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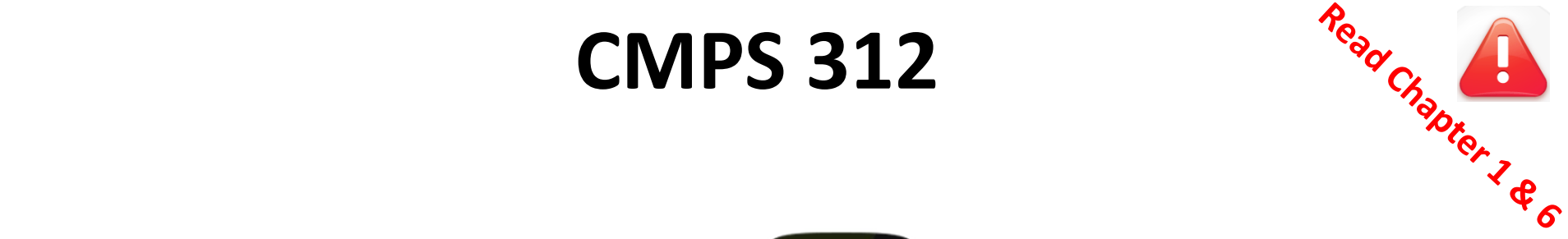

Android Fundamentals

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Outline

1. Introduction to Android
2. Android Programming Model

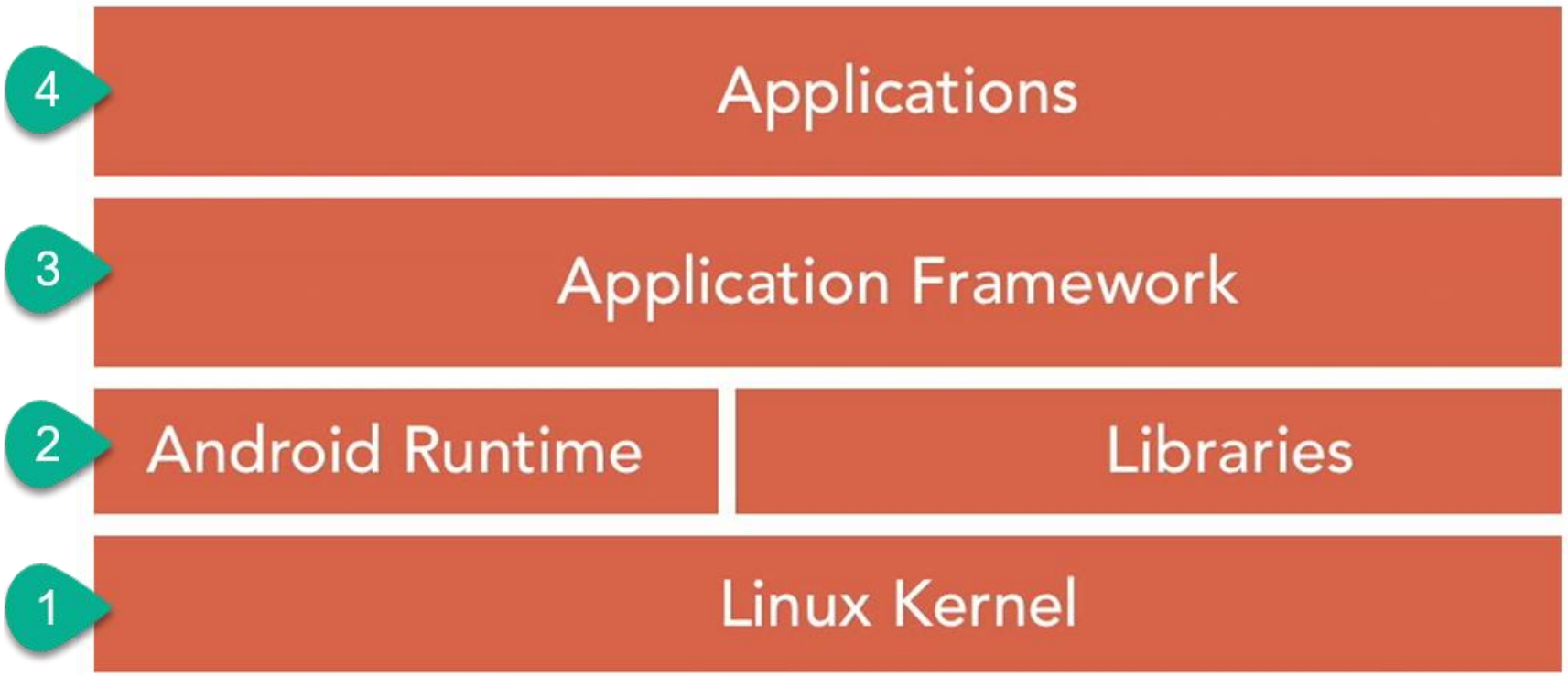
Introduction to Android

What is Android?

- Open source mobile operating system (OS) based on Linux kernel for phones, tablets, wearable
  - originally purchased by Google from Android, Inc. in 2005
- Used on over 80% of all smartphones
- The #1 OS worldwide

  - Over 2.5 billion active Android devices worldwide
  - Over 2 Million Android apps in Google Play store
- Highly customizable for devices by vendors

Android Software Stack



1. Linux Kernel: interacts and manages hardware
2. Expose native APIs; run apps
3. Java API exposing Android OS features
4. System and user apps

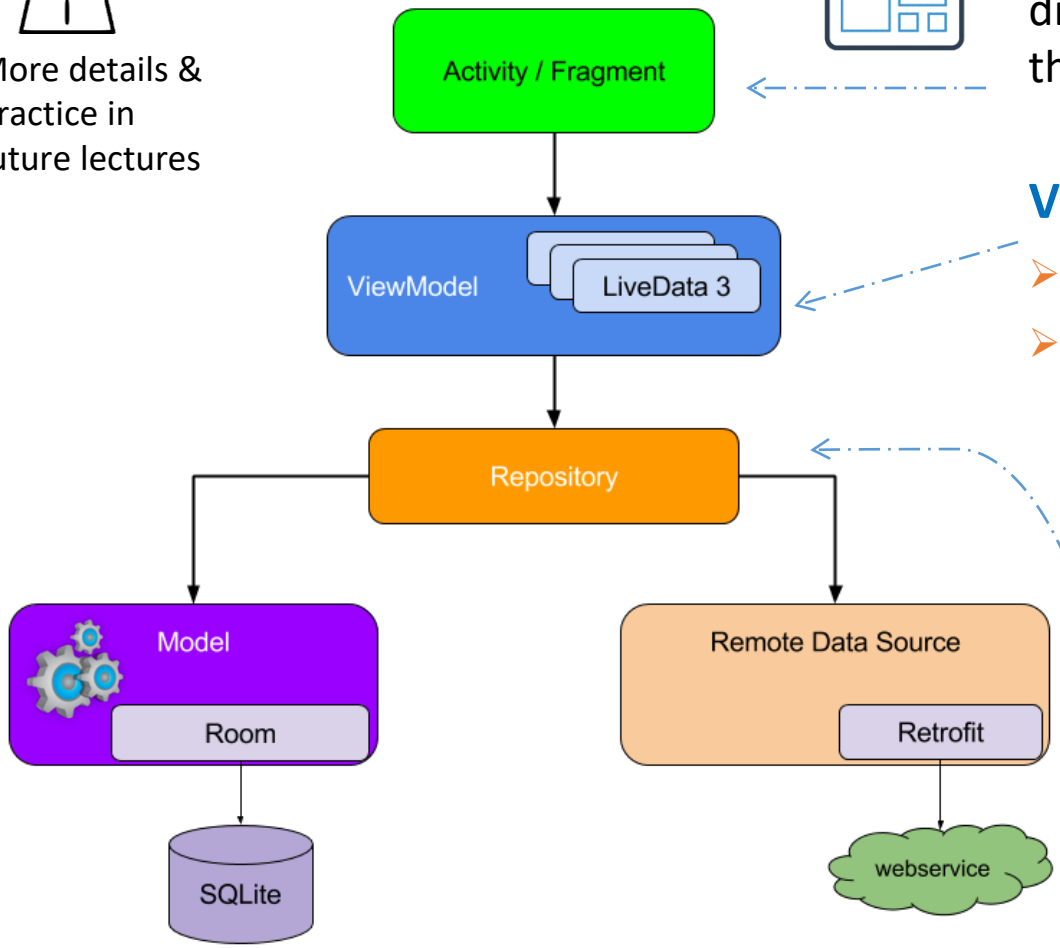
Android Software Stack

1. Optimized **Linux Kernel** for interacting with the device's processor, memory and hardware drivers
   - Acts as an abstraction layer between the hardware and the rest of the software stack
2. **Android runtime (ART)** = Virtual Machine to run Apps
   - Each app runs in its own process and with its own instance of the Android Runtime that controls the app execution (e.g., permission checks) in isolation from other apps
   - Expose native APIs and OS Core Libraries including 2D/3D graphics, SQLite database, encryption …
3. **Application Framework**: Java APIs (Application Programming Interfaces) make Android OS features available to Apps (e.g., Activity Manager that manages the lifecycle of apps)

https://developer.android.com/guide/platform

Model-View-ViewModel (MVVM) Architecture

More details & practice in future lectures



View = UI to get input from the user or display output. It forwards UI events to the ViewModel

ViewModel

- Holds data needed for the UI
- Implements UI logic
  - Handles events raised by the UI
  - Instructs the repository to perform actions based on user input
  - Passes the results to the View to display the output

Model

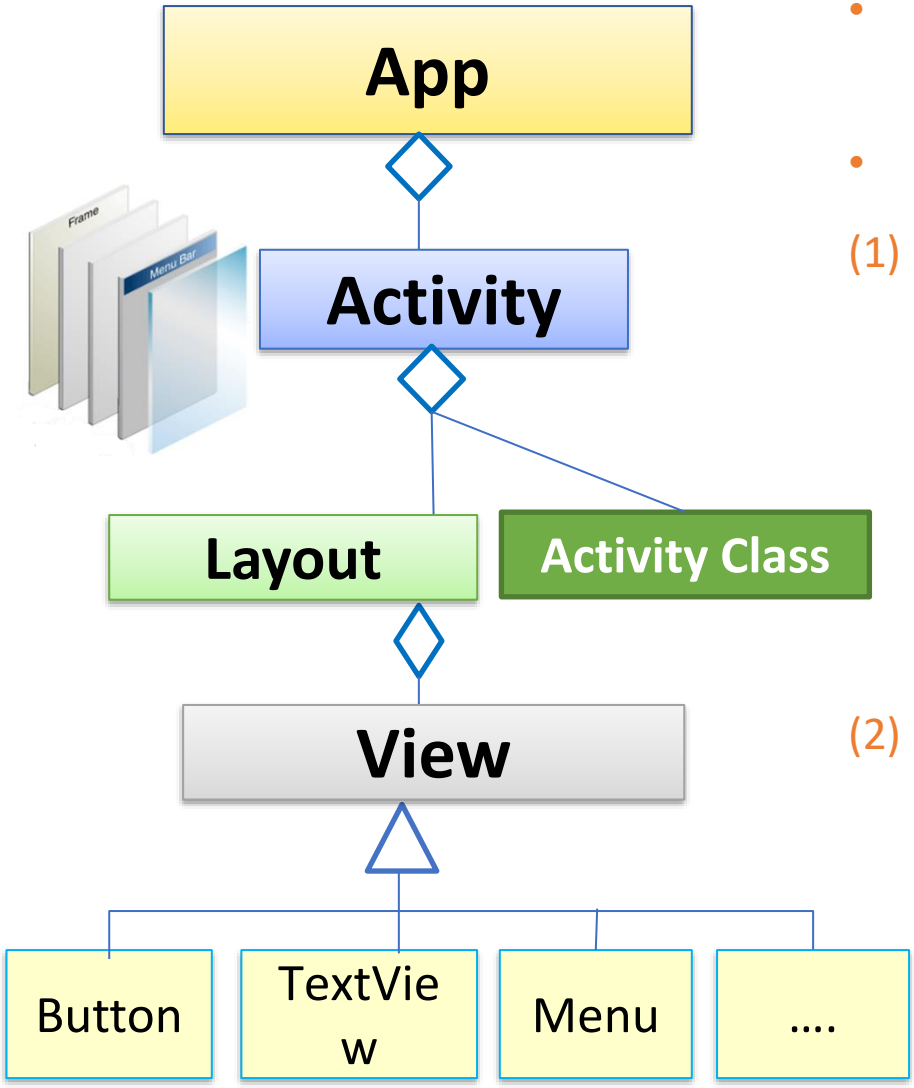
- Implements business logic / computation and manages the application data either in a Local SQLite Database (using **Room** library) or a Remote Web API (using **Retrofit** library)

Advantages of MVVM

- ***Separation of concerns***
  - View, ViewModel, and Model are **separate components**
    - Computation is not intermixed with UI. Consequently, code is cleaner, flexible and easier to understand and change.
    - Allow changing a component without significantly disturbing the others (e.g., UI can be completely changed without touching the model)

Android Programming Model

Android Programming Model



- App is composed of one or more **screens** (called **Activity**)
- An activity has:

(1) a **Layout** that define its appearance (how it **looks like**)

- Layout acts as a **container** for UI Components (called **View**)
- It decides the size and positions of views placed in it

(2) Activity Kotlin class that provides the data to the UI and handles events

- UI Components **raise Events** when the user interacts with them (such as a Clicked event is raised when a button is pressed).
- In the activity class we define **Event Handlers** to respond to the UI events

Activity

- **Activity** is a screen that displays a UI to allow the user to do something such order groceries, send email …
  - Has layout (.xml) file & Activity class
  - This allows a **clear separation** between the UI and the app logic
- Connecting activity with the layout is done in the **onCreate** method
- Can start other activities in the same or other apps
- Has a lifecycle: created, started, paused, resumed, stopped, and destroyed
- Listeners have code to handle events:
  - User interaction events such press a button or enters text in a text view
  - External events such as receiving a notification or screen rotation

Example

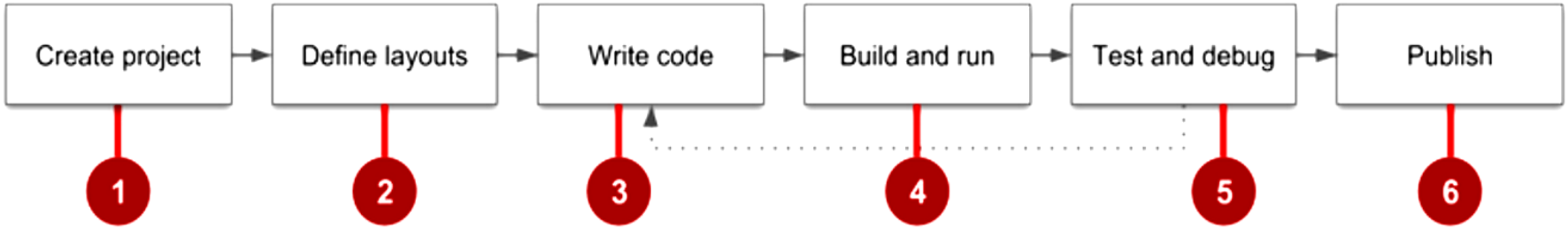
```
class MainActivity : AppCompatActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_main)

        changeColorBtn.setOnClickListener {
            greetingTv.setTextColor(getRandomColor())
        }
    }
```

Connects activity with layout

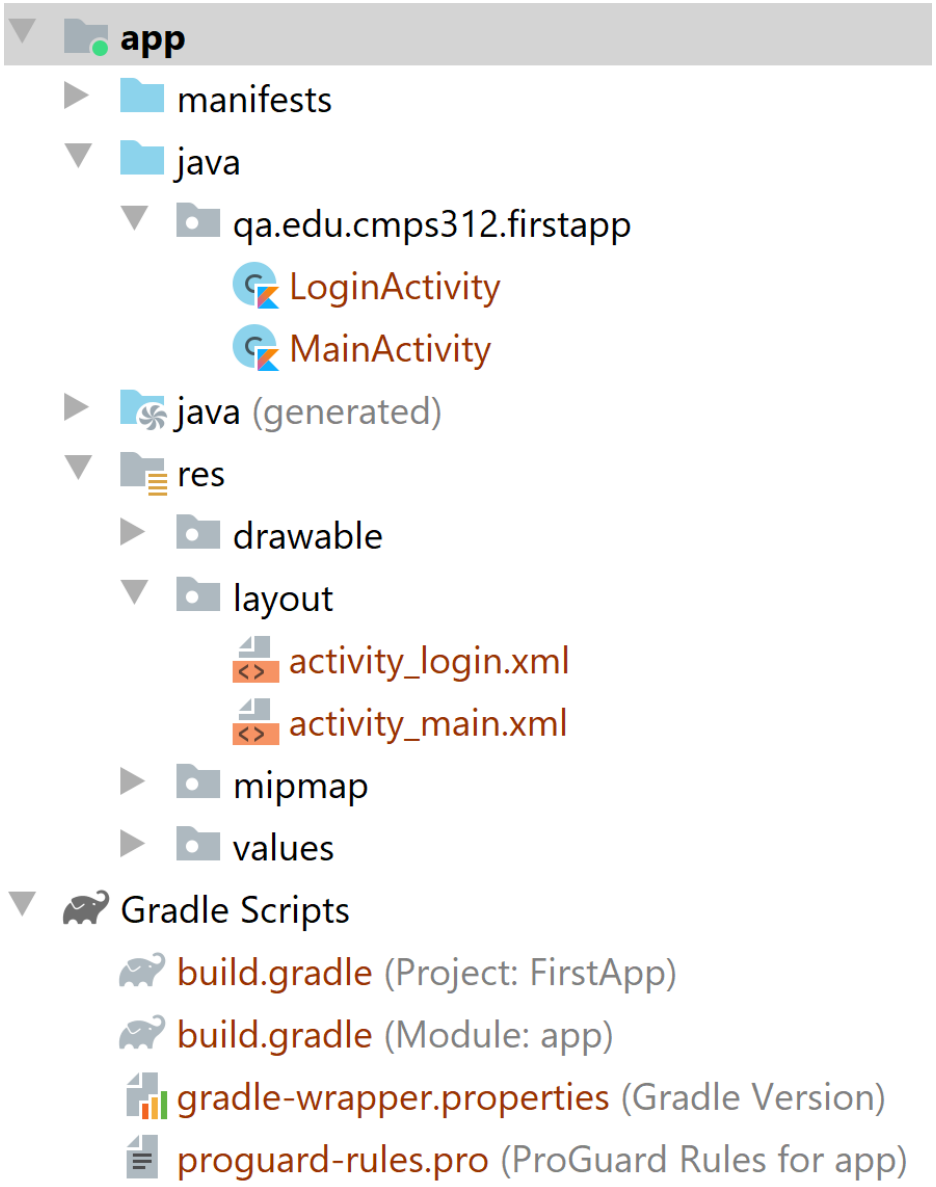
Event Driven Programming

- GUI programming model is based on **event driven programming**
  - Code is executed upon activation of events
- An **event** is a signal from Android system that some something of interest to the app has occurred
  - UI Events (click, tap, swipe, drag)
  - Input focus (gained, lost)
  - Keyboard (key press, key release)
  - Activity events (e.g., onCreate, onRestart)
  - Device: DetectedActivity such as walking, driving, tilting
- When an event is triggered, an event handler can run to respond to the event. e.g.,
  - When the button is clicked -> load the data from a file into a list

Development Process



Project structure



- **AndroidManifest.xml**
  - app config and settings (e.g., list app activities and required permissions)
- **java**/...
  - Kotlin source code
- **res**/... = resource files *(many are **XML**)*
  - drawable/ = images
  - layout/ = GUI layouts
  - menu/ = app menu options
  - values/ = Externalize constant values
  - strings/ = localized strings
  - styles/ = appearance styling
- **Gradle**
  - a build/compile management system
  - **build.gradle** = main build config file

Resources

- Separate static data from code in your layouts
  - Strings, dimensions, images, menu text, colors, styles
  - Useful for localization
- Resources and resource files are stored in res folder

Refer to resources in code

- Layout:

```
setContentView(R.layout.activity_main)
```

- View:

```
greetingTv.text = "Salam"
```

- String:

In Kotlin: `R.string.title`

In XML: `android:text="@string/title"`

Externalize Constants

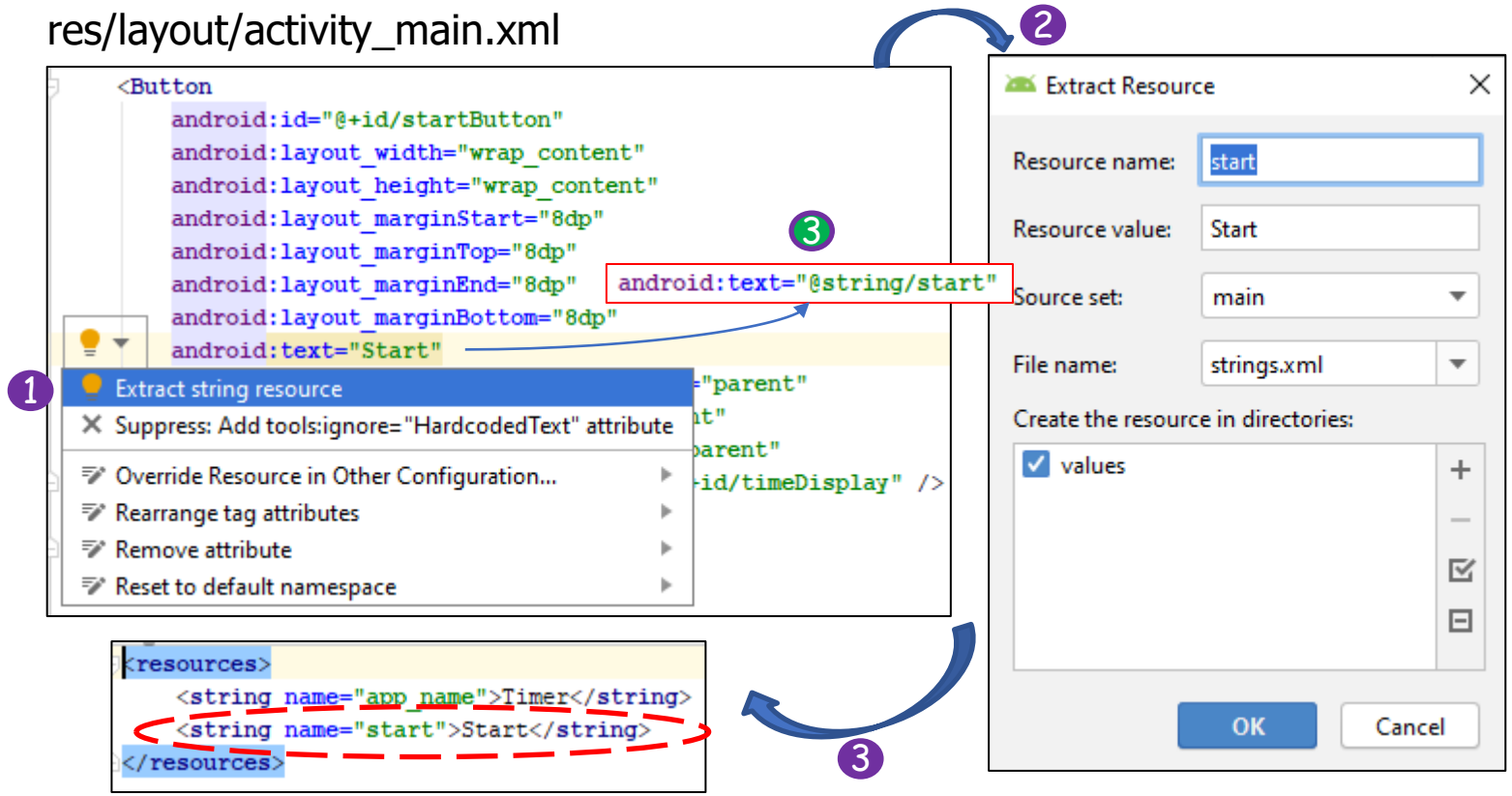
- Edit res/layout/activity_main.xml
  - Replace string “Start” of the start button with “@string/start”.
  - Benefit = Localization, e.g., `es/values-es/strings.xml`

Start

Comienzo

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <string name="start">Comienzo</string>
    <string name="stop">Detener</string>
</resources>
```

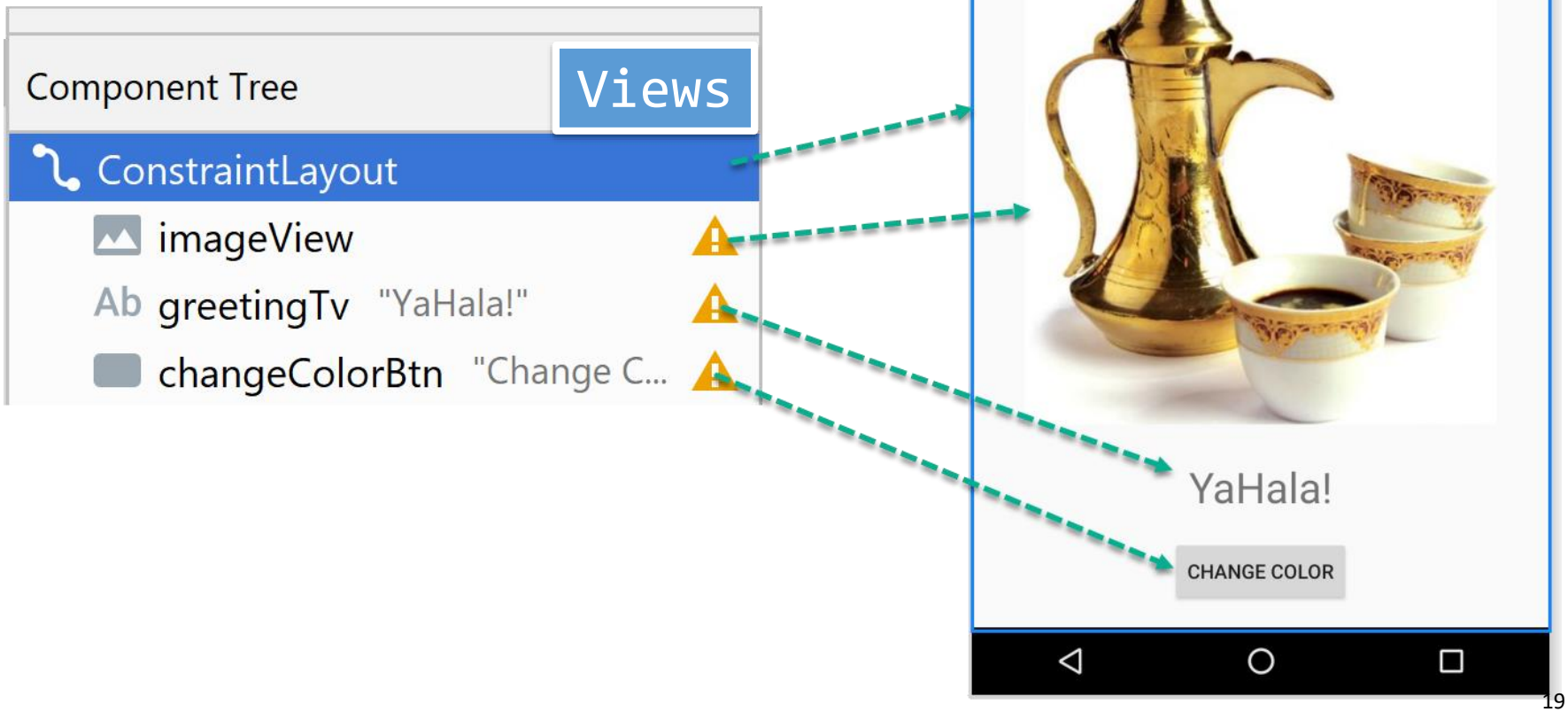
res/layout/activity_main.xml



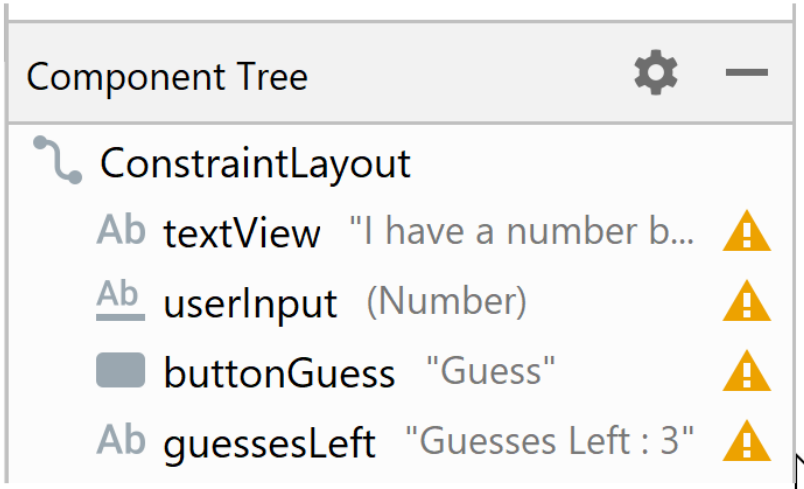
res/values/strings.xml

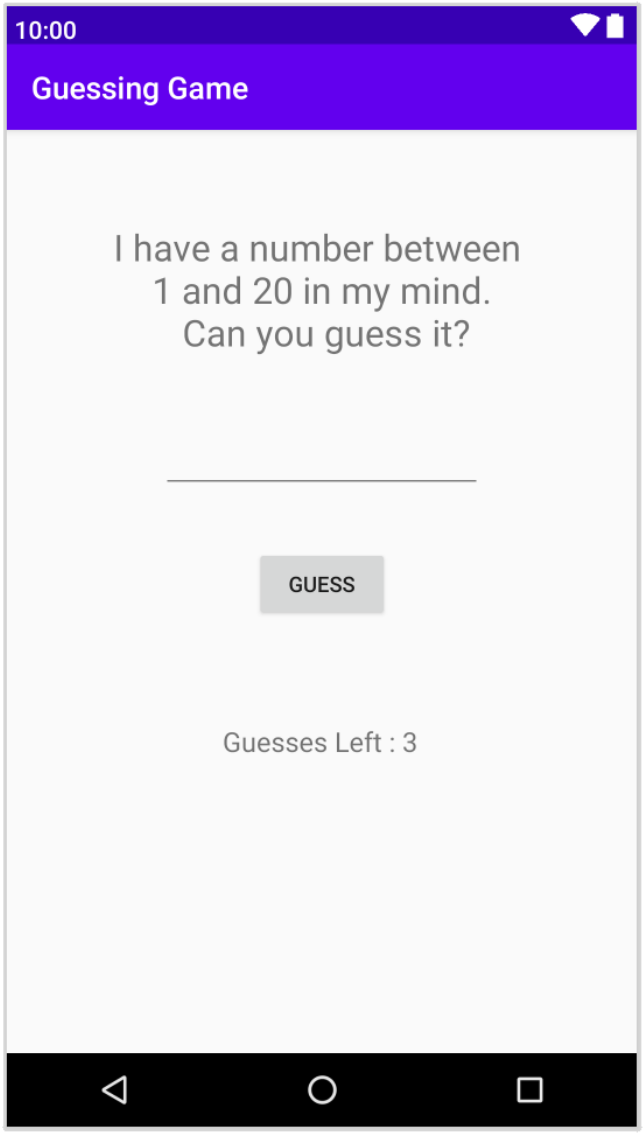
App 1 - Color Changer

App that contains Text reading “YaHala!”, an Image and a `Button` that randomly changes text’s color with every click

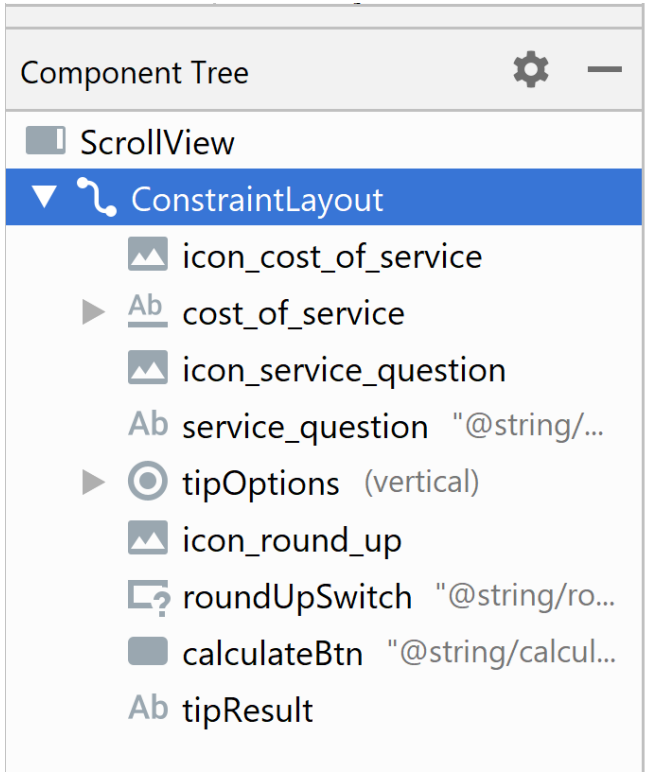


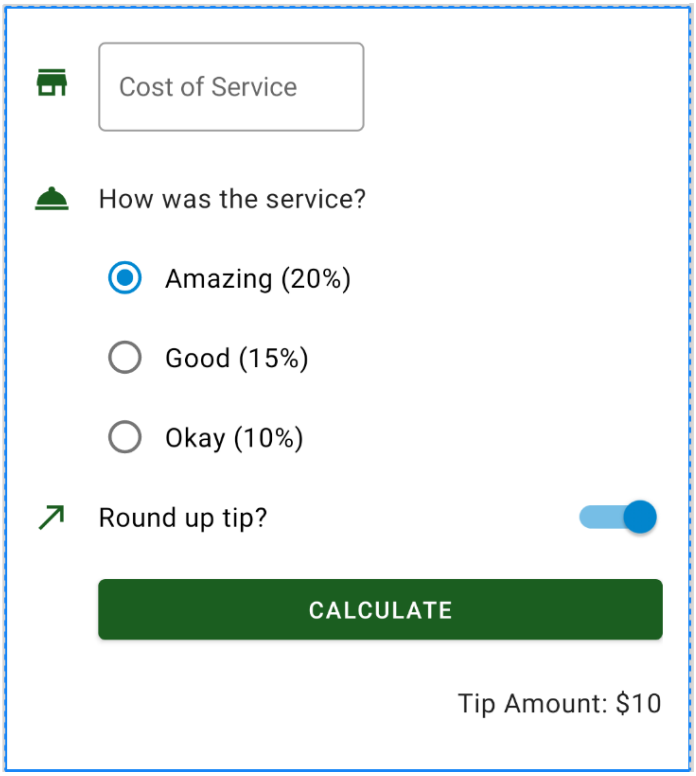
App 2 – Guessing Game



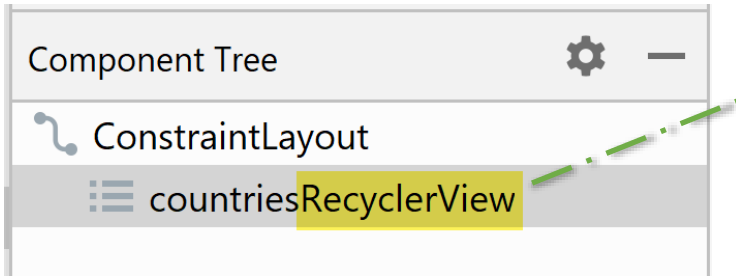


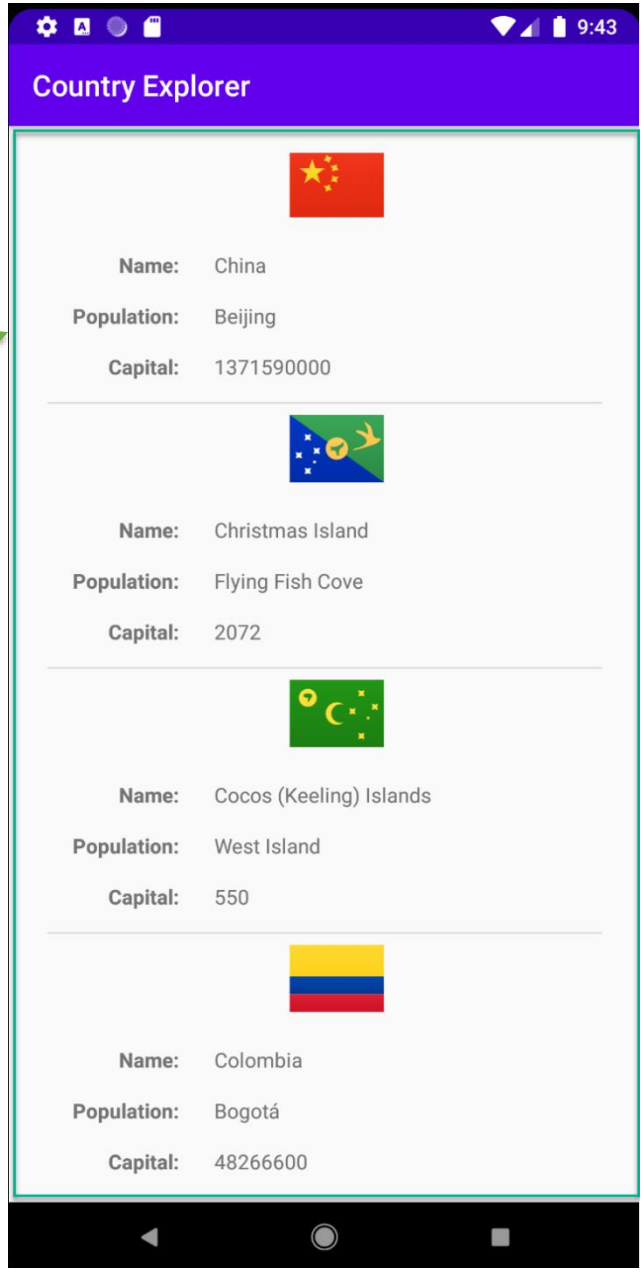
App 3 – Tips Calculator



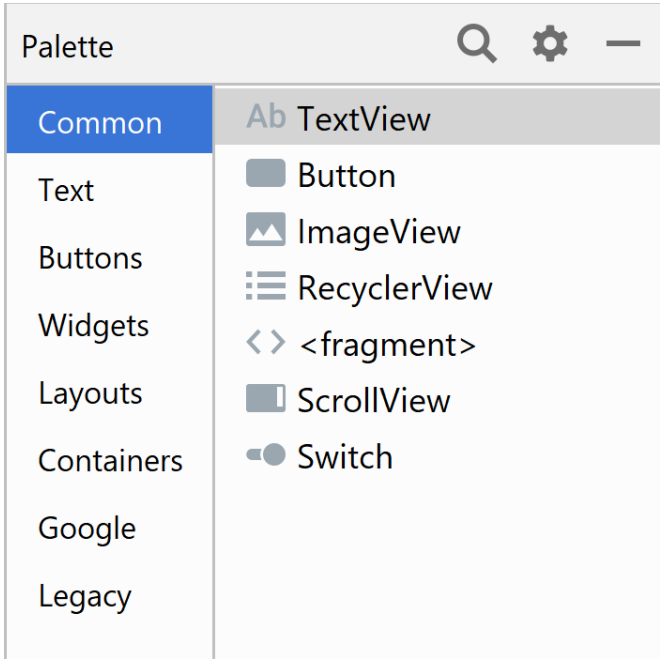


App 4 – Country Explorer





What Makes up Android UI?

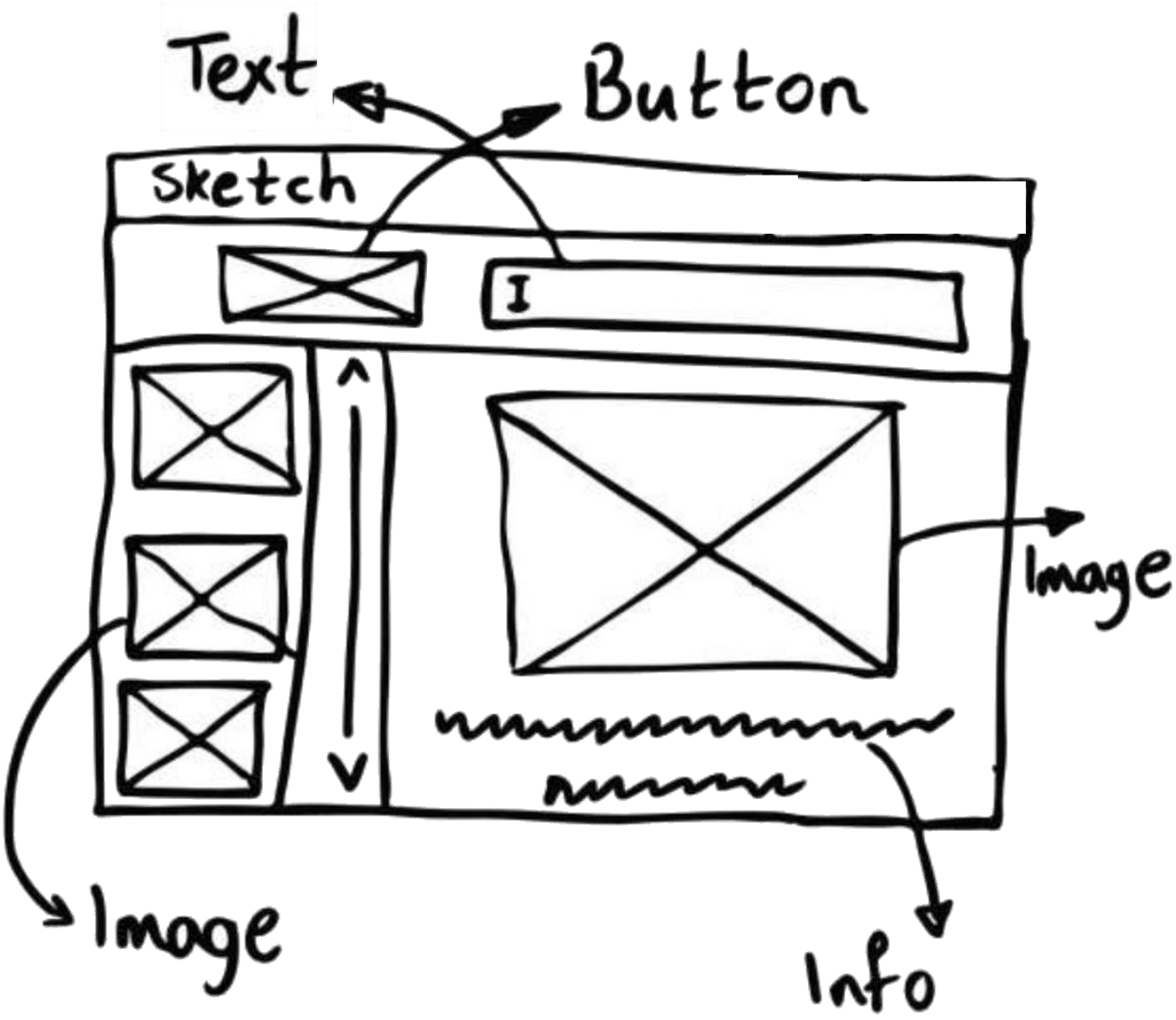


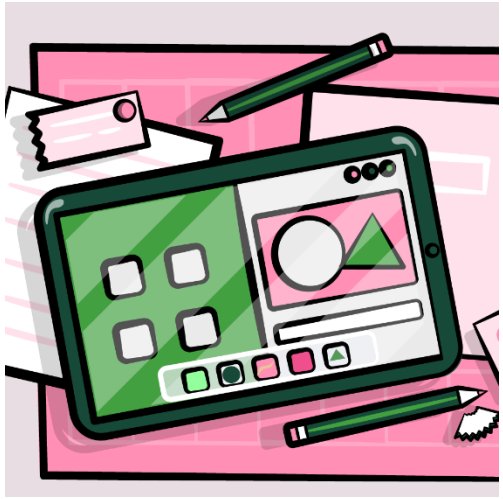
- **Views**
  - Set of pre-built UI components that can be composed to create a GUI
  - e.g. Button, TextView, Menu, List, etc.
- **Layout containers**
  - Control placement/ positioning of views in the Activity

Steps to creating a GUI Interface

1. Design it on paper (sketch)
   - Decide what information to present to user and what input they should supply
   - Decide the UI components and the layout on paper
2. Create a layout and add UI components to it using the Layout Editor
   - Use the Layout Editor to group and arrange components
3. Add event handlers to respond to the user actions
   - Do something when the user presses a button, selects an item from list, change text of input field, etc.

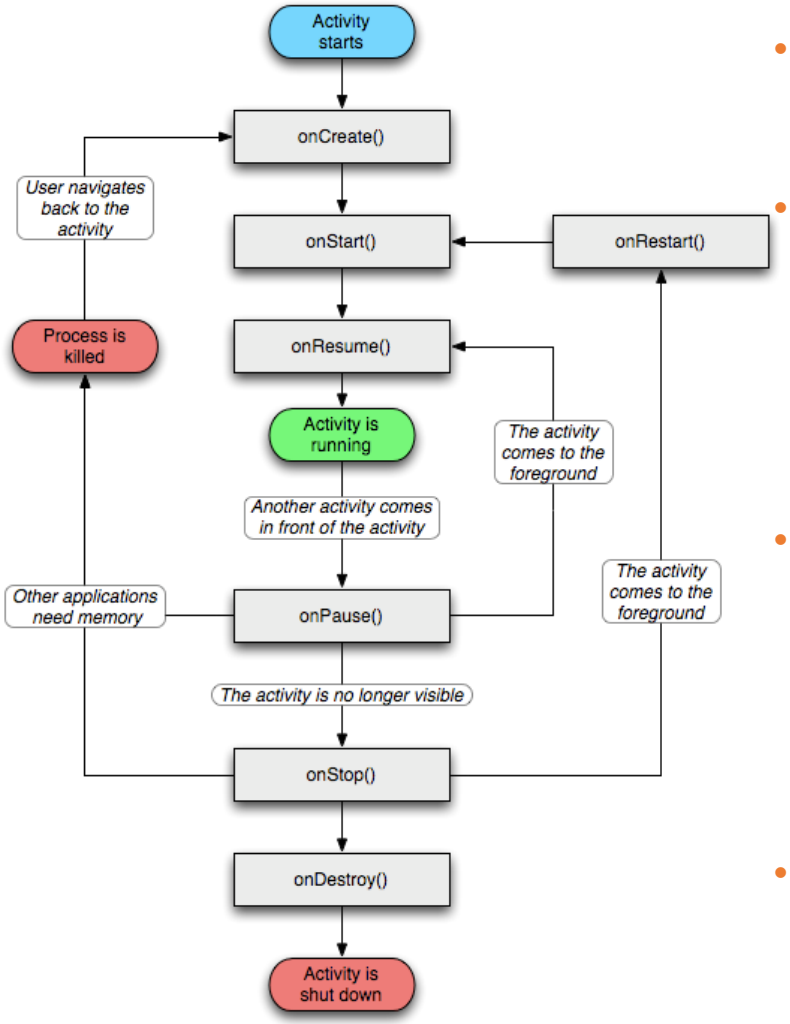
UI Sketch - Example





You may design different layouts per screen size

Activity Lifecycle



An activity has essentially **four states**:

- If an activity in the foreground of the screen (at the top of the stack), it is ***active***
- If an activity has lost focus but is still visible (e.g., beneath a dialog box), it is ***paused***. A paused activity is completely alive but can be killed by the system in case of low memory.
- If an activity is completely obscured by another activity, it is ***stopped***. It still retains all state and member information but can be **destroyed** by the system when memory is needed.
- If an activity is paused or stopped, it maybe killed. When it is displayed, it must be completely **restarted** and restored to its previous state.

Resources

- Android Kotlin Fundamentals Course
  - https://codelabs.developers.google.com/android-kotlin-fundamentals/
  - https://developer.android.com/courses/android-basics-kotlin/course

- Android Dev Guide
  - https://developer.android.com/guide/