Long presses on TextView invoke Context Menu
        registerForContextMenu(findViewById<TextView>(R.id.text_view))

    }
```

HelloAndroidWithMenuActivity.kt

```
// Create Options Menu
override fun onCreateOptionsMenu(menu: Menu): Boolean {
    val inflater = menuInflater
    inflater.inflate(R.menu.top_menu, menu)
    return true
}
```

HelloAndroidWithMenuActivity.kt

```
// Process clicks on Options Menu items
override fun onOptionsItemSelected(item: MenuItem): Boolean {
    return when (item.itemId) {
        R.id.help -> {
            showToast(R.string.helped_string)
            true
        }
        R.id.more_help -> {
            showToast(R.string.helped_more_string)
            true
        }
        R.id.even_more_help -> true
        else -> false
    }
}
```

HelloAndroidWithMenuActivity.kt

```
// Create Context Menu
override fun onCreateContextMenu(
    menu: ContextMenu, v: View,
    menuInfo: ContextMenuInfo?
) {
    super.onCreateContextMenu(menu, v, menuInfo)
    val inflater = menuInflater
    inflater.inflate(R.menu.context_menu, menu)
}
```

HelloAndroidWithMenuActivity.kt

```
// Process clicks on Context Menu Items
override fun onContextItemSelected(item: MenuItem): Boolean {
    return when (item.itemId) {
        R.id.help_guide -> {
            showToast(R.string.context_menu_shown_string)
            true
        }
        else -> false
    }
}
```

Menus

- Many other features supported
  - Grouping menu items
  - Binding shortcut keys to menu items
  - Binding Intents to menu items

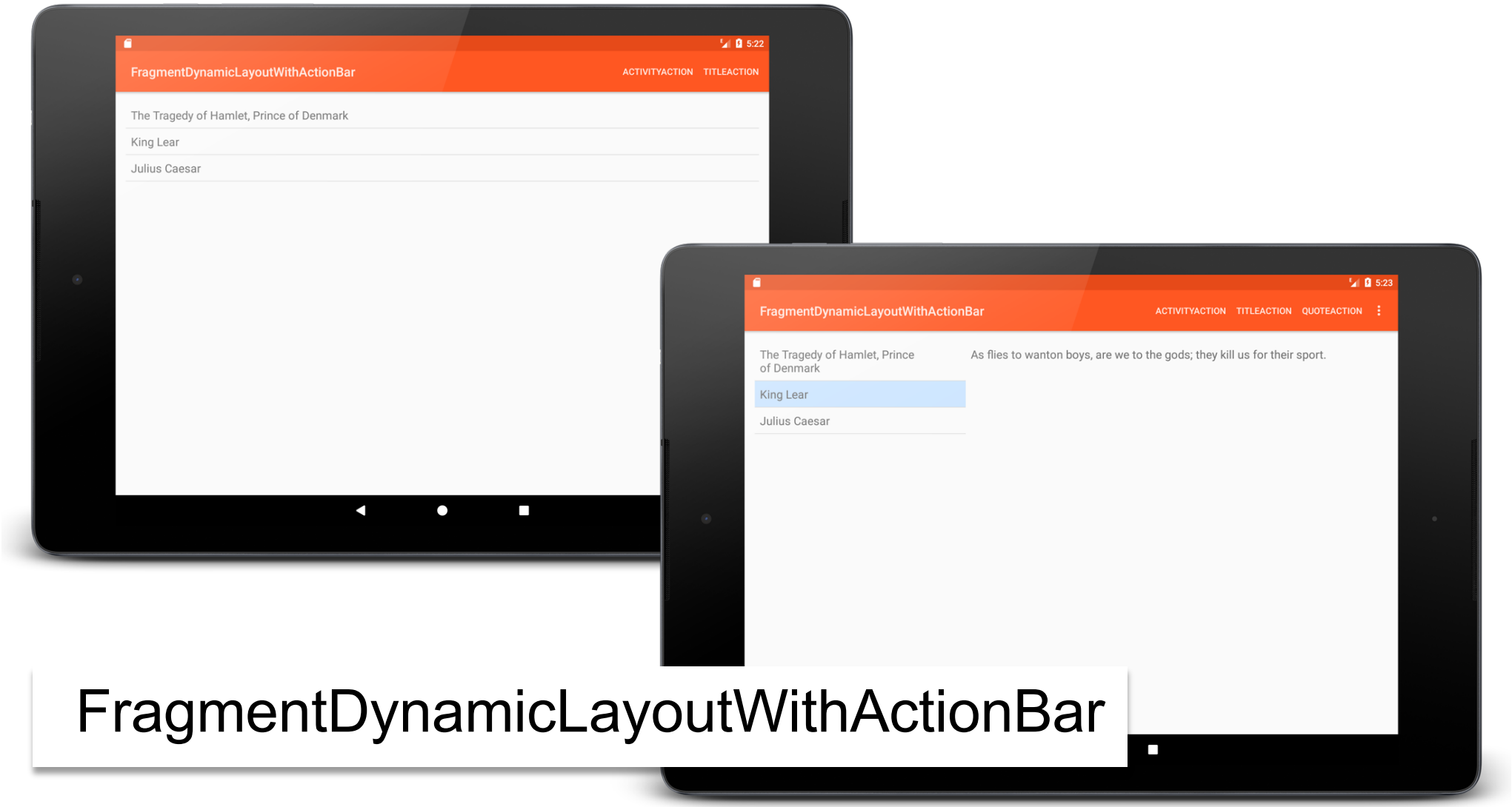
ActionBar

Similar to Application Bar in many desktop applications

Enables quick access to common operations

FragmentDynamicLayoutWithActionBar

- Shows play titles and one quote from selected play
- Provides actions for the ActionBar
- Three main objects
  - QuoteViewerActivity
  - TitleFragment
  - QuoteFragment



FragmentDynamicLayoutWithActionBar

Dialogs

Independent subwindows used by Activities to communicate with user

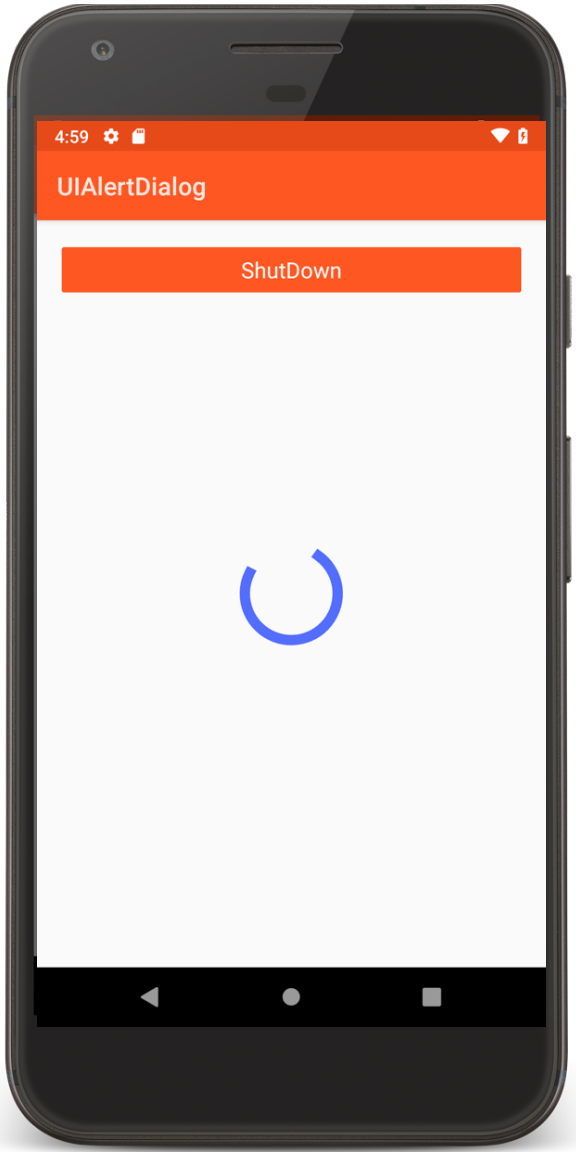
Dialog Subclasses

AlertDialog

DatePickerDialog

TimePickerDialog

UIAlertDialog



Next

Data Management

Example Applications

UIButton

UIToggleButton

UICheckbox

UIRatingBar

UIAutoCompleteTextView

UIRadioGroup

UITimePickerFragment

UIDatePickerFragment

UIWebView

UIGoogleMaps

UIListView

UIListViewWithCustom Adapter

UIRecyclerView

UISpinner

UIViewPager

UILinearLayout

UIRelativeLayout

UIConstraintLayout

UITableLayout

UIGridView

HelloAndroidWithMenus

UIAlertDialog