



Mobile Application Development

COMP-304
Fall 2018



Review of Lecture 3

❑ Declaration of Application resources:

- Declare resources, such as Strings, Integers, Booleans, Colors, Drawables, String Arrays, etc., in XML files
- Common files to use:
 - **strings.xml**
 - **color.xml**
 - **dimens.xml**
 - **drawables.xml**
- Also, you can declare resources in Java code

❑ Introduction to **Android User Interface** elements

- **View**, superclass of UI classes
- **ViewGroup**, inherits from View, represents a container which holds views
- Android Layout classes:
 - **LinearLayout**
 - **FrameLayout**
 - **RelativeLayout**
 - **ConstraintLayout**
 - **TableLayout**
 - **ScrollView**



Review of Lecture 3

❑ Simple UI controls and event handling:

- Declare Android controls in XML files, in **res\layout** folder
- Use Layout editor to create the UI
- Use the toolbars in Layout editor to arrange UI controls in the screen
- Drag UI controls from the palette to the layout
- Use Attributes window to set the values for attributes of UI controls

❑ Simple UI controls and event handling:

- TextView
- EditText
- Button
- ❑ Use findViewById method to instantiate UI objects in Java code
 - android.widget package
 - Use onClick attribute to handle Button click events
 - Use Attributes window to **associate an event handler** method in the activity class with onClick attribute



Designing UI with Views

Objectives:

- ❑ Use Menus in Android Apps
- ❑ Use Check boxes, RadioGroup & RadioButton, ImageButton, ToggleButton, ImageButton, Spinner, Progress Indicators
 - Defining UI elements
 - Event Handling
 - Handling threads



Using Menus in Android Apps

- ❑ There are three fundamental types of menus or action presentations on all versions of Android:
 - 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 "Search," "Compose email," and "Settings."
 - A **context menu** is a floating menu that appears when the user performs a long-click on an element.
 - A **popup menu** displays a list of items in a vertical list that's anchored to the view that invoked the menu
- ❑ Each menu resource is stored as a specially formatted XML files in the `/res/menu` directory
- ❑ Here's an example of a simple menu resource file `/res/menu/game_menu.xml` that defines a short menu with three items in a specific order:



Options Menu

```
?xml version="1.0" encoding="utf-8"?>
<menu xmlns:android="http://schemas.android.com/apk/res/android">
    <item
        android:id="@+id/start"
        android:title="@string/start">

    </item>

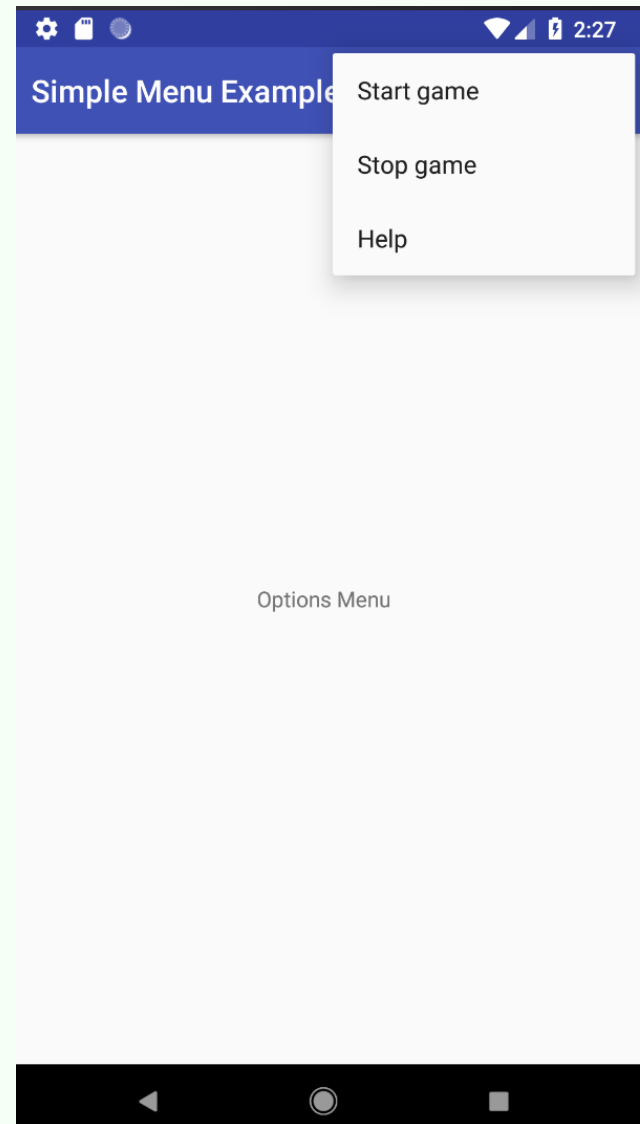
    <item
        android:id="@+id/stop"
        android:title="@string/stop">

    </item>

    <item
        android:id="@+id/help"
        android:title="@string/help">

    </item>

</menu>
```





Options Menu

- ❑ To access the preceding menu resource called `/res/menu/game_menu.xml`, simply override the method `onCreateOptionsMenu()` in your application:

@Override

```
public boolean onCreateOptionsMenu(Menu menu) {  
    MenuInflater inflater = getMenuInflater();  
    inflater.inflate(R.menu.game_menu, menu);  
    return true;  
}
```



Options Menu

❑ Handling the event when a menu option item is selected:

@Override

```
public boolean onOptionsItemSelected(MenuItem item) {  
    // Handle item selection  
    switch (item.getItemId()) {  
        case R.id.start:  
            Toast.makeText(this, "You selected start!", Toast.LENGTH_LONG).show();  
            break;  
        case R.id.stop:  
            Toast.makeText(this, "You selected stop!", Toast.LENGTH_LONG).show();  
            break;  
        case R.id.help:  
            Toast.makeText(this, "You selected help!", Toast.LENGTH_LONG).show();  
            break;  
        default:  
            return super.onOptionsItemSelected(item);  
    }  
    return true;  
}
```

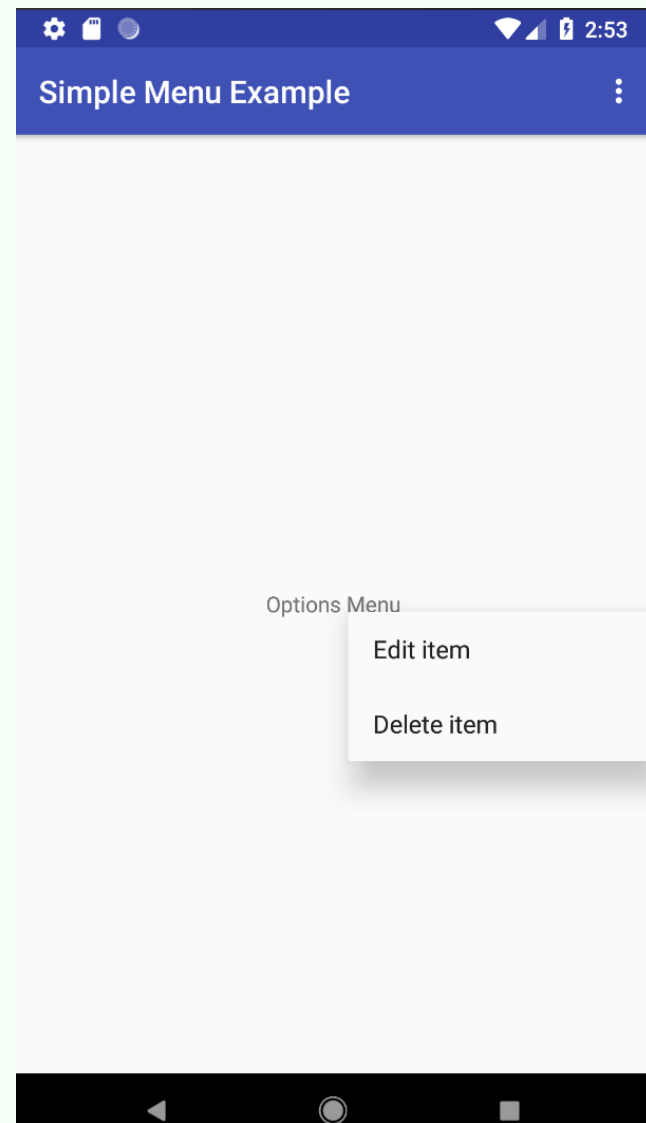
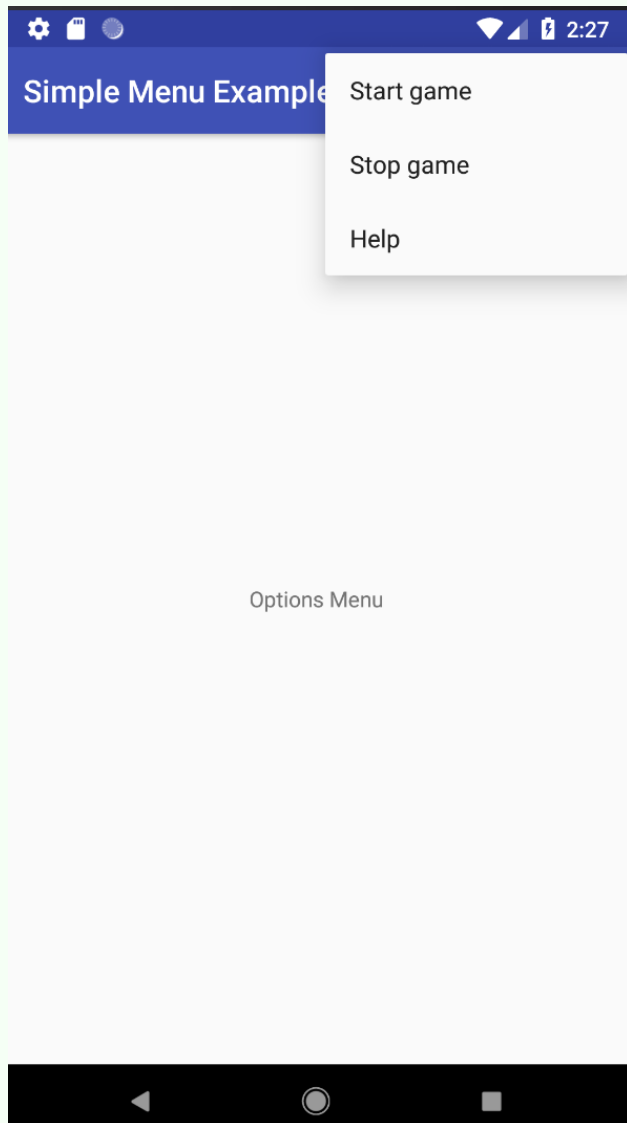



Context Menu

- ❑ Register the View to which the context menu should be associated by calling `registerForContextMenu()` and pass it the View.
- ❑ Implement the `onCreateContextMenu()` method in your Activity or Fragment.
- ❑ Implement `onContextItemSelected()` in your activity



SimpleMenuExample app



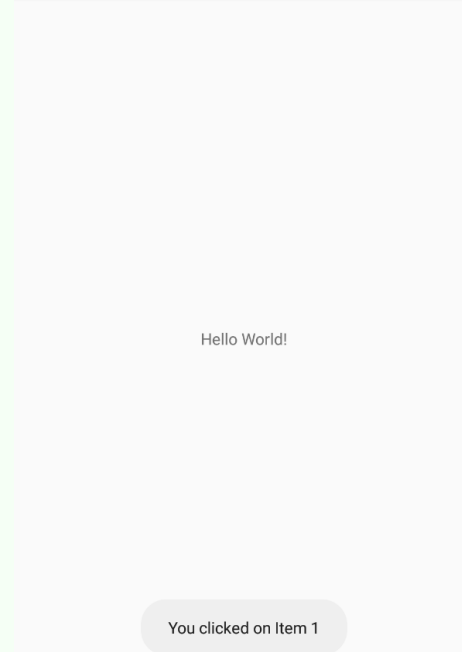


Action Bar

- ❑ Another newer feature introduced in Android 3 and 4 is the Action Bar.
- ❑ Located at the top of the device's screen, the Action Bar displays the application icon together with the activity title.
 - Optionally, on the right side of the Action Bar are *action items*.



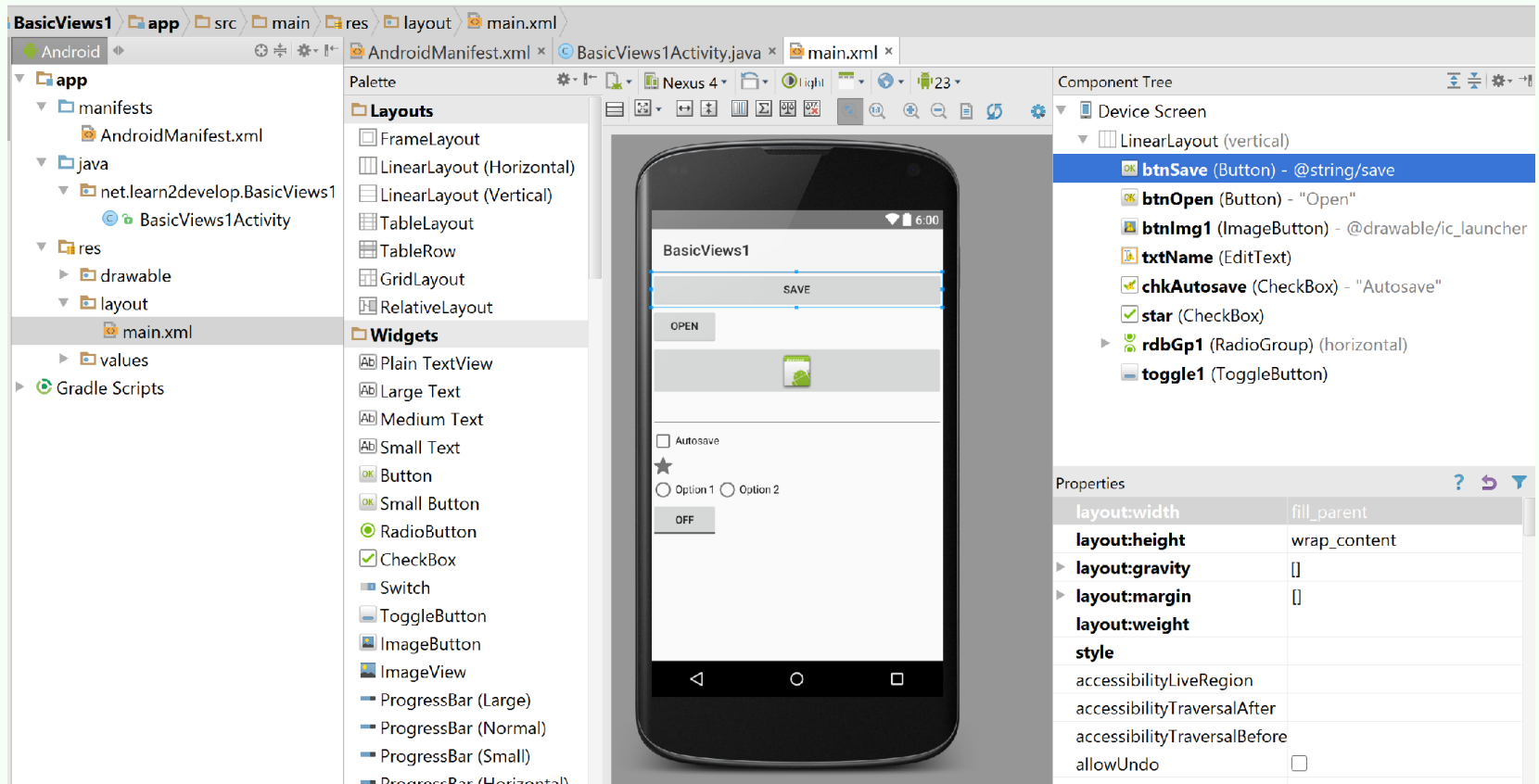
- ❑ *SimpleActionBar example*





Designing UI

- ❑ Use design editor (drag and drop)
- ❑ XML definitions will be stored in layout files





Event Handling of Basic Views

1. **Create a reference to the control** using **findViewById** method:

```
Button btnOpen = (Button) findViewById(R.id.btnOpen);
```

2. **Register the control** with a proper listener:

```
btnOpen.setOnClickListener(new View.OnClickListener() {
```

3. **//Implement the event handler method**

```
    public void onClick(View v) {  
        DisplayToast("You have clicked the Open button");  
    }  
});
```

- ❑ The code above does all it's needed for a button control click event.



Using Check Boxes

- ❑ The Android check box contains a **text** attribute that appears to the side of the check box.
- ❑ This is used in a similar way to the label of a basic button.
 - In fact, it's basically a `TextView` next to the button.
- ❑ Here's an XML layout resource definition for a `CheckBox` control:

<CheckBox

`android:id="@+id/checkbox"`

`android:layout_width="wrap_content"`

`android:layout_height="wrap_content"`

`android:text="Check me?" />`



Event handling of Check Boxes

//1- create the check box reference

```
CheckBox checkBox = (CheckBox) findViewById(R.id.chkAutosave);
```

//2- register the checkbox reference with a click listener

```
checkBox.setOnClickListener(new View.OnClickListener()  
{
```

//3- implement the event handler method

```
    public void onClick(View v) {  
        if (((CheckBox)v).isChecked())  
            DisplayToast("CheckBox is checked");  
        else  
            DisplayToast("CheckBox is unchecked");  
    }  
});
```



Using Check Boxes

- ❑ The following example checks the state of the button programmatically and changes the text label to reflect the change:

```
final CheckBox check_button = (CheckBox)
    findViewById(R.id.checkbox);
check_button.setOnClickListener(new View.OnClickListener()
{
    public void onClick (View v) {
        TextView tv = (TextView)findViewById(R.id.checkbox);
        tv.setText(check_button.isChecked() ? "This option is
            checked" : "This option is not checked");
    }
});
```




Using RadioGroups and RadioButtons

- ❑ The `RadioButton` controls are similar to `CheckBox` controls.
- ❑ They have a **text label** next to them, set via the `text` attribute, and they have a **state** (checked or unchecked)
- ❑ However, you should group **`RadioButton`** objects inside a **`RadioGroup`** that handles enforcing their combined states so that **only one `RadioButton` can be checked at a time.**



Using RadioGroups and RadioButtons

- ❑ The XML layout resource definition below shows a RadioGroup containing four RadioButton objects

```
<RadioGroup android:id="@+id/RadioGroup01"  
    android:layout_width="wrap_content"  
    android:layout_height="wrap_content">  
    <RadioButton  
        android:id="@+id/RadioButton01"  
        android:layout_width="wrap_content"  
        android:layout_height="wrap_content"  
        android:text="Option 1">  
    </RadioButton>
```



Using RadioGroups and RadioButtons

```
<RadioButton android:id="@+id/RadioButton02"  
    android:layout_width="wrap_content"  
    android:layout_height="wrap_content"  
    android:text="Option 2"></RadioButton>  
<RadioButton android:id="@+id/RadioButton03"  
    android:layout_width="wrap_content"  
    android:layout_height="wrap_content"  
    android:text="Option 3"></RadioButton>  
<RadioButton android:id="@+id/RadioButton04"  
    android:layout_width="wrap_content"  
    android:layout_height="wrap_content"  
    android:text="Option 4"></RadioButton>
```

```
</RadioGroup>
```



Using RadioGroups and RadioButtons

- ❑ You handle actions on these RadioButton objects through the RadioGroup object.
- ❑ The following example shows event handling of RadioButton objects for a click event.

A screenshot of an Android application interface titled "Simple Views 1". The interface has a blue header bar with the title. Below the header is a grey bar with a "SAVE" button. Underneath is a white bar with an "OPEN" button. Below that is a grey bar containing an Android logo. A horizontal pink line separates this section from the next. The next section contains a checked checkbox labeled "Autosave", a grey star icon, and two radio buttons: "Option 1" (which is selected with a pink dot) and "Option 2" (which is unselected with a grey dot). Below these is a grey bar with an "OFF" button. At the bottom of the screen, a grey rounded rectangle contains the text "Option 1 checked!".



Event handling of Radio buttons

//1- create the radio group reference

```
RadioGroup radioGroup = (RadioGroup) findViewById(R.id.rdbGp1);
```

//2- register the radio group reference with a click listener

```
radioGroup.setOnCheckedChangeListener(new OnCheckedChangeListener()  
{
```

//3- implement the event handler method

```
    public void onCheckedChanged(RadioGroup group, int checkedId)  
    {  
        RadioButton rb1 = (RadioButton) findViewById(R.id.rdb1);  
        if (rb1.isChecked()) {  
            DisplayToast("Option 1 checked!");  
        } else {  
            DisplayToast("Option 2 checked!");  
        }  
    }  
});
```



Using RadioGroups and RadioButtons

- ❑ The following example checks for the state of the radio button and changes the text label to reflect the change:

```
final RadioGroup group =  
    (RadioGroup)findViewById(R.id.RadioGroup01);  
final TextView tv = (TextView) findViewById(R.id.TextView01);  
group.setOnCheckedChangeListener(new  
    RadioGroup.OnCheckedChangeListener() {  
    public void onCheckedChanged( RadioGroup group, int checkedId) {  
        if (checkedId != -1) {  
            RadioButton rb = (RadioButton) findViewById(checkedId);  
            if (rb != null) { tv.setText("You chose: " + rb.getText());}  
        }  
        else { tv.setText("Choose 1");}  
    }  
});
```



Using RadioGroups and RadioButtons

- ❑ The entire RadioGroup can be cleared so that none of the RadioButton objects are selected.
- ❑ The following example demonstrates how to do this in response to a button click outside of the RadioGroup:

```
final Button clear_choice = (Button)
    findViewById(R.id.Button01);
clear_choice.setOnClickListener(new View.OnClickListener() {
    public void onClick(View v) { RadioGroup group =
        (RadioGroup) findViewById(R.id.RadioGroup01);
        if (group != null) {
            group.clearCheck();
        }
    }
})
```



Toggle buttons

- ❑ A **Toggle** Button is similar to a check box in behavior but is usually used to show or alter the **on** or **off state** of something.
- ❑ Like the CheckBox, it **has a state** (checked or not).
- ❑ Unlike the CheckBox, it does not show text next to it. Instead, it **has two text fields**.
 - The first attribute is **textOn**, which is the text that displays on the button when its checked state is on.
 - The second attribute is **textOff**, which is the text that displays on the button when its checked state is off.



Toggle buttons

- ❑ The following layout code shows a definition for a toggle button that shows “Enabled” or “Disabled” based on the state of the button:

<ToggleButton

android:id="@+id/toggle_button"

android:layout_width="wrap_content"

android:layout_height="wrap_content"

android:text="Toggle"

android:**textOff**="Disabled"

android:**textOn**="Enabled" />



Event handling of Toggle buttons

//1- create the toggle button reference

```
ToggleButton toggleButton = (ToggleButton) findViewById(R.id.toggle1);
```

//2- register the radio group reference with a click listener

```
toggleButton.setOnClickListener(new View.OnClickListener()  
{
```

//3- implement the event handler method

```
    public void onClick(View v) {  
        if (((ToggleButton)v).isChecked())  
            DisplayToast("Toggle button is On");  
        else  
            DisplayToast("Toggle button is Off");  
    }  
});
```



Validating Input

❑ Using attributes of UI controls:

➤ **maxLength**

```
<EditText
    android:id="@+id/editText1"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:maxLength="5" />
```

❑ Using **Input Filters** programmatically:

- Here is an example of an EditText control with two **built-in filters** that might be appropriate for a two-letter state abbreviation:

```
final EditText text_filtered = (EditText)
    findViewById(R.id.input_filtered);
text_filtered.setFilters(new InputFilter[] {
    new InputFilter.AllCaps(), new InputFilter.LengthFilter(2)
});
```



Using Spinner Controls

- ❑ Limit the choices available for users to type:
 - set the available choices in the layout definition by using **the entries attribute** with an array resource (specifically a string-array that is referenced as something such as `@array/state/province-list`):
- ❑ Here is an example of the XML layout definition for a Spinner control for choosing a color:

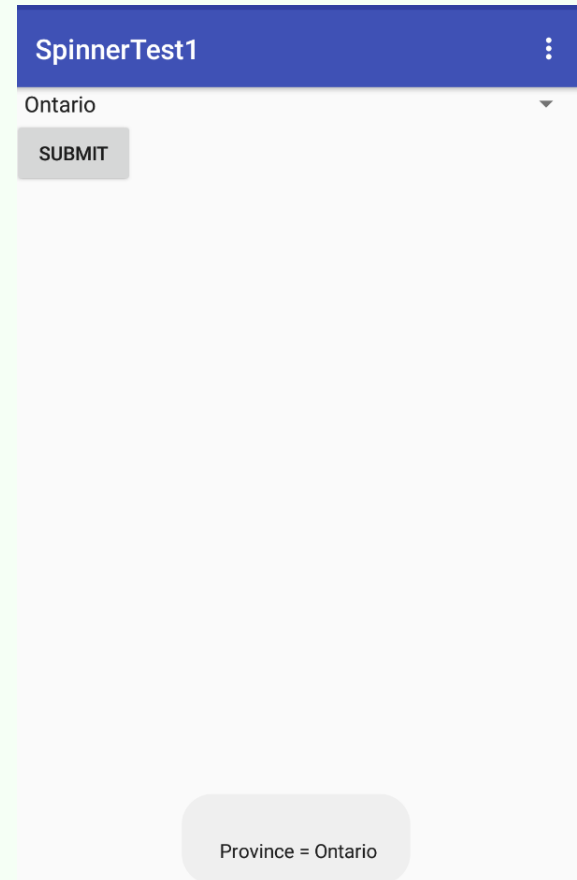
```
<Spinner  
    android:id="@+id/Spinner01"  
    android:layout_width="wrap_content"  
    android:layout_height="wrap_content"  
    android:entries="@array/colors"  
    android:prompt="@string/spin_prompt" />
```



Spinner Control example

- ❑ Retrieve the selected View and extract the text directly:

```
final Spinner spin = (Spinner)
    findViewById(R.id.provinces_spinner);
final Button submit =
    (Button)findViewById(R.id.submit);
submit.setOnClickListener(new
    OnClickListener() {
        public void onClick(View v) {
            TextView text_sel =
                (TextView)spin.getSelectedView();
            Toast.makeText(MainActivity.this, "\n
spinner = "+text_sel.getText(),
                Toast.LENGTH_SHORT).show();
        }
    });
```

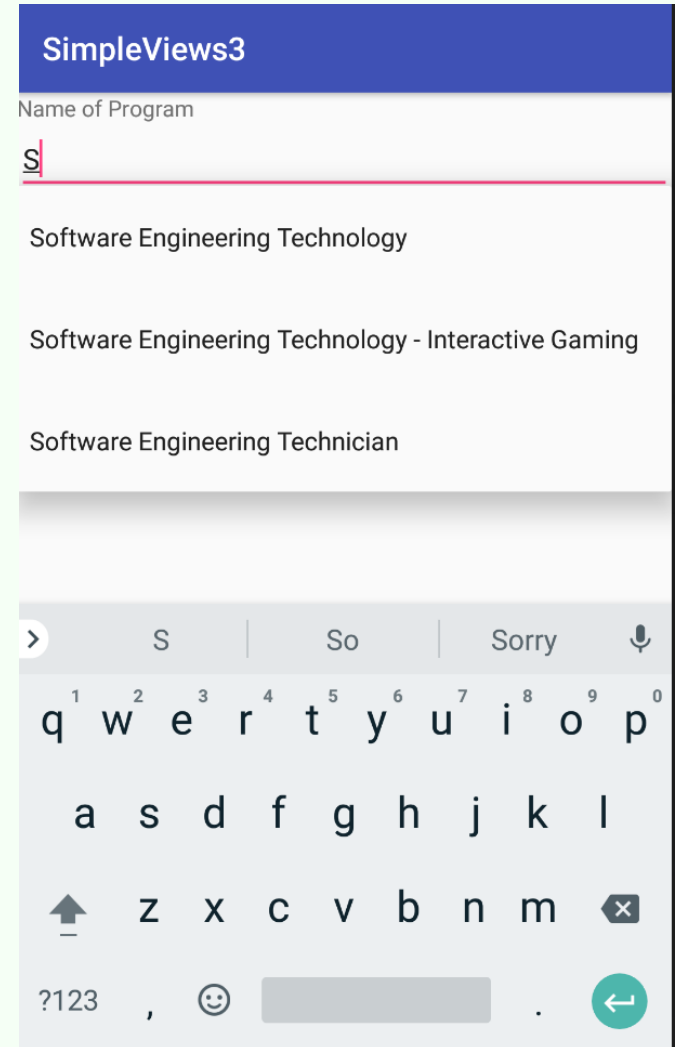


Filtering choices with a **spinner** control



AutoCompleteTextView View

- ❑ The **AutoCompleteTextView** is a view that is similar to EditText (in fact it is a subclass of EditText), except that it **shows a list of completion suggestions automatically while the user is typing.**





AutoCompleteTextView View

- ❑ An **ArrayAdapter** object manages the array of strings that will be displayed by the **AutoCompleteTextView**.

```
String[] programs = { "Software Engineering Technology",  
                      "Interactive Gaming", "Health Informatics Technology",  
                      "Mobile Apps Development", "Software Engineering  
Technician" };
```

- ❑ You set the **AutoCompleteTextView** to display in the ***simple_dropdown_item_1line*** mode:

```
ArrayAdapter<String> adapter = new ArrayAdapter<String>(this,  
              android.R.layout.simple_dropdown_item_1line, programs);  
AutoCompleteTextView textView = (AutoCompleteTextView)  
    findViewById(R.id.txtPrograms);  
textView.setThreshold(2);  
textView.setAdapter(adapter);
```



Using ImageButton

- ❑ An **ImageButton** is, for most purposes, almost exactly like a basic button.
 - Click actions are handled in the same way.
- ❑ The primary difference is that you can set its **src attribute to be an image**.
- ❑ Here is an example of an ImageButton definition in an XML layout resource file:

```
<ImageButton  
    android:layout_width="wrap_content"  
    android:layout_height="wrap_content"  
    android:id="@+id/image_button"  
    android:src="@drawable/droid" />
```




Progress Indicators

- ❑ The Android SDK provides several types of progress bars.
- ❑ The **standard progress** bar is a **circular** indicator that only animates.
 - It only shows that something is taking place
 - There **are three sizes** of this type of progress indicator
- ❑ A basic **indeterminate** progress bar:
`<ProgressBar`
 `android:id="@+id/progress_bar"`
 `android:layout_width="wrap_content"`
 `android:layout_height="wrap_content" />`
- ❑ The **default style is for a medium-size circular progress indicator**





Progress Indicators

- ❑ Two other styles for indeterminate progress bar are **progressBarStyleLarge** and **progressBarStyleSmall**.
 - This style animates automatically
 - When the value reaches the maximum value, the indicators fade away so that they aren't visible.
- ❑ The following code demonstrates how to place this type of indeterminate progress indicator on your Activity screen:

```
requestWindowFeature(Window.FEATURE_INDETERMINATE_PROGRESS);
requestWindowFeature(Window.FEATURE_PROGRESS);
setContentView(R.layout.indicators);
setProgressBarIndeterminateVisibility(true);
setProgressBarVisibility(true);
setProgress(5000);
```



Progress Indicators

- ❑ We can set the indicator progress status programmatically as follows:

```
Progress = (ProgressBar) findViewById(R.id.progress_bar);  
Progress.setProgress(75);
```

- Setting the progress to 75 shows the indicator at 75 percent complete



Progress Indicators

- ❑ The second type is a **horizontal progress** bar that **shows the completeness** of an action.
 - For example, you can see how much of a file is downloading.
 - This horizontal progress bar can also have a secondary progress indicator on it
- ❑ This example shows the layout definition for a horizontal progress indicator:

```
<ProgressBar android:id="@+id/progressbar"
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    style="@android:style/Widget.ProgressBar.Horizontal" />
```



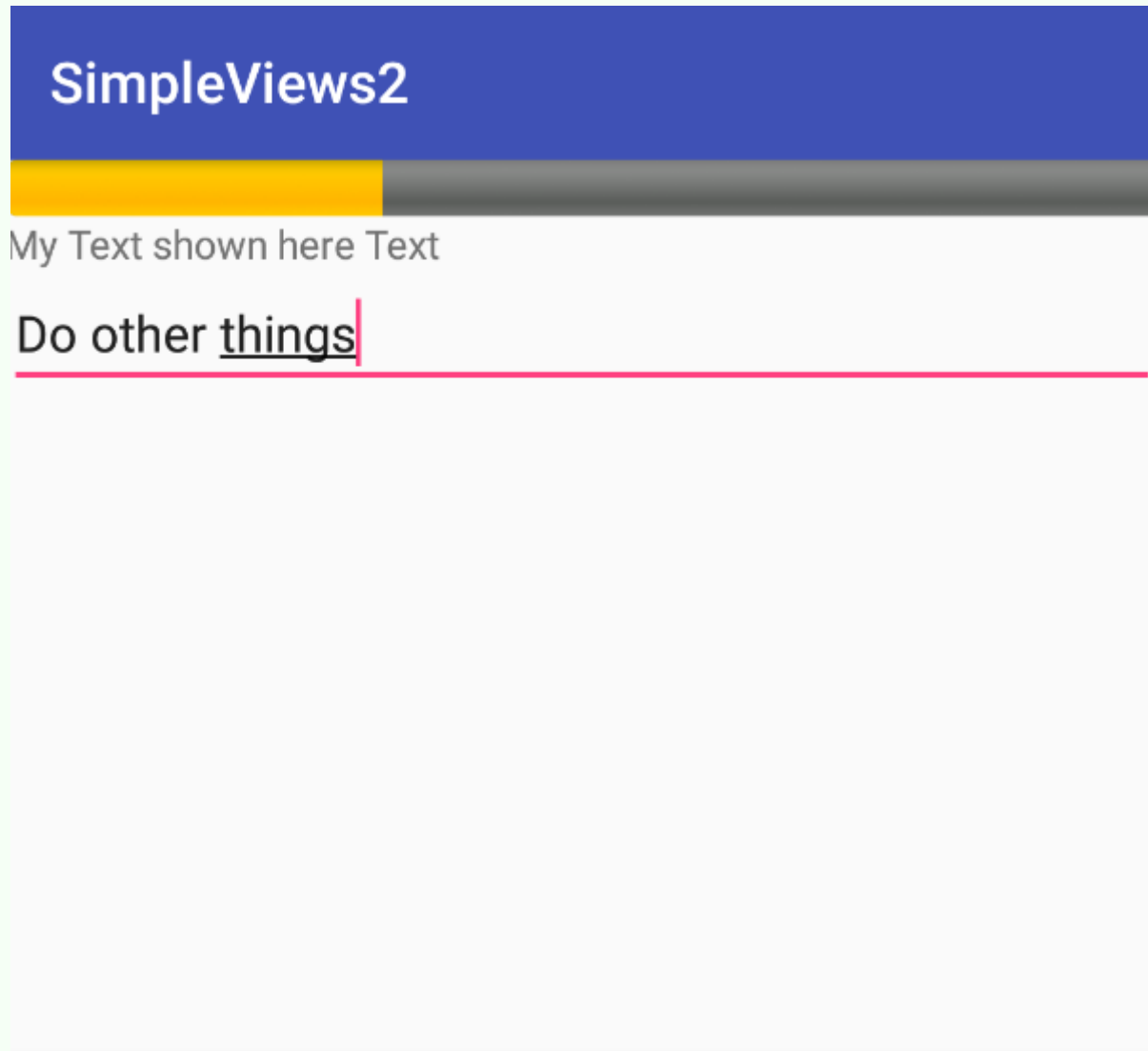
Android UI thread

- ❑ Android's main thread launched by the system is called UI thread. Android requires:
 - **Do not block the UI thread** – create other threads to do some time consuming work
 - **Do not access the Android UI toolkit from outside the UI thread** – to communicate with the UI thread from your new thread, just post a message to the Handler created on the UI thread:

```
while (progressStatus < 500)
{
    progressStatus = doSomeWork();
    //Update the progress bar
    handler.post(new Runnable()
    {
        public void run() {
            progressBar.setProgress(progressStatus);
        }
    });
}
```



SimpleViews2 example





Adjusting Progress with **SeekBar**

- ❑ **SeekBar looks** like the regular horizontal progress bar, but **includes a thumb**, or selector, that can be dragged by the user.
 - A default thumb selector is provided, but you can **use any drawable item as a thumb**.

<SeekBar

android:id="@+id/seekbar1"

android:layout_height="wrap_content"

android:layout_width="240px"

android:max="500" />



Adjusting Progress with **SeekBar**

- ❑ To show the user what exact value the user is selecting
 - Just provide an implementation of the `onProgressChanged()` method:

```
SeekBar seek = (SeekBar) findViewById(R.id.seekbar1);
seek.setOnSeekBarChangeListener(
    new SeekBar.OnSeekBarChangeListener()
    { //start anonymous class
        public void onProgressChanged(
            SeekBar seekBar, int progress, boolean fromTouch)
        {
            ((TextView)findViewById(R.id.seek_text)).setText("Value:
                "+progress);

            seekBar.setSecondaryProgress((progress+seekBar.getMax())
                /2);
        }
    }
);
```




Displaying Rating Data with **RatingBar**

- ❑ **RatingBar** has a more specific purpose: showing ratings or getting a rating from a user:
- ❑ Here's an example of an XML layout resource definition for a **RatingBar** with four stars:

```
<RatingBar android:id="@+id/ratebar1"
android:layout_width="wrap_content"
android:layout_height="wrap_content"
android:numStars="4"
android:stepSize="0.25" />
```
- ❑ Here, users can choose any rating value between 0 and 4.0, but only in increments of 0.25, the **stepSize** value



Displaying Rating Data with RatingBar

- ❑ To show a numeric representation of this value to the user implement `onRatingChanged()` method of the `RatingBar.OnRatingBarChangeListener` class.

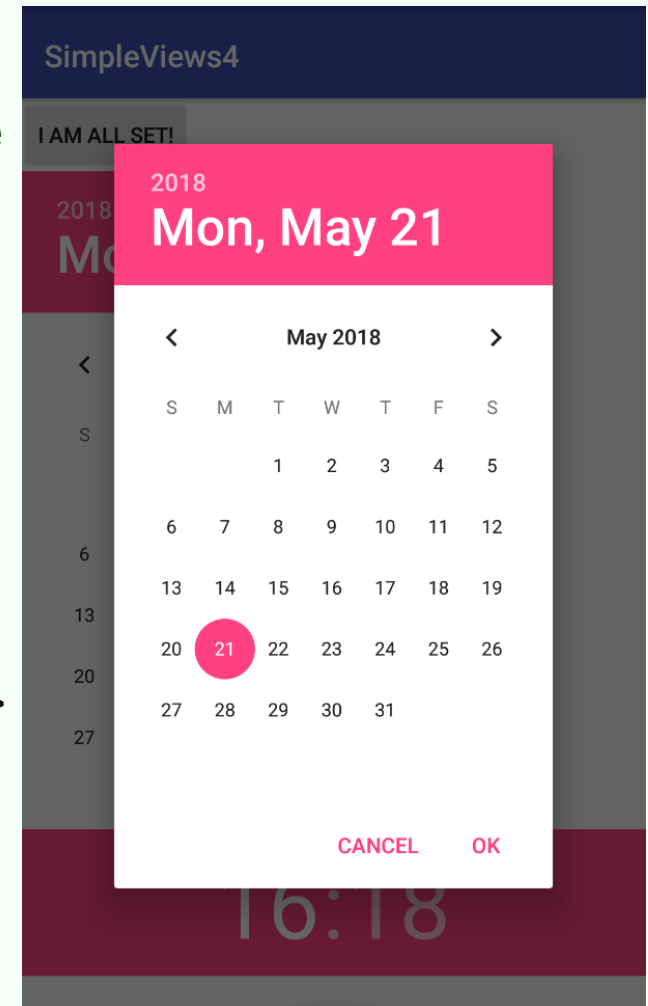
```
RatingBar rate = (RatingBar) findViewById(R.id.ratebar1);
rate.setOnRatingBarChangeListener(new
RatingBar.OnRatingBarChangeListener()
{
    public void onRatingChanged(RatingBar ratingBar,
float rating, boolean fromTouch)
    {
        ((TextView)findViewById(R.id.rating_text)).setText("Rating: "+
rating);
    }
});
```



Getting Dates and Times from Users

- ❑ DatePicker control can be used to get a month, day, and year from the user
- ❑ The basic XML layout resource definition for a DatePicker follows:

```
<DatePicker  
    android:id="@+id/DatePicker01"  
    android:layout_width="wrap_content"  
    android:layout_height="wrap_content" />
```





Getting Dates and Times from Users

- ❑ Your code can register to receive a method call when the date changes.
- ❑ You do this by implementing the `onDateChanged()` method.

```
final DatePicker date = (DatePicker)findViewById(R.id.DatePicker01);
date.init(date.getYear(), date.getMonth(), date.getDayOfMonth(),
new DatePicker.OnDateChangedListener() {
public void onDateChanged(DatePicker view, int year,
int monthOfYear, int dayOfMonth) { Date dt = new Date(year-1900,
monthOfYear, dayOfMonth, time.getCurrentHour(),
time.getCurrentMinute());
text.setText(dt.toString());
}
});
```



Getting Dates and Times from Users

- ❑ The preceding code sets the `DatePicker.OnDateChangeListener` by a call to the `DatePicker.init()` method.
- ❑ A `DatePicker` control is initialized with the current date.
- ❑ A `TextView` is set with the date value that the user entered into the `DatePicker` control.
- ❑ The value of 1900 is subtracted from the year parameter **to make it compatible with the `java.util.Date` class.**



Getting Dates and Times from Users

- ❑ A **TimePicker** control is similar to the DatePicker control.
 - It also doesn't have any unique attributes.
 - To register for a method call when the values change, you call `setOnTimeChangeListener()` method:

```
time.setOnTimeChangeListener(new  
    TimePicker.OnTimeChangeListener() {  
    public void onTimeChanged(TimePicker view,  
        int hourOfDay, int minute) {  
        Date dt = new Date(date.getYear()-1900, date.getMonth(),  
            date.getDayOfMonth(), hourOfDay, minute);  
        text.setText(dt.toString());  
    }  
});
```

- ❑ Sets a TextView to a string displaying the time value that the user entered



Working with Styles

- ❑ Android user interface designers can **group layout element attributes together** in styles
- ❑ Styles are tagged with the `<style>` tag and should be stored in the `/res/values/` directory.
- ❑ Style resources are defined in XML and compiled into the application binary at build time
- ❑ Styles in Android share a similar philosophy to cascading stylesheets in web design—they allow you to **separate the design from the content**.



Working with Styles

- ❑ For example, by using a style, you can take this layout XML:

```
<TextView
    android:layout_width="fill_parent"
    android:layout_height="wrap_content"
    android:textColor="#00FF00"
    android:typeface="monospace"
    android:text="@string/hello" />
```

And turn it into this:

```
<TextView
    style = "@style/mandatory_text_field_style"
    android:text="@string/hello" />
```




Working with Styles

- ❑ Here's an example of a simple style resource file `/res/values/styles.xml` containing two styles:
 - one for mandatory form fields, and one for optional form fields on `TextView` and `EditText` objects:

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <style name="mandatory_text_field_style">
        <item name="android:textColor">#000000</item>
        <item name="android:textSize">14pt</item>
        <item name="android:textStyle">bold</item>
    </style>
    <style name="optional_text_field_style">
        <item name="android:textColor">#0F0F0F</item>
        <item name="android:textSize">12pt</item>
        <item name="android:textStyle">italic</item>
    </style>
</resources>
```



Working with Styles

- ❑ Here's the **styles.xml** file again; this time, the color and text size fields are available in the other resource files: colors.xml and dimens.xml:

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <style name="mandatory_text_field_style">
        <item name="android:textColor">@color/mand_text_color</item>
        <item name="android:textSize">@dimen/important_text</item>
        <item name="android:textStyle">bold</item>
    </style>
    <style name="optional_text_field_style">
        <item name="android:textColor">@color/opt_text_color</item>
        <item name="android:textSize">@dimen/unimportant_text</item>
        <item name="android:textStyle">italic</item>
    </style>
</resources>
```



Working with Styles

- ❑ You can set each control's style attribute by referencing it as:

`style="@style/name_of_style"`

For example:

```
<TextView  
    android:id="@+id/TextView01"  
    style="@style/mandatory_text_field_style"  
    android:layout_height="wrap_content"  
    android:text="@string/mand_label"  
    android:layout_width="wrap_content" />
```



Working with Themes

- ❑ **Themes** are like styles, but instead of being applied to one layout element at a time, they **are applied to all elements of a given activity**.
- ❑ Themes are defined in exactly the same way as styles.
 - Themes use the `<style>` tag and should be stored in the `/res/values` directory.
- ❑ The only difference is that instead of applying that named style to a layout element, you define it as the **theme attribute of an activity in the AndroidManifest.xml file**



Working with Themes

- ❑ To set a theme for all the activities of your application, open the `AndroidManifest.xml` file and edit the `<application>` tag to include the `android:theme` attribute with the style name. For example:

```
<application android:theme="@style/CustomTheme">
```

- ❑ To apply a theme to just one Activity in your application, add the `android:theme` attribute to the `<activity>` tag instead:

```
<activity android:theme="@android:style/CustomTheme">
```

- ❑ You can inherit built-in themes. For example:

```
<activity android:theme="@android:style/Theme.Dialog">
```

will make your activity to look like a dialog box



Styles Example

❑ SimplyStyleTest app





References

- ❑ Textbook
- ❑ Android Documentation
- ❑ Lauren Darcey, Shane Conder: Introduction to Android Application Development: Android Essentials (5th Edition)