Introduction to Android OS, Kotlin, Android Studio, Activity Lifecycle & Intents

IN721: Mobile Application Development

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Today’s Content

- Android OS
- Kotlin
- Android Studio
- Activity lifecycle
- Intents

Android OS

History

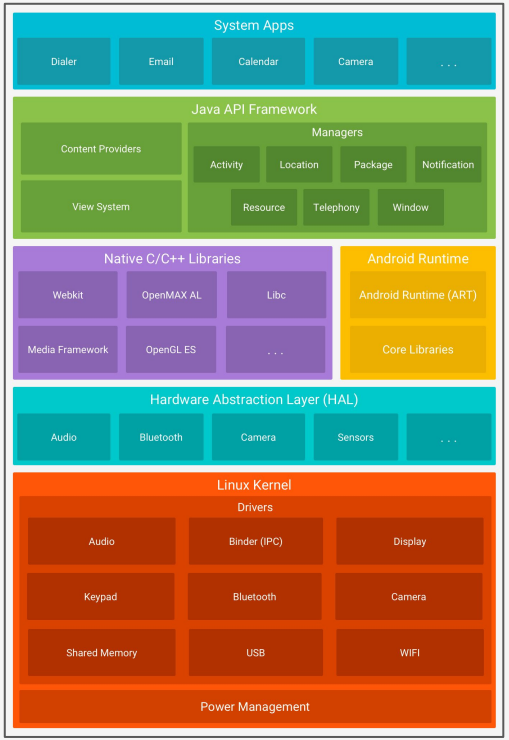
- Founded in Palo Alto, CA in October 2003
- Early intentions were to develop an advanced OS for digital cameras
- Google acquired Android Inc. in July 2005
- Developed by Open Handset Alliance (OHA)
- Defacto software for numerous smartphone manufacturing companies, i.e., Huawei, Meizu, Samsung, Xiaomi
- Android’s mascot is a green robot
- Designed by Irina Block in November 2007
- No official name. The Android team at Google call it Bugdroid
- One of the most recognisable icons in the tech world

Linux Kernel

- Based on the Linux kernel long-term support (LTS) branches
- Android uses versions 4.14, 4.4 & 4.9 of the Linux kernel
- Kernel depends on the individual device
- A Linux distribution according to the Linux Foundation

Software Stack

- Apps
- Android framework
- Native libraries
- Android runtime
  - Android runtime (ART)
  - Core libraries
- Hardware abstraction layer (HAL)
  - Audio, bluetooth, camera
- Linux Kernel
  - Drivers
  - Power management



Kotlin

Additional Resources

- Documentation - https://kotlinlang.org/docs/reference/
- Style guide - https://developer.android.com/kotlin/style-guide
- Online sandbox - https://play.kotlinlang.org/

Comments

```
// This is a single-line comment

/* This is a
   multi-line comment */
```

Variables

```
fun main() {
    val x: Int = 1
    val y = 2
    val z: Int
    z = 3
    z = 4 // Val cannot be reassigned

    var x = 1
    x += 1
    println("$x") // 2
}
```

Functions

```
fun main() { // Entry point of a Kotlin app
    println("Hello World!")
}
```

Functions

```
fun add(x: Int, y: Int): Int { // Two Int params with Int return type
   return x + y
}

fun add(x: Int, y: Int) = x + y // Expression body with inferred return type

fun main() {
    val x = 1
    val y = 2
    println(add(x, y)) // 3
}
```

Functions

```
fun add(x: Int, y: Int): Unit { // Two Int params with Unit return type
    println("$x + $y = ${x + y}")
}

fun add(x: Int, y: Int) { // Omit Unit return type
    println("$x + $y = ${x + y}")
}

fun main() {
    val x = 1
    val y = 2
    add(x, y) // 1 + 2 = 3
}
```

String Templates

```
fun main() {
    val x = 1
    val y = 2
    println("$x") // 1
    println("$x + $y = ${x + y}") // 1 + 2 = 3
}
```

Conditional Expressions

```
fun compare(x: Int, y: Int): Int {
    if (x < y) {
        return x
    } else {
        return y
    }
}

fun compare(x: Int, y: Int) = if (x < y) x else y

fun main() {
    val x = 1
    val y = 2
    println(compare(x, y)) // 1
}
```

For Loop

```
fun main() {
    val vegetables = arrayOf("broccoli", "carrot", "potato")
    for (v in vegetables) {
        println(v) // broccoli
                   // carrot
                   // potato
    }

    // or

    for (v in vegetables.indices) {
        println(vegetables[v]) // broccoli
                               // carrot
                               // potato
    }
}
```

For Loop

```
fun main() {
    for (idx in 1..10) {
        print(idx) // 12345678910
    }

    for (idx in 1..10 step 2) {
        print(idx) // 13579
    }

    for (idx in 10 downTo 1) {
        print(idx) // 10987654321
    }
}
```

While Loop

```
fun main() {
    val vegetables = arrayOf("broccoli", "carrot", "potato")
    var idx = 0
    while (idx < vegetables.size) {
        println("Vegetable at $idx is ${vegetables[idx]}") // Vegetable at 0 is broccoli
                                                           // Vegetable at 1 is carrot
                                                           // Vegetable at 2 is potato
        idx++
    }
}
```

When Expression

```
fun greeting(isoCode: String): String =
    when (isoCode) {
        "en" -> "Hello"
        "fr" -> "Bonjour"
        "it" -> "Salve"
        else -> "Greeting not found."
}

fun main() {
    var isoCode = "fr"
    println(greeting(isoCode)) // Bonjour
    isoCode = "es"
    println(greeting(isoCode)) // Greeting not found.
}
```

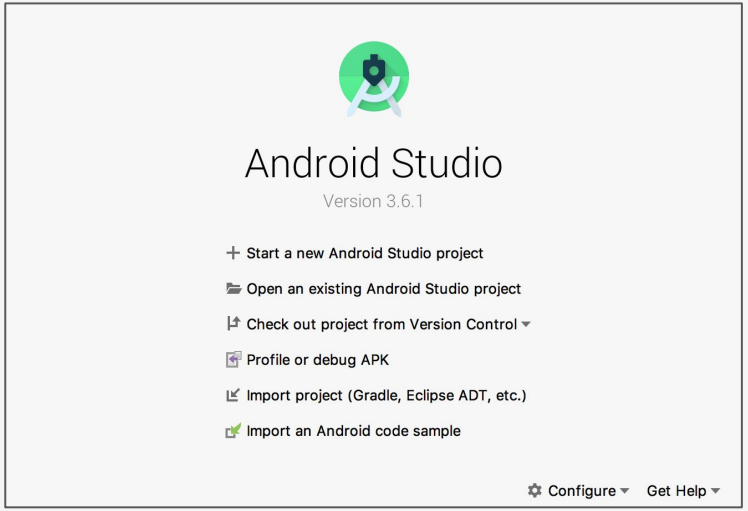
Android Studio

Android Studio

- Built on JetBrains' IntelliJ IDEA
  - Specifically designed for Android development
  - Available for download on Windows, macOS & Linux
- Supports Java, C++ & Kotlin
  - Kotlin replaced Java as Google's preferred language for Android development

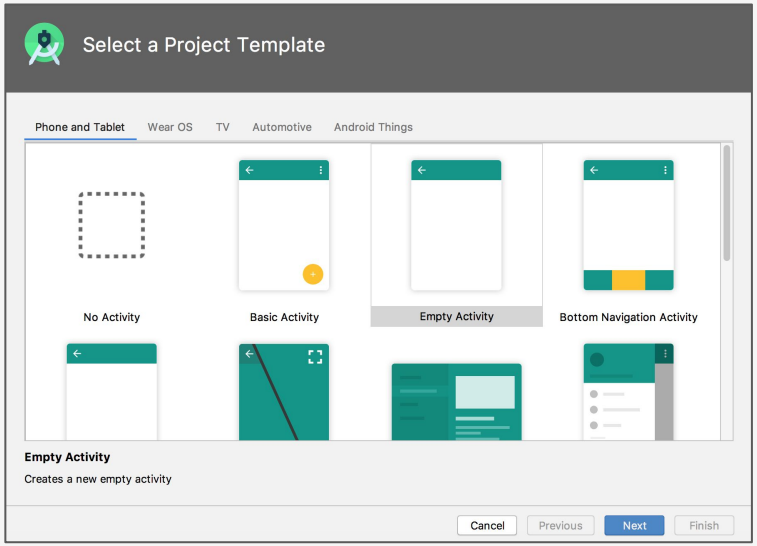
Startup

- Open Android Studio
- Start a new Android Studio project
- Download - https://developer.android.com/studio



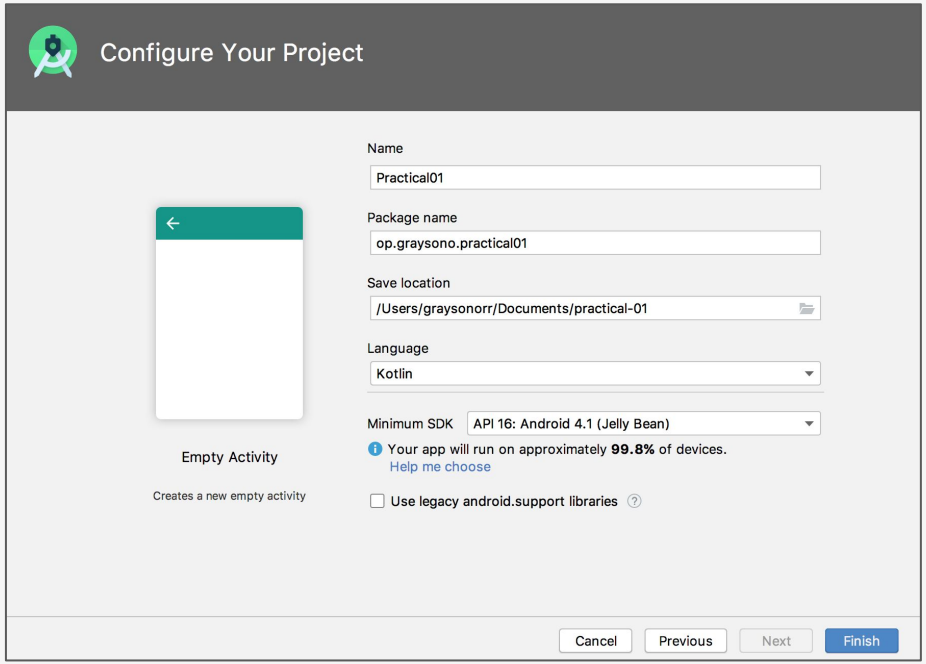
Project Template

- Select the empty activity template



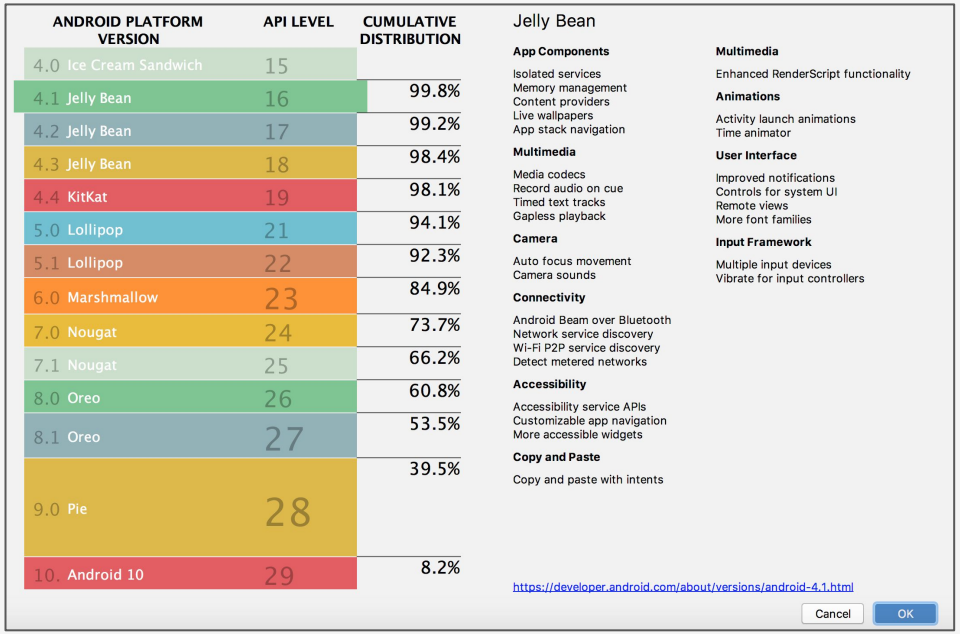
Configure Project

- Name
- Package name
- Save location
- Language
- Minimum SDK



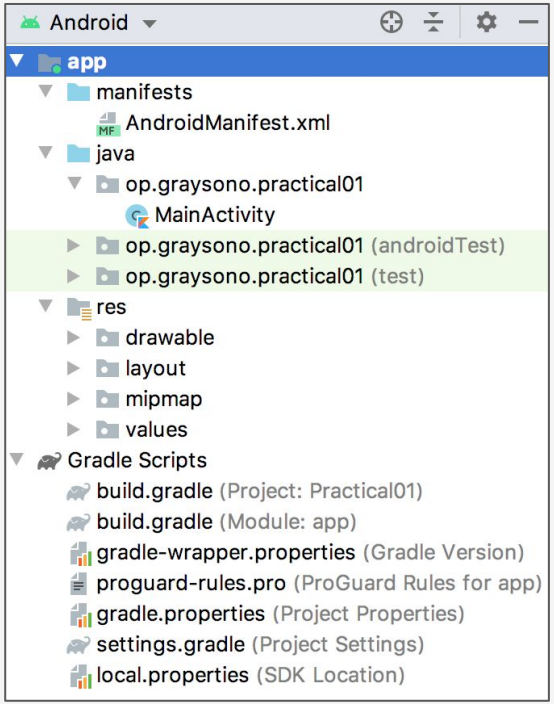
API Version Distribution

- Android platform version
- API level
- Cumulative distribution



Project Structure

- app
  - manifests
  - java
  - res
- Gradle Scripts



AndroidManifest.xml

```xml
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="op.graysono.practical01">

    <application
        android:allowBackup="true"
        android:icon="@mipmap/ic_launcher"
        android:label="@string/app_name"
        android:roundIcon="@mipmap/ic_launcher_round"
        android:supportsRtl="true"
        android:theme="@style/AppTheme">
        <activity android:name=".MainActivity">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />

                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>

</manifest>
```

AndroidManifest.xml

- The system must know that the component exists
- Reads the app’s manifest file
- Identifies any user permissions
- Declares the minimum API level
- Declares hardware & software features
- Declares API libraries

Resource Directory

- Drawable
  - A general concept for a graphic that can drawn to the screen
  - Resource: Drawable Resource
- Layout
  - Defines the architecture for the UI in an Activity or a component of a UI
  - View & ViewGroup
  - Resource: Layout Resource
- Mipmap
  - Drawable files for different launcher densities
  - Image Asset Studio
- Values
  - Colors
  - Strings
  - Styles

Colors

- colors.xml
- A color value defined in XML
- RGB value & alpha channel
- Color resource - `@android:color/<name>`
- Resource: Color Resource

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <color name="colorPrimary">#6200EE</color>
    <color name="colorPrimaryDark">#3700B3</color>
    <color name="colorAccent">#03DAC5</color>
</resources>
```

Strings

- strings.xml
- Provides text strings for an app
- Optional text styling & formatting
- String - a single string
- String array - array of strings
- Quantity strings - different strings for pluralisation
- Resource: String Resource

```
<resources>
    <string name="app_name">Practical01</string>
</resources>
```

Styles

- styles.xml
- Defines the format & look for a UI
- Can be applied to a View, activity or app
- Resource: Style Resource

```
<resources>
    <style name="AppTheme" parent="Theme.AppCompat.Light.DarkActionBar">
        <item name="colorPrimary">@color/colorPrimary</item>
        <item name="colorPrimaryDark">@color/colorPrimaryDark</item>
        <item name="colorAccent">@color/colorAccent</item>
    </style>
</resources>
```

Gradle Scripts

- build.gradle (Module)
  - Defines the module-specific build configurations
- build.gradle (Project)
  - Defines your build configurations that apply to all modules

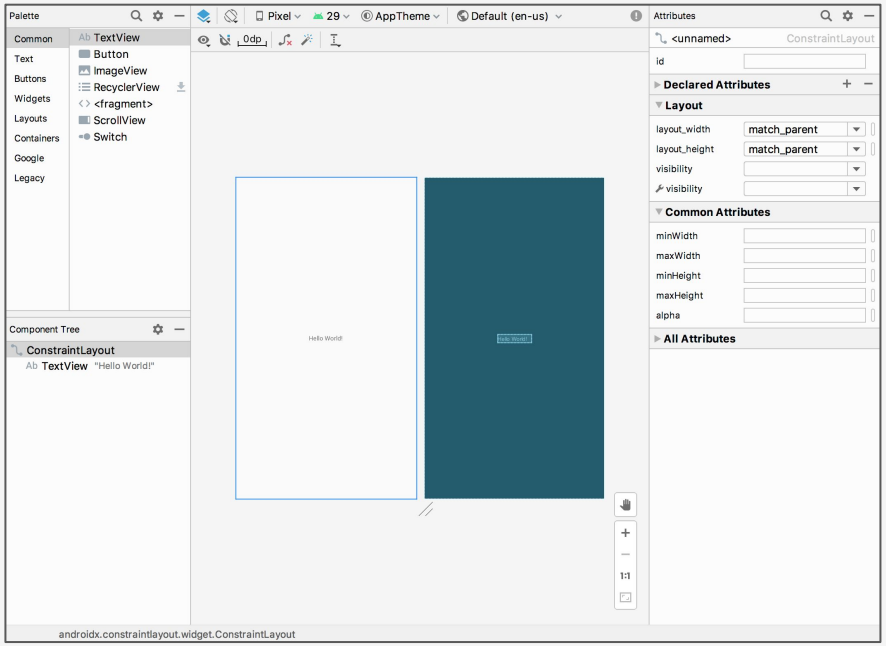
MainActivity.kt

- Default activity
- AppCompatActivity
- onCreate()
- setContentView()

```
package op.graysono.practical01

import androidx.appcompat.app.AppCompatActivity
import android.os.Bundle

class MainActivity : AppCompatActivity() {

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_main)
    }
}
```

activity_main.xml

- Design view



activity_main.xml

- Code view

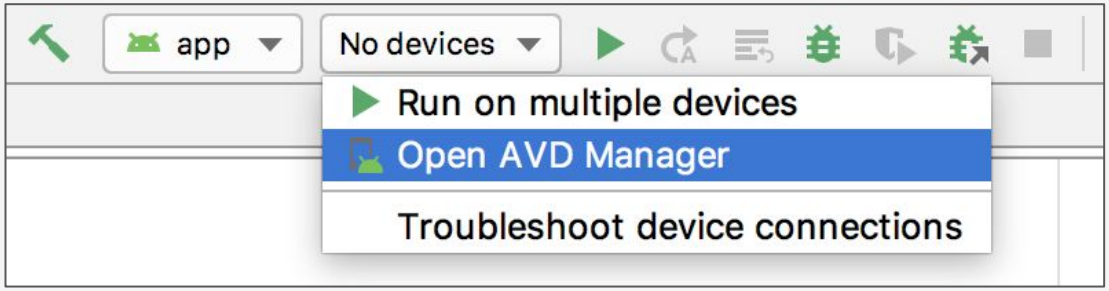
```
<?xml version="1.0" encoding="utf-8"?>
<androidx.constraintlayout.widget.ConstraintLayout
    xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context=".MainActivity">

    <TextView
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="Hello World!"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintLeft_toLeftOf="parent"
        app:layout_constraintRight_toRightOf="parent"
        app:layout_constraintTop_toTopOf="parent" />

</androidx.constraintlayout.widget.ConstraintLayout>
```

Emulator

- Simulates an Android device on your computer
- You can test your app on a variety of devices & API levels
- Provides almost all of the capabilities of a real Android device

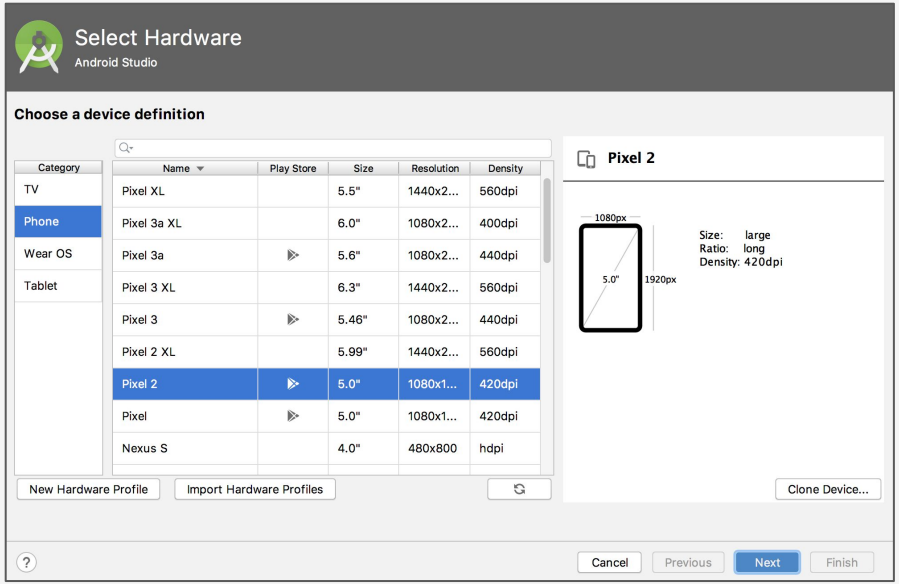
Emulator

- AVD manager



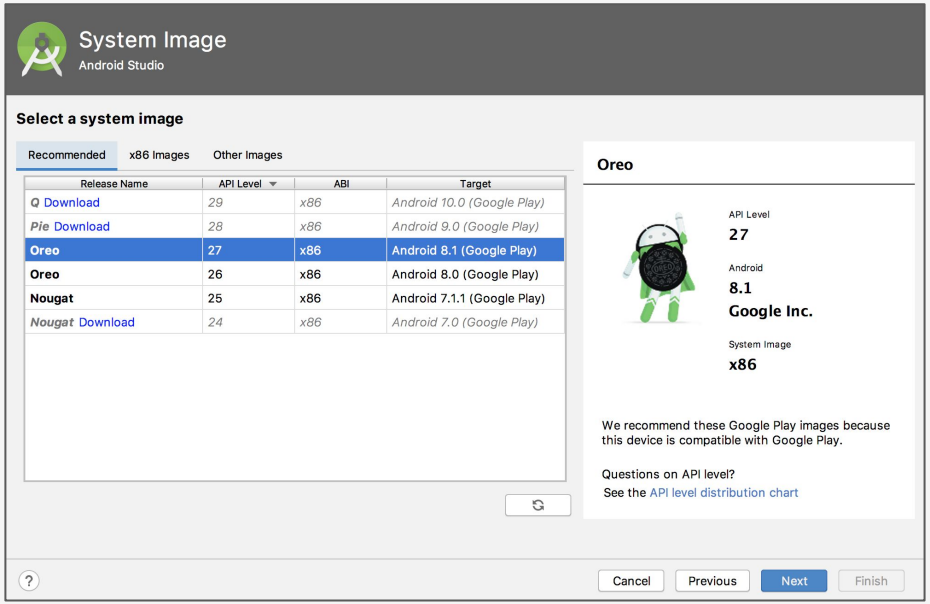
Emulator

- Choosing a device definition
  - Name
  - Play Store
  - Size
  - Resolution
  - Density



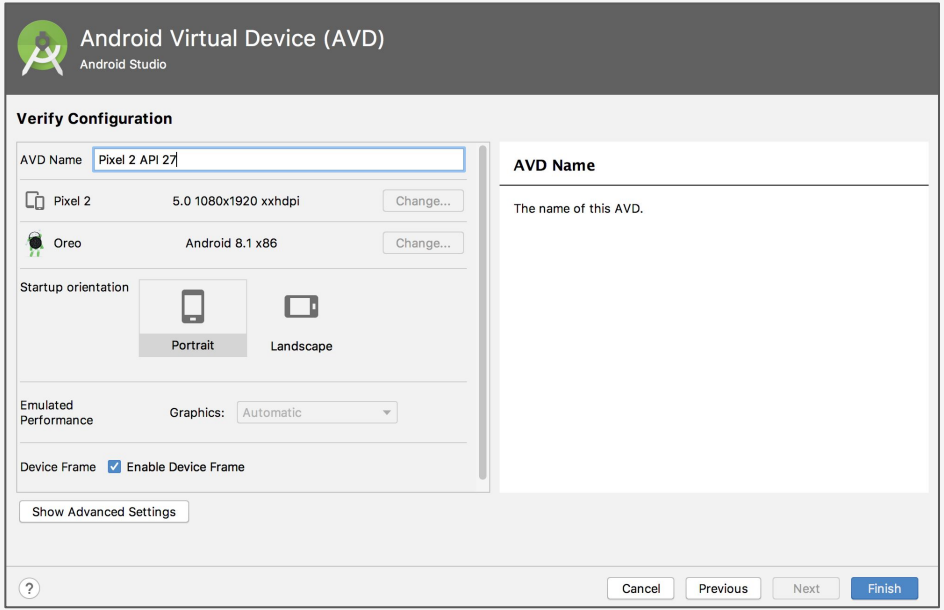
Emulator

- Selecting a system image
  - Release name
  - API level
  - ABI
  - Target



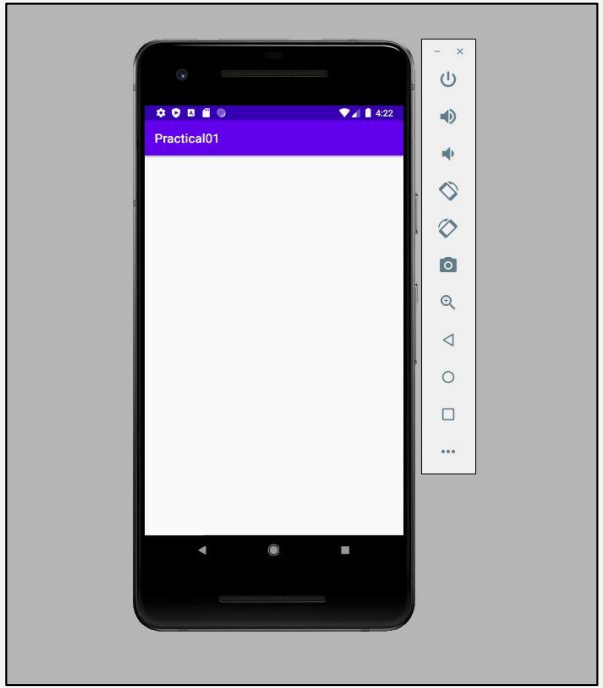
Emulator

- Verifying configuration
  - AVD name
  - Startup orientation



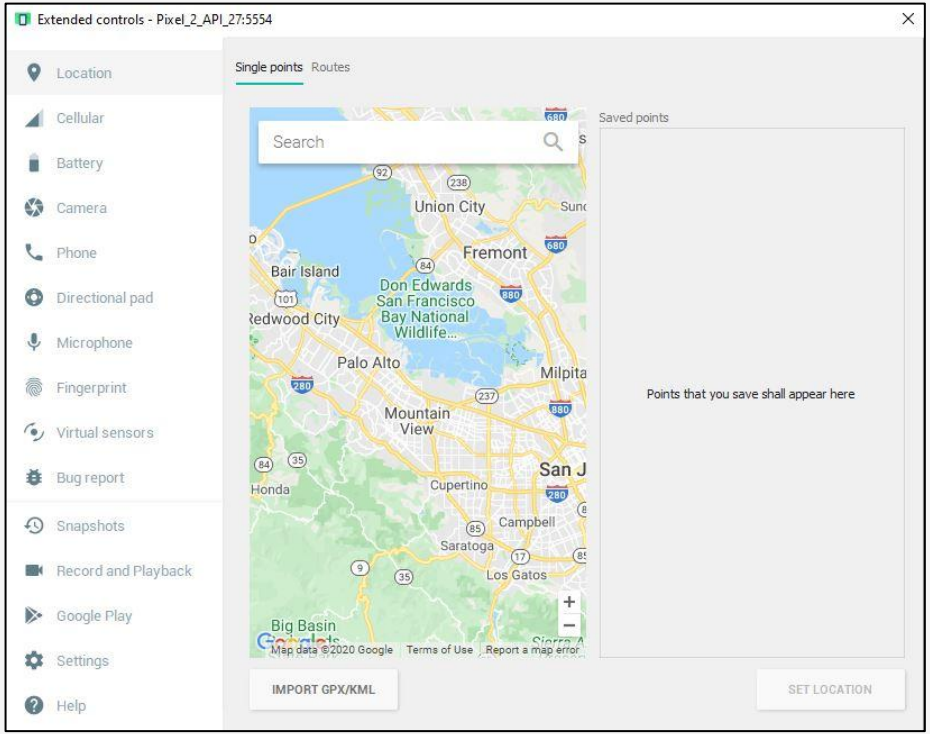
Emulator

- Click the green play button
- The emulator will boot
- Controls
  - Power
  - Volume
  - Rotate
  - Screenshot
  - Zoom
  - Back
  - Home
  - Overview
  - Extended controls (horizontal ellipsis)



Emulator

- Extended controls
  - Location
  - Cellular
  - Battery
  - Camera
  - Phone
  - Virtual sensors
  - Record & playback
  - Google Play

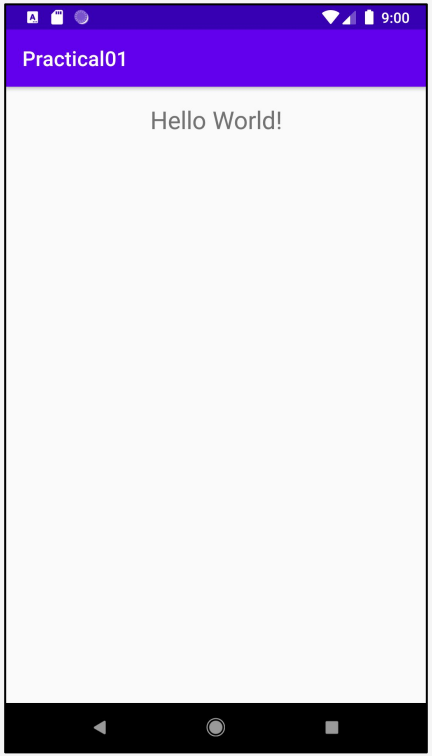


activity_main.xml

- Go to activity_main.xml
- Update the TextView
- Run app (Shift+F10)

```
<TextView
    android:id="@+id/output_text"
    android:layout_width="0dp"
    android:layout_height="wrap_content"
    android:layout_marginLeft="16dp"
    android:layout_marginTop="16dp"
    android:layout_marginRight="16dp"
    android:gravity="center"
    android:text="Hello World!"
    android:textSize="24sp"
    app:layout_constraintLeft_toLeftOf="parent"
    app:layout_constraintRight_toRightOf="parent"
    app:layout_constraintTop_toTopOf="parent" />
```

Emulator



activity_main.xml

- Add a Button
- Why is `android:text="Click Me!"` highlighted orange?

```
<Button
    android:id="@+id/click_me_button"
    android:layout_width="0dp"
    android:layout_height="wrap_content"
    android:layout_marginStart="16dp"
    android:layout_marginLeft="16dp"
    android:layout_marginTop="16dp"
    android:layout_marginEnd="16dp"
    android:layout_marginRight="16dp"
    android:text="Click Me!"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toBottomOf="@+id/output_text" />
```

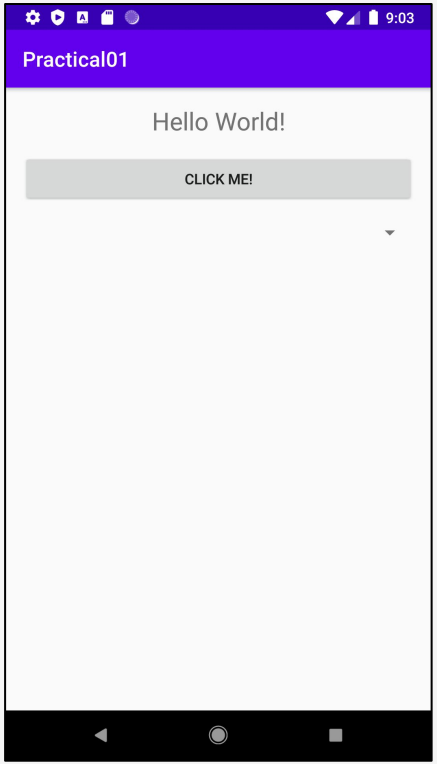
activity_main.xml

- Add a Spinner
- Run app

```
<Spinner
    android:id="@+id/months_spinner"
    android:layout_width="0dp"
    android:layout_height="wrap_content"
    android:layout_marginStart="16dp"
    android:layout_marginLeft="16dp"
    android:layout_marginTop="16dp"
    android:layout_marginEnd="16dp"
    android:layout_marginRight="16dp"
    app:layout_constraintEnd_toEndOf="parent"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toBottomOf="@+id/click_me_button" />
```

Emulator

- Click Me! Button does not do anything
- Spinner has no items



MainActivity.kt

- Go to MainActivity.kt
- Extends AppCompatActivity
- findViewById

```
class MainActivity : AppCompatActivity() {

    private lateinit var outputText: TextView
    private lateinit var clickMeButton: Button
    private lateinit var monthsSpinner: Spinner

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

        outputText = findViewById(R.id.output_text)
        clickMeButton = findViewById(R.id.click_me_button)
        monthsSpinner = findViewById(R.id.months_spinner)
    }
}
```

MainActivity.kt

- Add a click listener
- Run app

```
class MainActivity : AppCompatActivity() {

    private lateinit var outputText: TextView
    private lateinit var clickMeButton: Button
    private lateinit var monthsSpinner: Spinner

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

        outputText = findViewById(R.id.output_text)
        clickMeButton = findViewById(R.id.click_me_button)
        monthsSpinner = findViewById(R.id.months_spinner)

        clickMeButton.setOnClickListener { outputText.text = getString(R.string.foobar) // Foobar }
    }
}
```

Emulator

- Click on the **Click Me!** Button
- TextView text will be set to Foobar

MainActivity.kt

- This is not very exciting...I want to display items in the Spinner
- ArrayAdapter
  - Returns a view for each object in a collection of data objects, i.e. months string array
  - Used with list-based widgets such as ListView (legacy) & Spinner
  - Resource: ArrayAdapter

strings.xml

- Go to strings.xml
- Add a string array

```
<string-array name="months">
    <item>January</item>
    <item>February</item>
    <item>March</item>
    <item>April</item>
    <item>May</item>
    <item>June</item>
    <item>July</item>
    <item>August</item>
    <item>September</item>
    <item>October</item>
    <item>November</item>
    <item>December</item>
</string-array>
```

MainActivity.kt

- Create a private function called populateSpinner()
- Args - Spinner & Array<String>
- ArrayAdapter(Context context, int resource, List<T> objects)

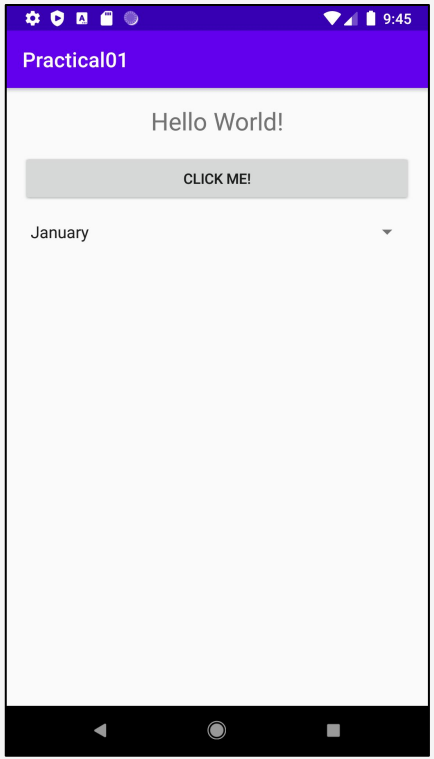
```
private fun populateSpinner(spinner: Spinner, array: Array<String>) {
    val layoutID: Int = android.R.layout.simple_spinner_item
    spinner.adapter = ArrayAdapter(this@MainActivity, layoutID, array)
}
```

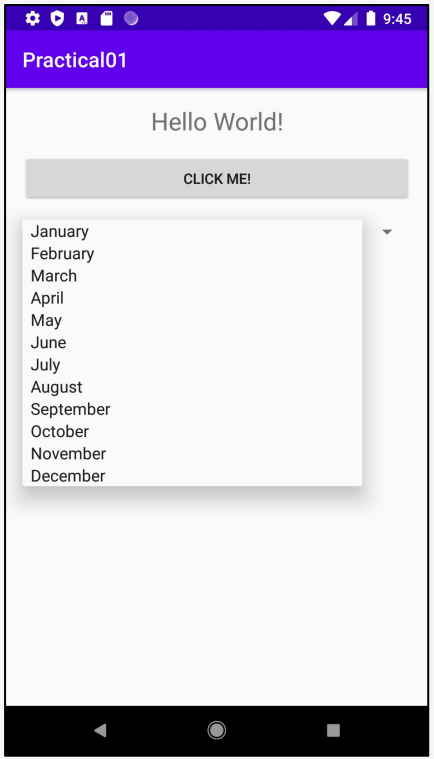
MainActivity.kt

- Call populateSpinner() in the onCreate()
- Run app

```
override fun onCreate(savedInstanceState: Bundle?) {
    super.onCreate(savedInstanceState)
    setContentView(R.layout.activity_main)

    outputText = findViewById(R.id.output_text)
    clickMeButton = findViewById(R.id.click_me_button)
    monthsSpinner = findViewById(R.id.months_spinner)

    clickMeButton.setOnClickListener { outputText.text = getString(R.string.foobar) }

    populateSpinner(monthsSpinner, resources.getStringArray(R.array.months))
}
```

Emulator


9:45
Practical01
Hello World!
CLICK ME!
January


9:45
Practical01
Hello World!
CLICK ME!
January
February
March
April
May
June
July
August
September
October
November
December

MainActivity.kt

- Alternative

```
private fun populateSpinnerAlt(spinner: Spinner, array: Int) {
    val layoutID: Int = android.R.layout.simple_spinner_item
    ArrayAdapter.createFromResource(
        this@MainActivity,
        array,
        layoutID
    ).also { adapter ->
        adapter.setDropDownViewResource(android.R.layout.simple_spinner_dropdown_item)
        spinner.adapter = adapter
    }
}
```

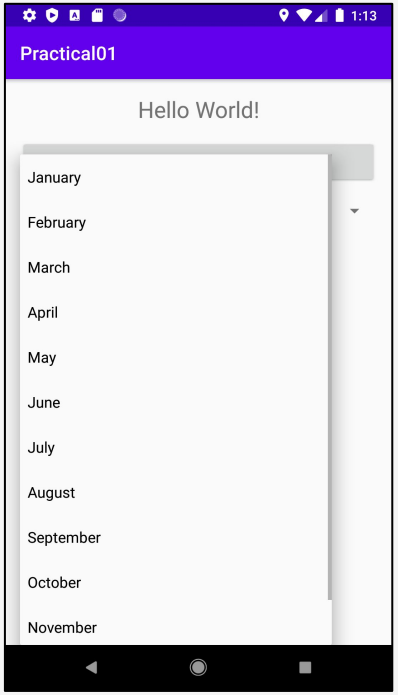
MainActivity.kt

- Comment out populateSpinner()
- Call populateSpinnerAlt() in the onCreate()
- Run app

```
override fun onCreate(savedInstanceState: Bundle?) {
    super.onCreate(savedInstanceState)
    setContentView(R.layout.activity_main)

    outputText = findViewById(R.id.output_text)
    clickMeButton = findViewById(R.id.click_me_button)
    monthsSpinner = findViewById(R.id.months_spinner)

    clickMeButton.setOnClickListener { outputText.text = getString(R.string.foobar) }

    populateSpinnerAlt(monthsSpinner, R.array.months)
}
```

Emulator

- Different drop down layout file



Practical Part 1

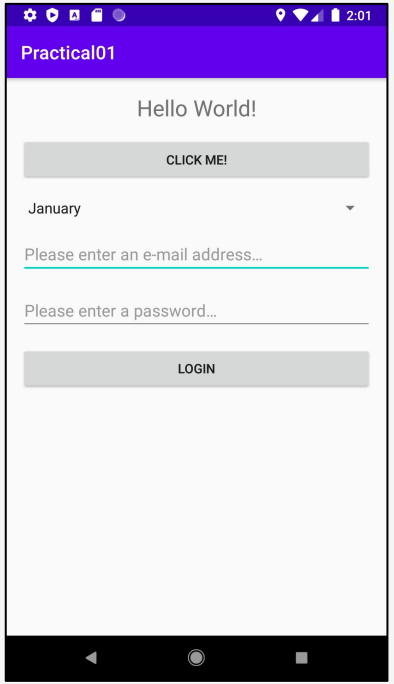
- Please use the current app
- Independent tasks:
  - Implement the code as specified in the previous lecture slides
  - Refactor the Click Me! Button click listener so the TextView text is set to the value of the selected Spinner item
  - In activity_main.xml, under the Spinner, add two EditText (one e-mail & one password) widgets
  - In activity_main.xml, under the EditText widgets, add one Button with the text Login
    - Ensure each EditText has an autofillHints attribute
    - Resource: Autofill Optimize
  - Create a Login Button click listener which gets the value from both EditText widgets & sets it to the TextView text
    - Ensure correct handling of inputs, i.e. empty inputs
    - Resources: isBlank & error

Practical Part 1 - Additional Resources

- Additional resources:
  - Special characters - Escaping Quotes
  - Formatted strings - Formatting Strings
  - Dimension - Dimension Resource

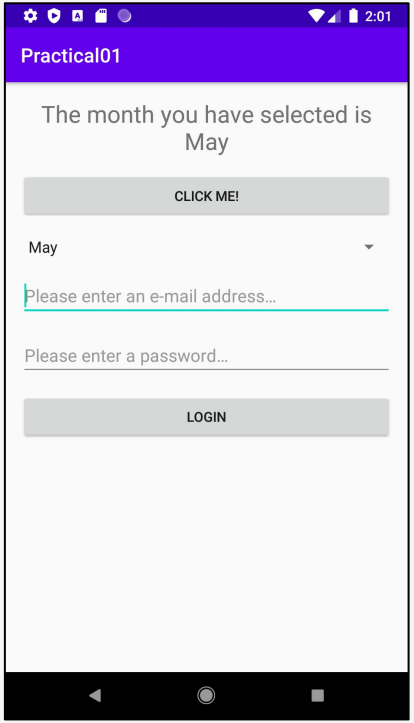
Practical Part 1 - Expected Output

- I will leave the UI upto you...just make sure you implement the required functionality



Practical Part 1 - Expected Output

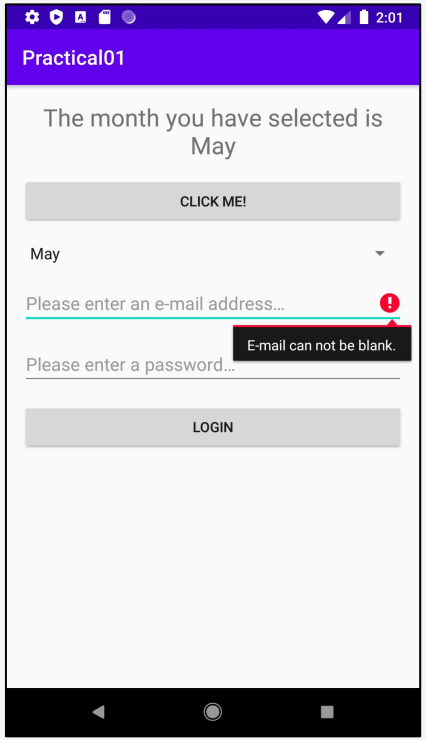
- Default Spinner item is January
- Change the Spinner item to May
- Click the Click Me! Button
- TextView text has changed

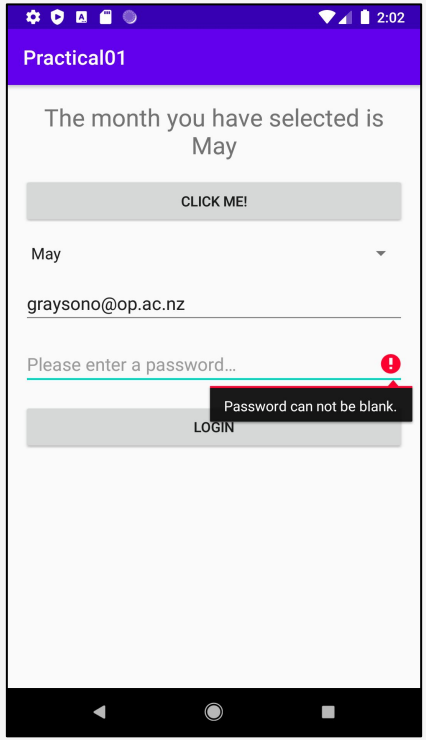


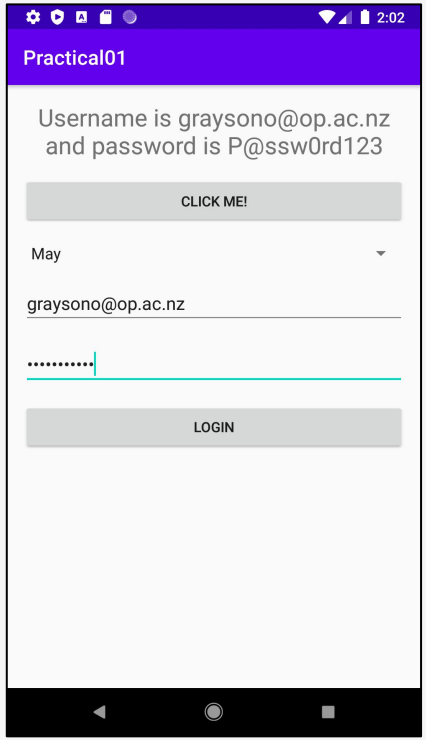
Practical Part 1 - Expected Output

- Click the Login Button
- If you have made the correct check, it should display an error on the e-mail EditText
- Enter a value into the email EditText
- Click the Login Button again
- Again, if you have made the correct check it should display an error on the password EditText
- Enter a value into the password EditText
- Click the Login Button again
- TextView text has changed

Practical Part 1 - Expected Output







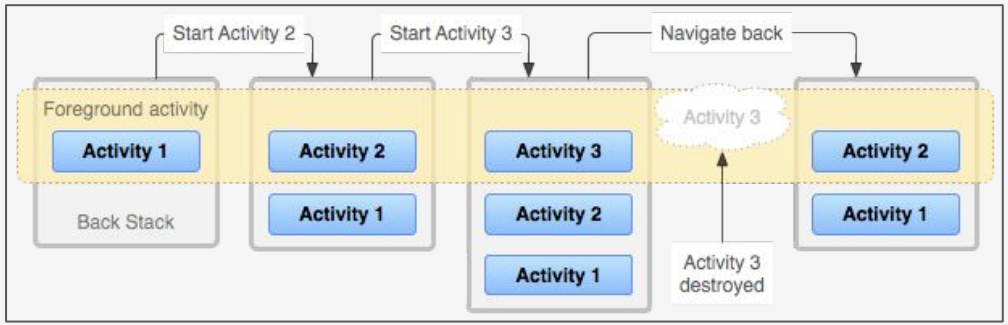
Formative Assessment

- Please write your answers to the following questions in your app:
  - What is the difference between a View & ViewGroup?
  - What does an ArrayAdapter return?

Activity Lifecycle

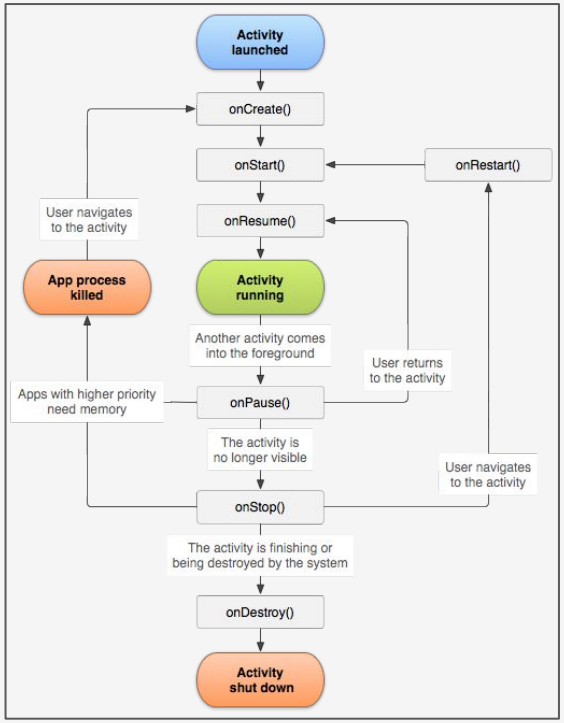
Activity Lifecycle

- What is happening here?



Activity Lifecycle

- Callback methods
  - onCreate()
  - onStart()
  - onRestart()
  - onResume()
  - onPause()
  - onStop()
  - onDestroy()
- Resource: [Activity Lifecycle]

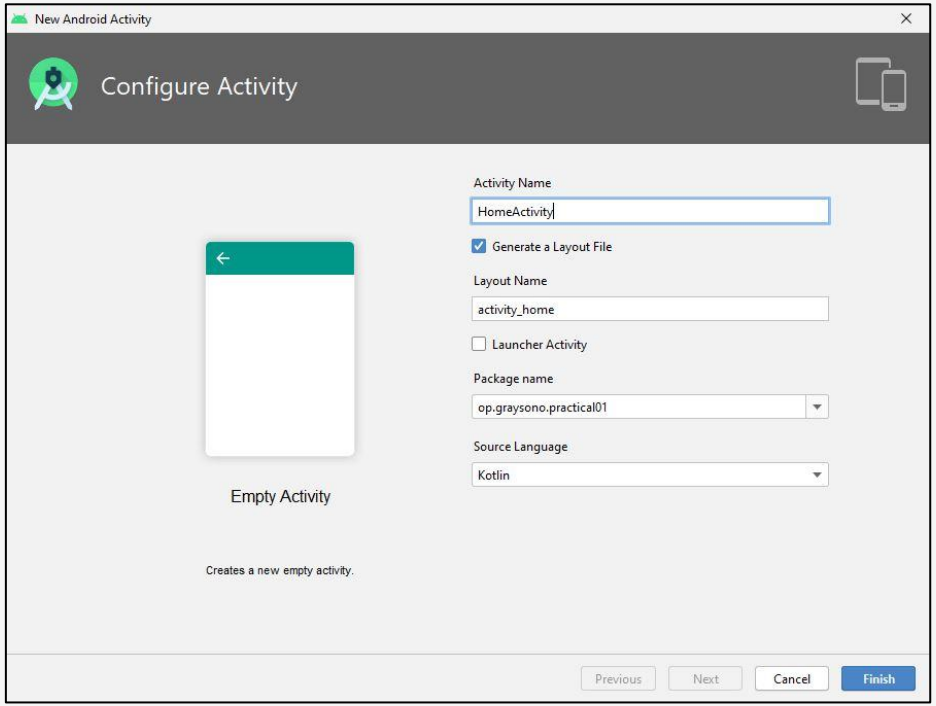


New Activity

- How do we add a new activity to our app?
  - Right click on the package name, for example, op.graysono.practical01
  - New > Activity > Empty Activity

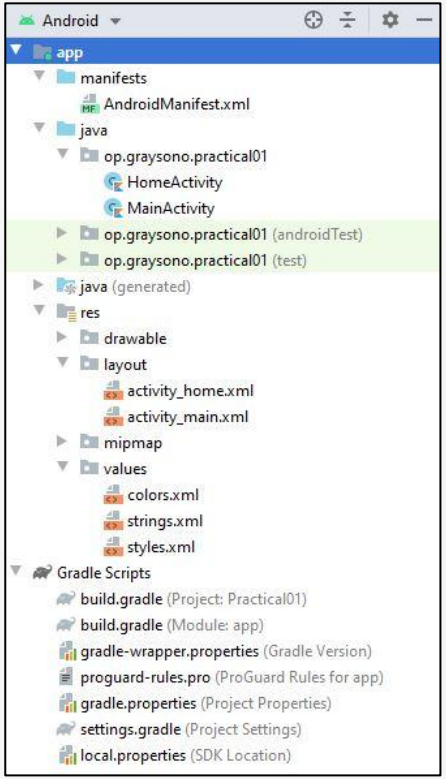
New Activity

- Configure the activity
  - Activity name
  - Layout name
  - Package name
  - Source language



New Activity

- View the file structure. The app should have a new Activity class file & layout file
- What has been added to AndroidManifest.xml ?



Intents

Intent

- Abstract description of an operation to be performed
- Late runtime binding between the code in different apps
- Used mostly in the launching of activities
- Resource: Intent

Intent Structure

- Two primary components of information in an intent:
  - Action - general action to be performed
  - Data - data to operate on
  - Resource: Intent Structure

Intent Resolution

- Two primary forms of intents:
  - Explicit - specified a component
  - Implicit - not specified a component
  - Resource: Intent Resolution

Starting Activity From Another

- startActivity() - the started activity does not need to return a result
- startActivityForResult()
- Resource: Starting One Activity From Another

```
val intent = Intent(this@MainActivity, HomeActivity::class.java)
startActivity(intent)
```

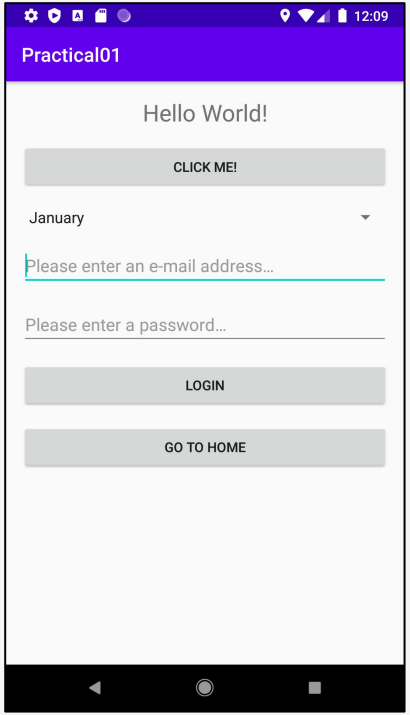
Sending Data To/From An Activity

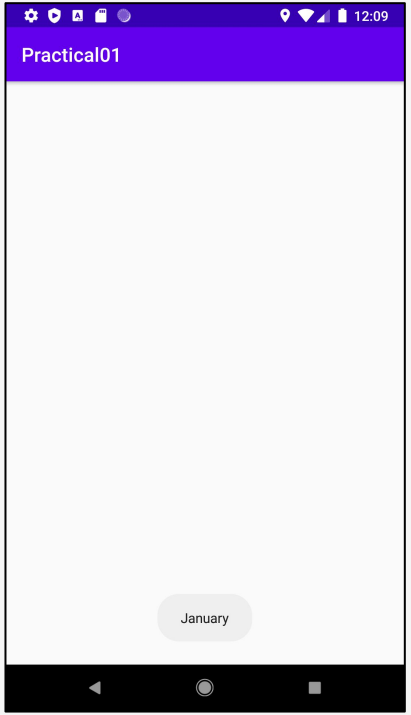
- putExtra()
- getExtra()

```
/* MainActivity.kt.
Note: In activity_main.xml, add a new Button. Create a Button
click listener. This code will go in there */
val intent = Intent(this@MainActivity, HomeActivity::class.java)
intent.putExtra("month", monthsSpinner.selectedItem as String)
startActivity(intent)

/* HomeActivity.kt
Note: This code will go in the onCreate() */
val bundle: Bundle? = intent.extras
val month = bundle?.get("month")
Toast.makeText(this@HomeActivity, month as String, Toast.LENGTH_LONG).show()
```

Emulator

- Click the Go to Home Button
- Create a new intent
- Put the value into the intent
- Start activity
- Get the value from the intent
- Display the value in a Toast

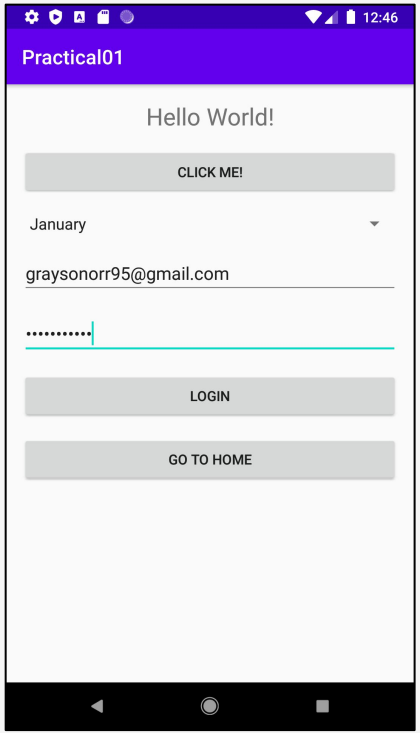




Practical Part 2

- Please use the current app
- Independent tasks:
  - Implement the code as specified in the previous lecture slides
  - In activity_home.xml, add a TextView. If you wish, you can copy & paste the TextView XML code from activity_main.xml. Ensure you change the TextView id
  - In the Go to Home Button click listener, get the username & password values from the two EditText widgets and put them into the intent. Ensure you make the correct error checking as specified in part 1
  - Start activity
  - Get the value from the intent & display it in the TextView
  - Research: Implement an implicit intent in your app
  - Once you have completed the practical, create a branch named 01-submission, push the app to the branch, make a pull request & set Grayson-Orr as the reviewer
  - If you do not set Grayson-Orr as a reviewer, I will not mark off your practical
  - DO NOT MERGE YOUR OWN PULL REQUEST!

Practical Part 2 - Expected Output



Formative Assessment

- Please write your answers to the following questions in your app:
  - In the practical part 2, you implemented an intent. What type of intent is this?
  - Which activity lifecycle method is called when the activity is no longer visible to the user?