Mobile Applications

2. User interfaces in Android

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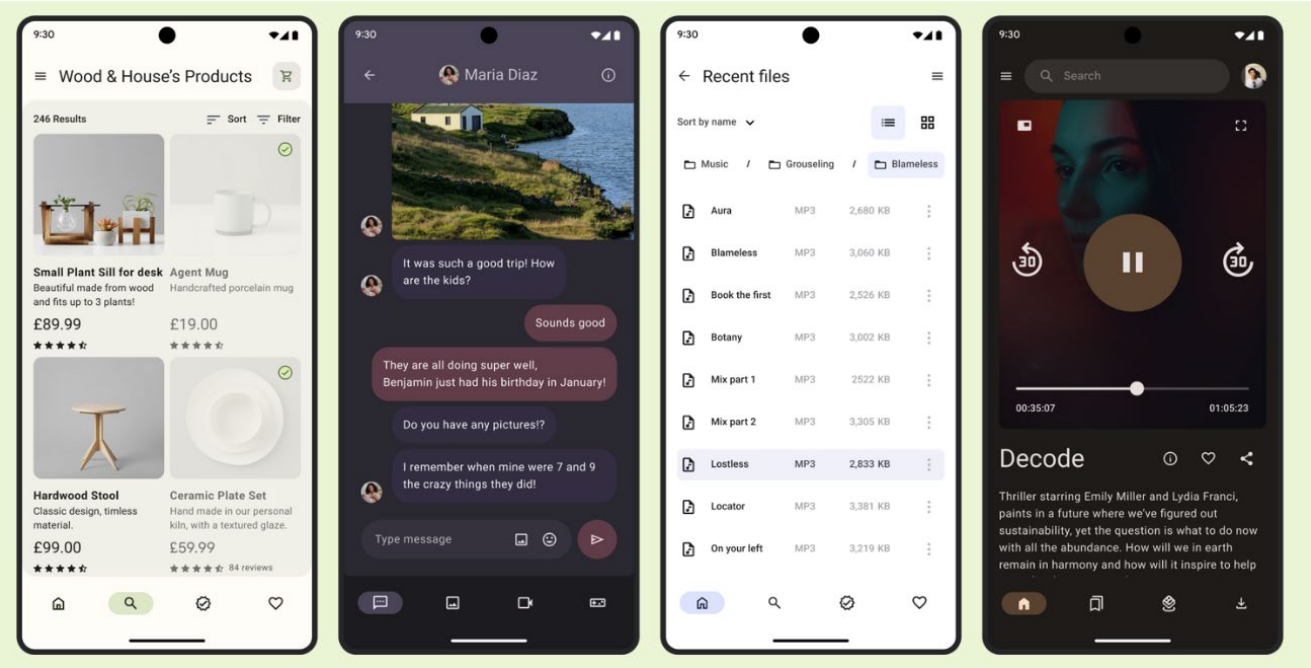
1. Introduction

- In mobile apps, the **User Interface** (**UI**) refers to the visual and interactive elements through which users interact with an app to perform tasks or access information



https://developer.android.com/design/ui

1. Introduction

- The UI is critical for the overall user experience (UX) and includes:

1. Interactive elements: buttons, text fields, and other touchable components
2. Visual design: layout, colors, typography, icons, and images
3. Navigation: how users move between screens or sections (e.g., tabs, menus, back navigation)
4. Responsiveness: adaptation to different screen sizes, orientations, and devices
5. Accessibility: features that make the app usable for people with disabilities (e.g., screen readers, larger text)

1. Introduction

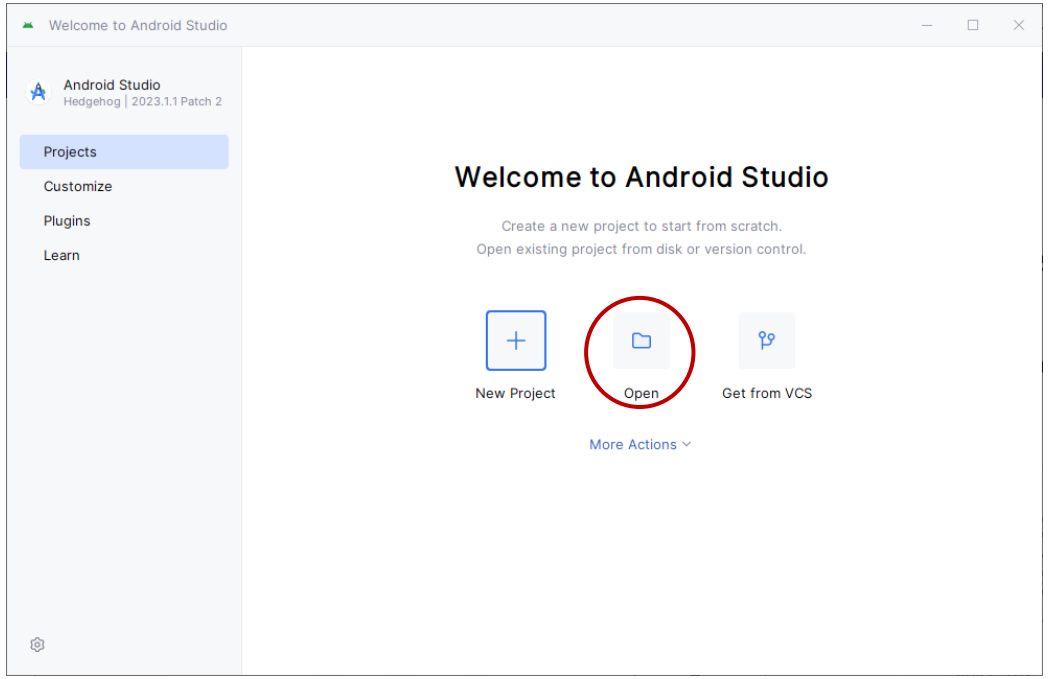
- Android provides two main approaches to build UIs:

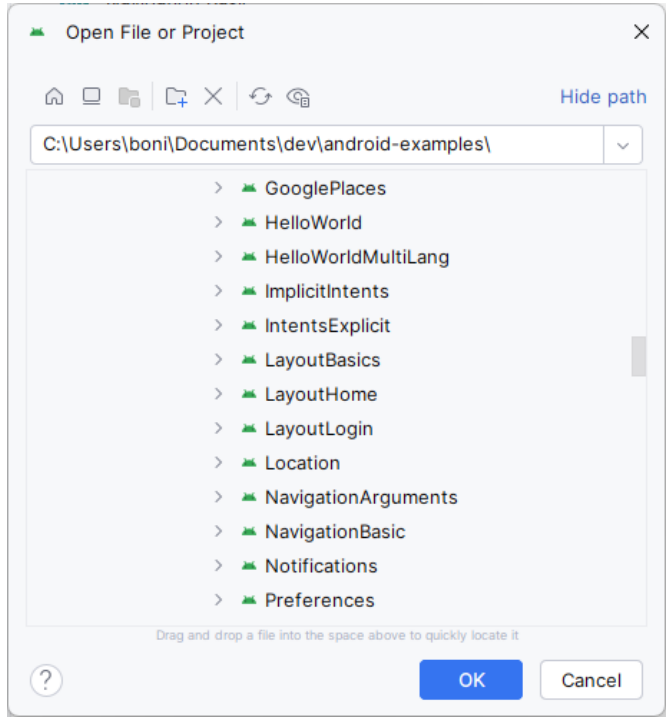
1. Android view system (legacy approach):
   - UI defined using XML layout files
   - Imperative programming model (step-by-step instructions)
   - Widely used in existing apps
2. Jetpack Compose (modern approach):
   - UI defined directly in Kotlin code
   - Declarative programming model (state-driven, reactive updates)
   - Recommended for new apps

In this course, we focus on **Jetpack Compose**, which represents the recommended approach for modern Android development

1. Introduction

- To follow the master lectures, it is highly recommended to clone the **GitHub examples repository** and import each app in Android Studio to play with it





https://github.com/bonigarcia/android-examples/

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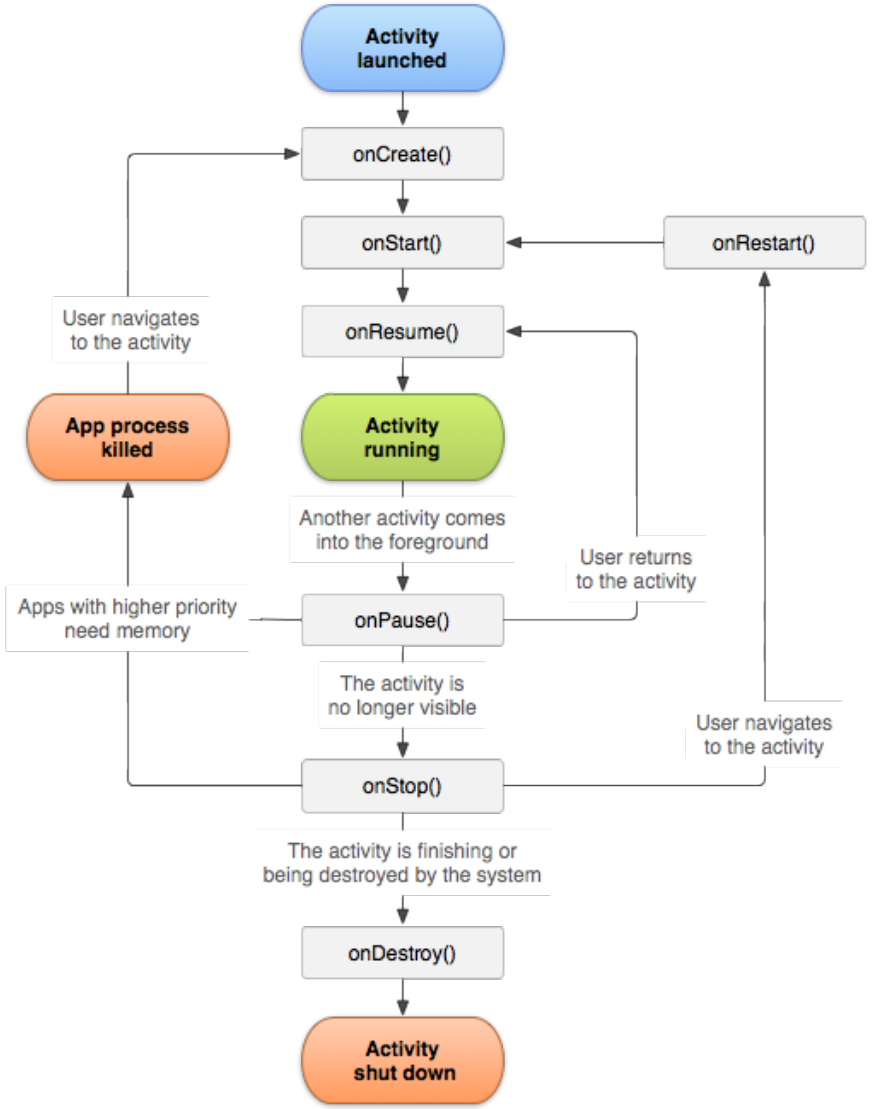
2. Activities

- An **Activity** is a type of app component which represents a single screen with a UI
- Activities acts as:
  - The entry point for user interaction
  - A container that hosts the UI
- Each activity (like any other app component in Android) is implemented using a Java/Kotlin class and declared in the Android **manifest**
- Activities are managed by the Android system and move through different **lifecycle** states based on user actions and system events

https://developer.android.com/guide/components/activities/intro-activities

2. Activities

- Activities through different states (e.g., *created*, *paused*, *destroyed*, etc.) based on the user's interactions and the lifecycle of the app
- When an activity changes state, Android invokes specific Java/Kotlin methods called lifecycle *callbacks*



Typically, we only need to implement the `onCreate()` callback in our activities

https://developer.android.com/guide/components/activities/activity-lifecycle

2. Activities

- Example of Android manifest in the “hello world” app:

AndroidManifest.xml

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

    <application
        android:icon="@mipmap/ic_launcher"
        android:label="@string/app_name"
        android:roundIcon="@mipmap/ic_launcher_round"
        android:theme="@style/Theme.HelloWorld">
        <activity
            android:name=".MainActivity"
            android:exported="true">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>

</manifest>
```

The activity `MainActivity` will be implemented as a Java/Kotlin class

2. Activities

- The structure of an Activity implemented in Kotlin is as follows:

```
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)

        // UI logic
    }
}
```

- `class MainActivity` → Kotlin class
- `ComponentActivity` → Parent class for activities
- `override fun onCreate` → activity entry point (*callback*)
- `savedInstanceState: Bundle?` → parameter used to restore saved state when the activity is recreated. The operator `?` allows this parameter to be null
- `super.onCreate(savedInstanceState)` → call to parent to ensure proper initialization
- `// UI logic` → View definition (int Android view system) or composables (in Jetpack Compose)

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3. Android view system

- The **Android view system** is the original framework used to build user interfaces in Android
- Key characteristics:
  - UI is defined using XML layout files
  - Follows an imperative programming model
    - Developers explicitly tell how to handle the UI step by step (e.g., create views, modify them, show or hide them)

XML-based views are still supported alongside Jetpack Compose for backward compatibility and mixed use cases where apps have both XML layouts and Jetpack Compose

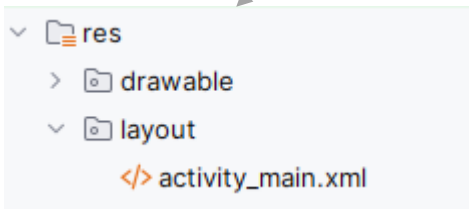
3. Android view system

- A basic example (Hello World) using the legacy Android View System:

MainActivity.java

```java
public class MainActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
    }
}
```

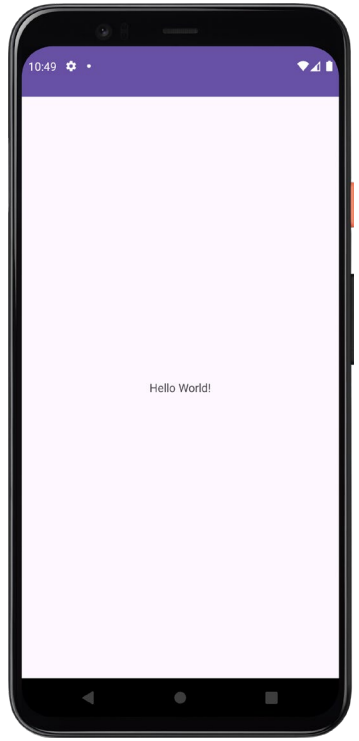


activity_main.xml

```xml
<?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_constraintEnd_toEndOf="parent"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toTopOf="parent" />

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



This layout contained only one visual element: a `TextView`, which displays some text to the user

3. Android view system

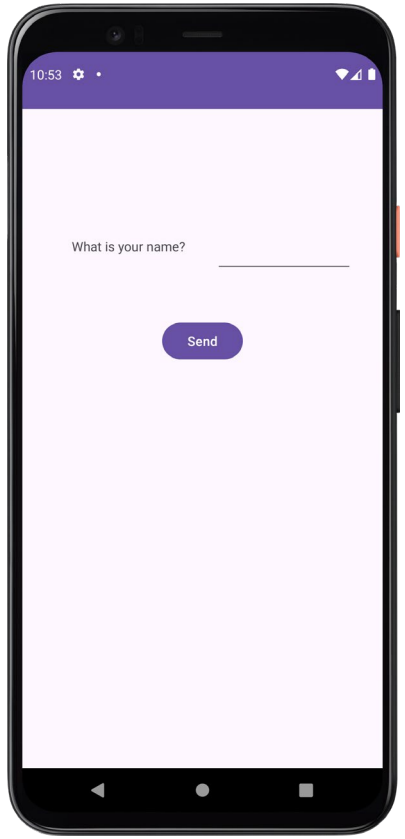
- Another example:

```
public class MainActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        View button = findViewById(R.id.button);
        button.setOnClickListener(view -> {
            Intent intent = new Intent(getBaseContext(), SecondActivity.class);
            EditText nameText = findViewById(R.id.editText);
            intent.putExtra("name", nameText.getText().toString());
            startActivity(intent);
        });
    }

}
```



The Android view system required a lot of repetitive code (*boilerplate*) and was error-prone, so we **won't use** this type of UI in this course

```
<?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:id="@+id/nameLabel"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="@string/edit_message"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintHorizontal_bias="0.2"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toTopOf="parent"
        app:layout_constraintVertical_bias="0.2" />

    <EditText
        android:id="@+id/editText"
        android:layout_width="150dp"
        android:layout_height="wrap_content"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintHorizontal_bias="0.5"
        app:layout_constraintStart_toEndOf="@+id/nameLabel"
        app:layout_constraintTop_toTopOf="parent"
        app:layout_constraintVertical_bias="0.2" />

    <Button
        android:id="@+id/button"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="@string/button_send"
        app:layout_constraintBottom_toBottomOf="parent"
        app:layout_constraintEnd_toEndOf="parent"
        app:layout_constraintHorizontal_bias="0.5"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toBottomOf="@+id/editText"
        app:layout_constraintVertical_bias="0.1" />

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

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4. Jetpack Compose

- **Jetpack Compose** is a Google's toolkit for building native UIs in Android, recommended in modern Android development
- Key characteristics and advantages:
  - Kotlin-based: UI is written entirely in Kotlin, without XML layouts
  - Declarative: The UI describes what it should look like, not how to draw it
  - Reactive: The UI automatically updates in response to state changes
  - Less boilerplate: More functionality with less code compared to the XML View system
  - High performance: Optimized rendering with efficient UI updates
  - Rich tooling support: Live previews and multiple preview configurations in Android Studio

https://developer.android.com/compose

Jetpack Compose requires API level 21 (Android 5.0) or higher

4. Jetpack Compose - Setup

- To use Jetpack Compose, we need to set up our Android project (using Gradle) with the necessary configuration and dependencies

build.gradle.kts (project)

```
plugins {
    alias(libs.plugins.android.application) apply false
    alias(libs.plugins.kotlin.compose) apply false
}
```

We don't need to implement this configuration manually, since Android Studio creates it for us (e.g., using the "Empty activity" wizard to create a new project)

The versions of these plugins and dependencies are defined in the *version catalog* (`libs.versions.toml` file)

build.gradle.kts (app)

```
plugins {
    alias(libs.plugins.android.application)
    alias(libs.plugins.kotlin.compose)
}

android {
    buildFeatures {
        compose = true
    }
}

dependencies {
    implementation(libs.androidx.core.ktx)
    implementation(libs.androidx.lifecycle.runtime.ktx)
    implementation(libs.androidx.activity.compose)
    implementation(platform(libs.androidx.compose.bom))
    implementation(libs.androidx.ui)
    implementation(libs.androidx.ui.graphics)
    implementation(libs.androidx.ui.tooling.preview)
    implementation(libs.androidx.material3)
    debugImplementation(libs.androidx.ui.tooling)
    debugImplementation(libs.androidx.ui.test.manifest)
}
```

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5. Compose functions

- A **composable** (or **compose function**) is a Kotlin function that defines a piece of UI. They are the building blocks of Jetpack Compose:
  - Functions annotated with `@Composable`
  - Describe how a portion of the UI should look based on the current state
- Key characteristics:
  - Declarative: Instead of describing how the UI changes step by step, composables describe what the UI should look like
  - Reusable: Composable functions can be called from other composables, making UIs modular and reusable
  - State-driven: Composables react to changes in state; when the state changes, the composable is recomposed to reflect the new state

5. Compose functions

- In Jetpack Compose, activities are lightweight containers for UI composables:

```
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        enableEdgeToEdge()
        setContent {
            MyAppTheme {
                Scaffold(modifier = Modifier.fillMaxSize()) { innerPadding ->
                    Greeting(
                        name = "Android",
                        modifier = Modifier.padding(innerPadding)
                    )
                }
            }
        }
    }
}

@Composable
fun Greeting(name: String, modifier: Modifier = Modifier) {
    Text(
        text = "Hello $name!",
        modifier = modifier
    )
}
```

- `@Composable` → Annotation to mark the function as a compose function
- `Greeting` → The name of the function. It takes a string parameter (`name: String`) and displays it in a `Text` composable
- `modifier: Modifier = Modifier` → A modifier is an object that allows us to decorate or modify a composable. This parameter has a default value, i.e., an empty modifier (`Modifier`) which means no modifications applied
- `Text` → A built-in composable that displays text on the screen

5. Compose functions


```
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        enableEdgeToEdge()
        setContent {
            MyAppTheme {
                Scaffold(modifier = Modifier.fillMaxSize()) { innerPadding ->
                    Greeting(
                        name = "Android",
                        modifier = Modifier.padding(innerPadding)
                    )
                }
            }
        }
    }
}

@Composable
fun Greeting(name: String, modifier: Modifier = Modifier) {
    Text(
        text = "Hello $name!",
        modifier = modifier
    )
}
```

- `enableEdgeToEdge()` → draw app content behind the status bar
- `setContent` → method provided by the parent class that takes a composable function as argument and renders it as the root of the UI
- `MyAppTheme` → custom composable that applies a Material Design theme to our app (explained latter)
- `Scaffold()` → Recommended container to apply themes correctly (the other possibility is `Surface`)
- `modifier = Modifier.fillMaxSize()` → ensures the Scaffold expands to fill the entire screen
- `innerPadding` → parameter in lambda expression used to ensure that the content doesn't overlap with system UI elements (e.g., status bar, navigation bar)
- `Greeting(...)` → Call to our composable function

5. Compose functions


```
@Preview(showBackground = true)
@Composable
fun GreetingPreview() {
    MyAppTheme {
        Greeting("Android")
    }
}
```

- @Preview → Annotation that tells Android Studio that this composable should be shown in the design view (it has no impact in runtime)

MainActivity.kt

```
28  import androidx.compose.ui.Modifier
29  import androidx.compose.ui.tooling.preview.Preview
30  import es.uc3m.android.helloworld.ui.theme.HelloWorldTheme
31
32  class MainActivity : ComponentActivity() {
33      override fun onCreate(savedInstanceState: Bundle?) {
34          super.onCreate(savedInstanceState)
35          enableEdgeToEdge()
36          setContent {
37              HelloWorldTheme {
38                  Scaffold(modifier = Modifier.fillMaxSize()) { inn
39                      Greeting(
40                          name = "Android",
41                          modifier = Modifier.padding(innerPadding)
42                      )
43                  }
44              }
45          }
46      }
47  }
48
49  @Composable
50  fun Greeting(name: String, modifier: Modifier = Modifier) {
51      Text(
52          text = "Hello $name!",
53          modifier = modifier
54      )
55  }
56
57  @Preview(showBackground = true)
58  @Composable
59  fun GreetingPreview() {
60      HelloWorldTheme {
61          Greeting( name: "Android")
62      }
63  }
```

Up-to-date

GreetingPreview

Hello Android!

5. Compose functions

- A Compose UI is built as a hierarchy of compose functions. Each composable can contain others composables, forming a tree-like structure
  - In the hello-world example the composable hierarchy is:

```
MyAppTheme
└── MaterialTheme
    └── Scaffold
        └── Greeting
            └── Text
```

- When the `Greeting` function is called, Compose renders the `Text` composable with the provided `name`
- If the **state** (i.e., the data that can change over time and affects the UI –the variable `name` in this example–) changes, Compose automatically **recomposes** (redraws) the UI to reflect the new value

5. Compose functions

We study these composables in the following sections

- Jetpack Compose provides a rich set of built-in composable functions:

1. Basic components: used to create the UI, e.g., `Text`, `Button`, `Image`, `Icon`
2. Modifiers: used to customize the appearance and behavior of composables, e.g., `padding`, `fillMaxSize`, `background`, `clickable`
3. Layouts: used to define the structure of the UI, e.g., `Column`, `Row`, `Box`, `Spacer`, `Scaffold`, `Surface`
4. Theming: used to handle the styles for an app: `MaterialTheme`
5. State management: used to handle the UI state, e.g., `mutableStateOf`, `remember`, `rememberSaveable`
6. List and grids: used to display a group of elements, e.g., `LazyColumn`, `LazyRow`, `LazyVerticalGrid`, `LazyHorizontalGrid`
7. Navigation: used to change between different screens, e.g., `NavHost`
8. Animations: used to provide transitions to our apps, e.g., `animate*AsState`, `AnimatedVisibility`

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6. Basic components

- The `Text` composable is used to display a text string
  - It can be customized with the attributes `fontSize`, `color`, `fontWeight`, etc.
    - Nevertheless, it is not recommended to change this attributes individually (instead, we will use global theme styles)

```
Text(
    text = "Hello, Compose!",
    fontSize = 20.sp,
    color = Color.Blue,
    fontWeight = FontWeight.Bold
)
```

- The `Button` composable displays a clickable button with a text label
  - It handles clicks using the `onClick` lambda

```
Button(onClick = { /* Handle click */ }) {
    Text("Click Me")
}
```

6. Basic components

- The `Image` composable is used to display an image
  - It can load images from resources, URIs, or bitmaps

```
Image(
    painter = painterResource(R.drawable.ic_launcher_foreground),
    contentDescription = "App Icon"
)
```

- The `Icon` composable displays an icon
  - Defaults to a standard size of 24dp, as defined by Material Design guidelines

```
Icon(
    painter = painterResource(R.drawable.baseline_directions_bus_24),
    contentDescription = "App Icon"
)
```

We study how to get graphics from the resources in the next section

https://developer.android.com/develop/ui/compose/graphics

6. Basic components - Modifiers

- Modifiers are compose functions that allow us to decorate or augment (i.e., style, position, and add behavior) other composables
- Common modifiers are:
  - *padding*: Adds space around the composable (`top`, `bottom`, `start`, `end`)
  - *fillMaxSize*: Makes the composable fill the available space in its parent layout, both in terms of width and height
  - *fillMaxWidth*: Makes the composable fill the maximum width given to it from its parent
  - *fillMaxHeight*: Makes the composable fill the maximum height given to it from its parent
  - *clickable*: Makes the composable respond to clicks
  - *background*: Sets the background color

https://developer.android.com/develop/ui/compose/modifiers

6. Basic components - Modifiers

- A basic example using some modifiers:

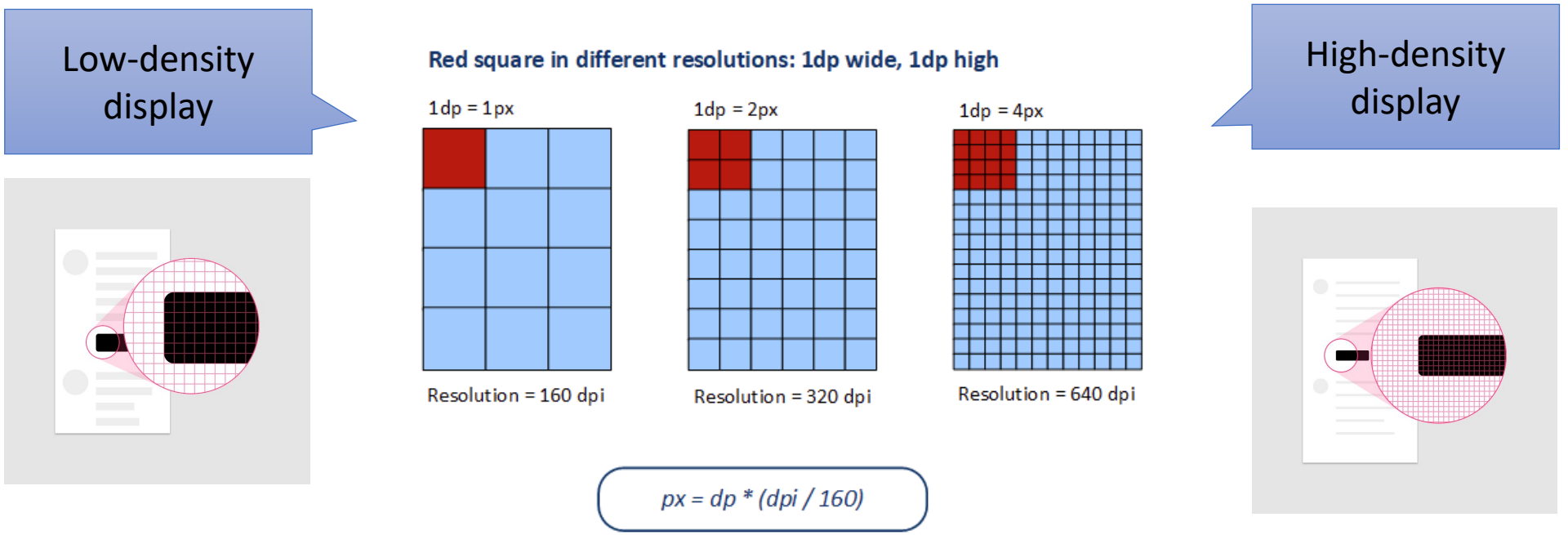
```
@Composable
fun Greeting(name: String, modifier: Modifier = Modifier) {
    Text(
        text = "Hello, $name!",
        modifier = modifier
            .fillMaxWidth()
            .background(Color.LightGray)
    )
    Button(
        onClick = {
            println("TODO handle click")
        },
        modifier = modifier.padding(32.dp)
    ) {
        Text(
            text = "Click Me",
            fontSize = 24.sp,
            color = Color.Green
        )
    }
}

@Preview(showBackground = true)
@Composable
fun Preview() {
    MyAppTheme {
        Greeting("Android")
    }
}
```

6. Basic components - Units of measurement

- Proper use of measurement units is essential to ensure that the UI looks consistent and scales correctly across devices with different screen sizes and densities. Common units of measurement are:
  - Density-independent pixels (*dp*)
    - Purpose: used for layout dimensions (e.g., padding, margins, width, height)
    - Behavior: scales based on the screen's density
    - Use case: responsive designs
  - Scale-independent pixels (*sp*)
    - Purpose: used for text sizes
    - Behavior: scales based on the screen's density and the user's font size preferences
    - Use case: similar to dps, but adjusts for the user's preferred text size
  - Pixels (*px*)
    - Purpose: rarely used directly. Represents actual screen pixels
    - Behavior: does not scale with screen density
    - Use case: only use px for very specific cases (e.g., custom drawing or precise control)

6. Basic components - Units of measurement

- A pixel (px) is the smallest unit of display on a screen
  - Each pixel represents a single point of color
- Density-independent pixels (dp or dpi) refers to the number of pixels that fit into an inch
  - For example, 1 dp is equal to 1 pixel on a medium-density screen (160 dpi) and it automatically scales on screens with higher densities



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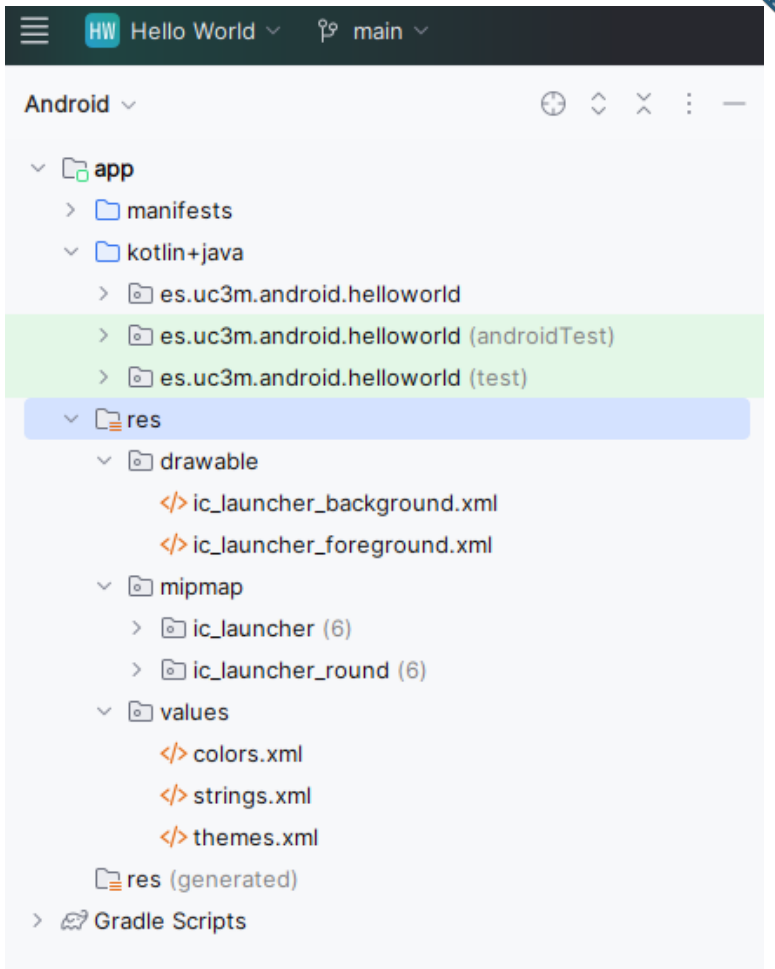
7. Resources

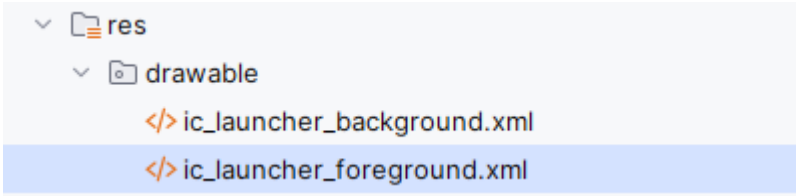
- Resources are the additional files and static content that your app uses, such as images, icons, or, strings
- Resources allow separating UI content from code, improving maintainability and localization
- These resources are located in a folder called `res` within the app module
- We can use these resources in the Kotlin code using the class **R** (a dynamically generated class created during build process to map all resources)

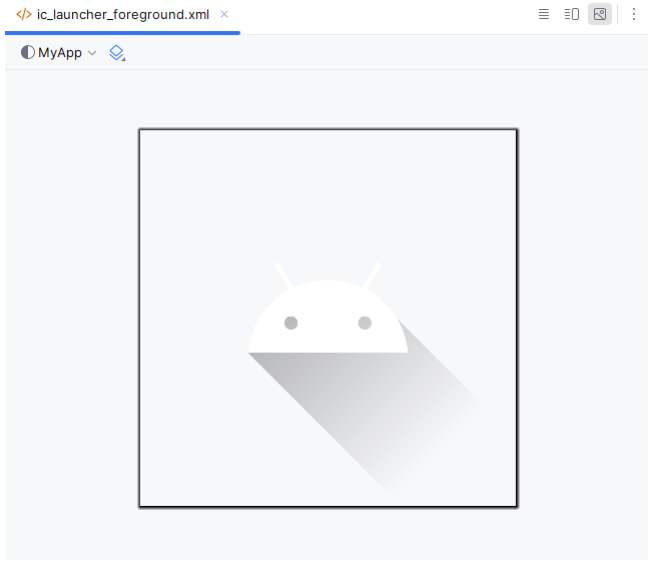


https://developer.android.com/guide/topics/resources/providing-resources

7. Resources - Drawable

- Drawable resources are pictures in the following formats:
  - Bitmap images in PNG, JPG, or other format
  - XML-based vector images
- Android Studio provides a couple of XML-based vector images used for the app icon

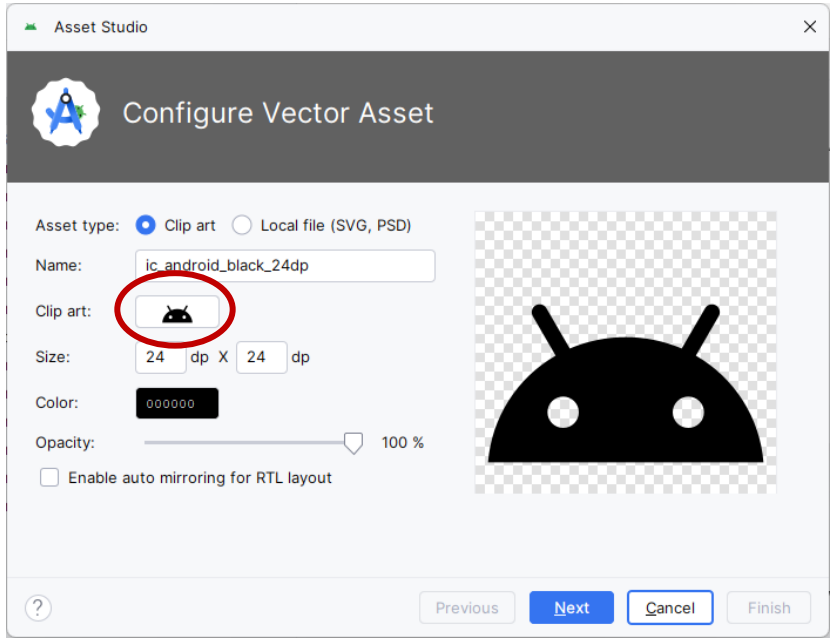


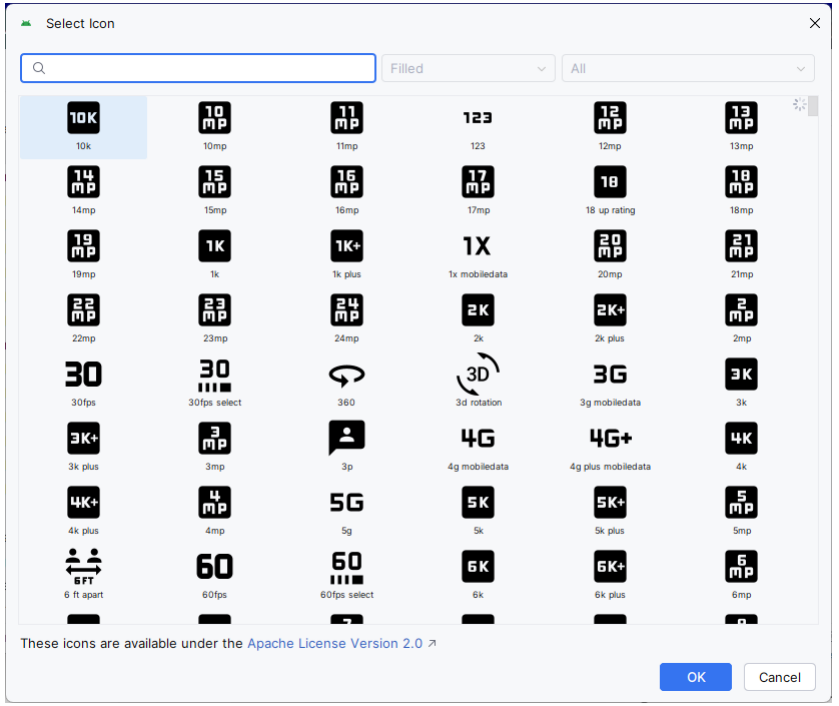


https://developer.android.com/guide/topics/resources/drawable-resource

7. Resources - Drawable

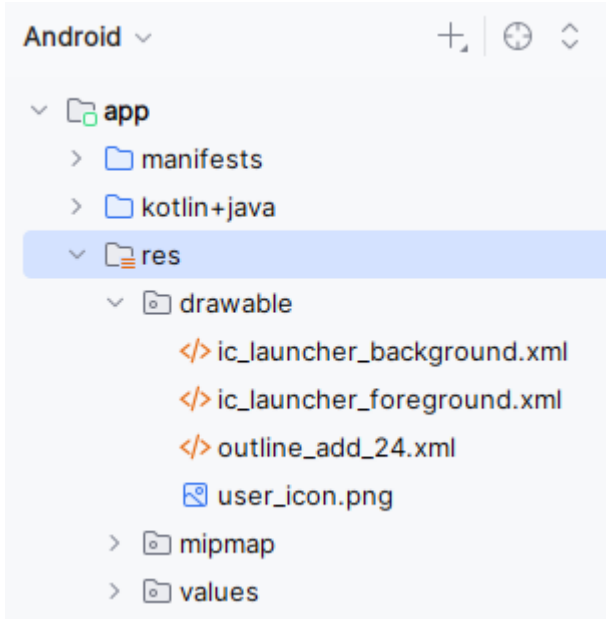
- Android Studio provides a graphical tool to include XML-based vector images for our app:
  - File → New → Vector Asset





7. Resources - Drawable

- We can include custom pictures in the drawable folder and use them in our composables:



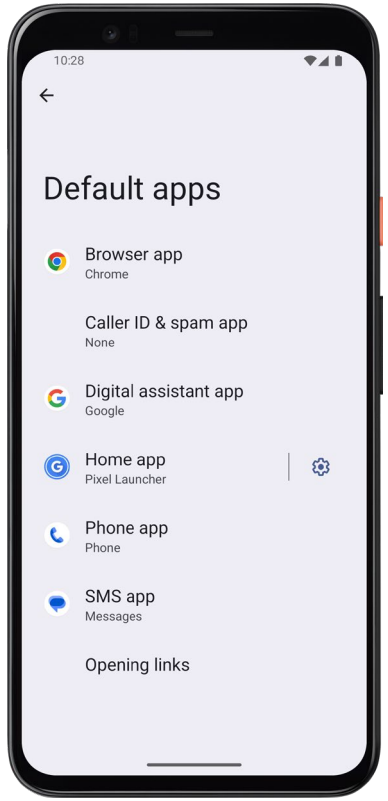

```
Box {
    Image(
        bitmap = ImageBitmap.imageResource(R.drawable.user_icon),
        contentDescription = "Developer image"
    )
    Icon(
        imageVector = ImageVector.vectorResource(R.drawable.outline_add_24),
        contentDescription = "Edit user"
    )
}
```

BoxPreview

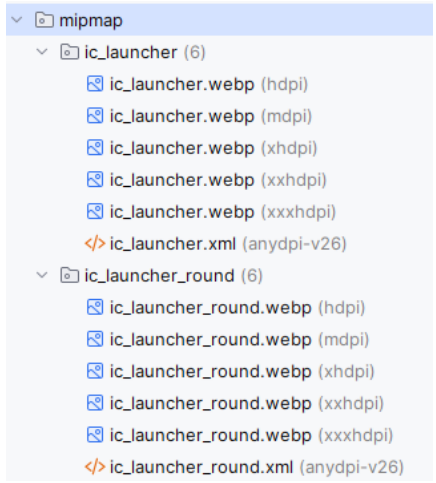
We study layouts (e.g., Box) in the next section

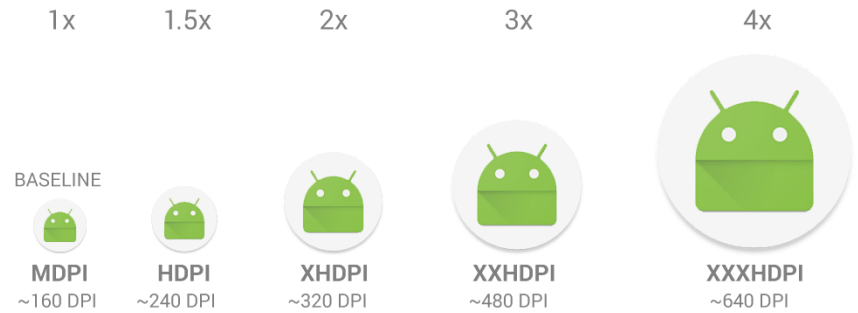
7. Resources - Mipmap

- The mipmap folder(s) provide contains the icons used by the **launcher**
  - The Android launcher is an app that provides the home screen and overall device navigation, allowing us to execute the rest of the apps
  - We can configure the Launcher app in Settings → Apps → Default apps



- Since Android runs on a variety of devices that have different screen sizes and pixel densities, it is a good practice to provide icons different pixel densities





https://developer.android.com/training/multiscreen/screendensities

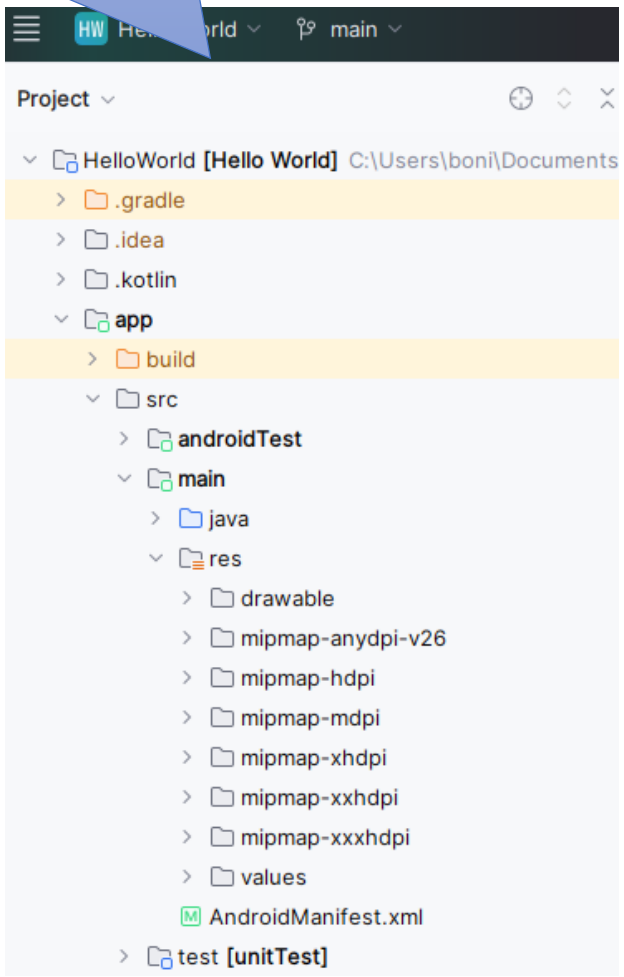
7. Resources - Mipmap

- The common screen densities are the following:

Density	Description
ldpi	Low-density (*ldpi*) screens (~120dpi)
mdpi	Medium-density (*mdpi*) screens (~160dpi)
hdpi	High-density (*hdpi*) screens (~240dpi)
xhdpi	Extra-high-density (*xhdpi*) screens (~320dpi)
xxhdpi	Extra-extra-high-density (*xxhdpi*) screens (~480dpi)
xxxhdpi	Extra-extra-extra-high-density (*xxxhdpi*) uses (~640dpi)
nodpi	These are density-independent resources
tvdpi	Smart TVs screens between mdpi and hdpi (~213dpi)

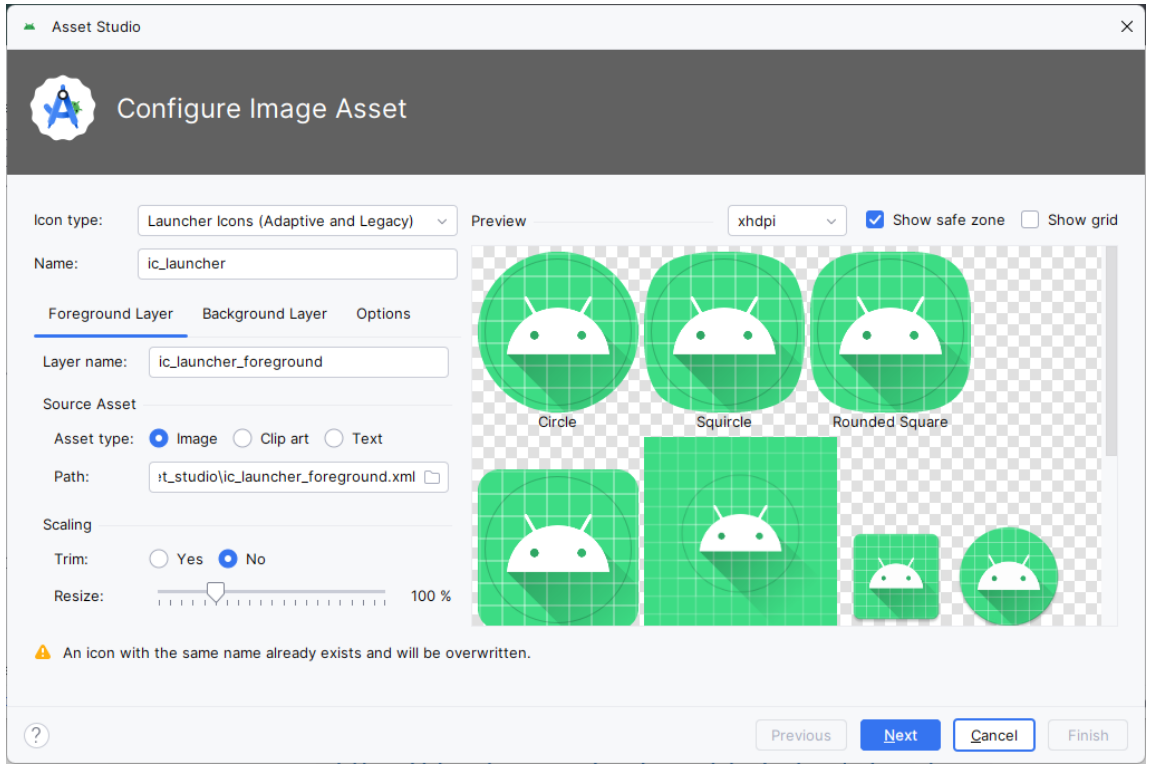
https://developer.android.com/guide/topics/resources/providing-resources

We can use these density labels as **resource qualifiers**, i.e., alternative resources based on screen densities.



7. Resources - Mipmap

- Android Studio provides a graphical tools to create icons for our app:
  - File → New → Image Asset



https://developer.android.com/studio/write/create-app-icons

7. Resources - Qualifiers

- Resource qualifiers allow providing alternative resources for different device configurations
- Examples:
  - Screen density (hdpi, xhdpi, etc.)
  - Language and region (es, es-rES, etc.)
  - Screen size or orientation
- At runtime, Android selects the most appropriate resource automatically

https://developer.android.com/studio/write/add-resources

7. Resources - Values

- The values folder contains XML files with simple values, such as:
  - Strings
  - Colors
  - Styles
  - Other data in XML (e.g., dimensions)

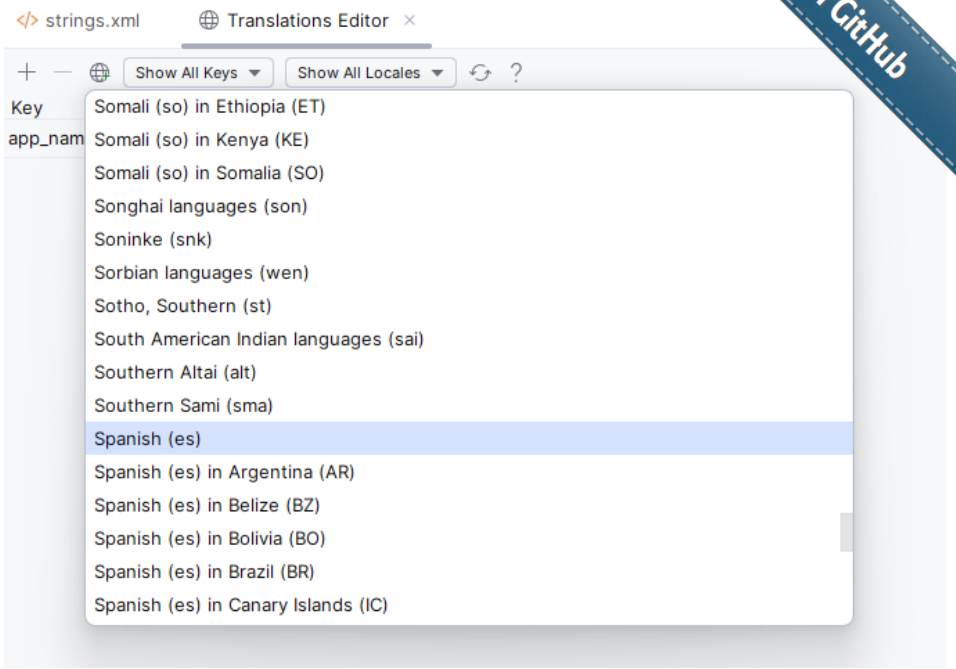
Storing text in `strings.xml` avoids hardcoding strings in code and enables easy localization

- These resources are referenced by ID from the code
- For using alternative string resources for different languages, we locale qualifiers (ISO 639-1 codes), for instance:
  - string-es.xml : For Spanish language
  - string-es-rES.xml : For Spanish language and Spain region

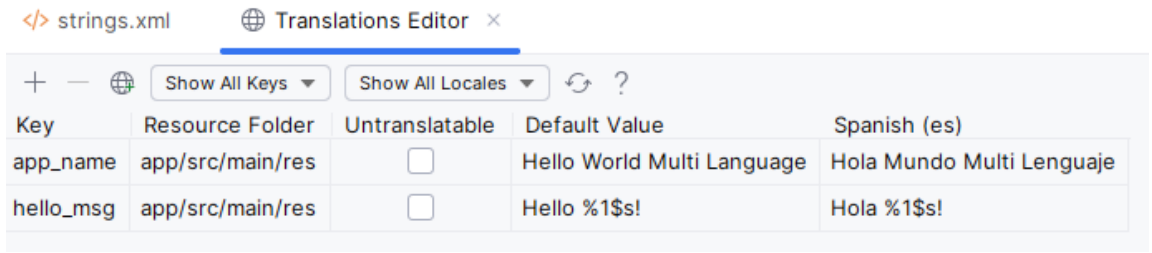
https://developer.android.com/guide/topics/resources/providing-resources

7. Resources - Values

A simple way to include multilanguage messages is by using Android Studio




```
@Composable
fun Greeting(name: String, modifier: Modifier = Modifier) {
    Text(
        text = stringResource(R.string.hello_msg, name),
        modifier = modifier
    )
}
```



Finally, we read the string values from our composables

7. Resources - Values

- If we change the system language (Settings → System → Language & input → Language), our app will use the locale messages

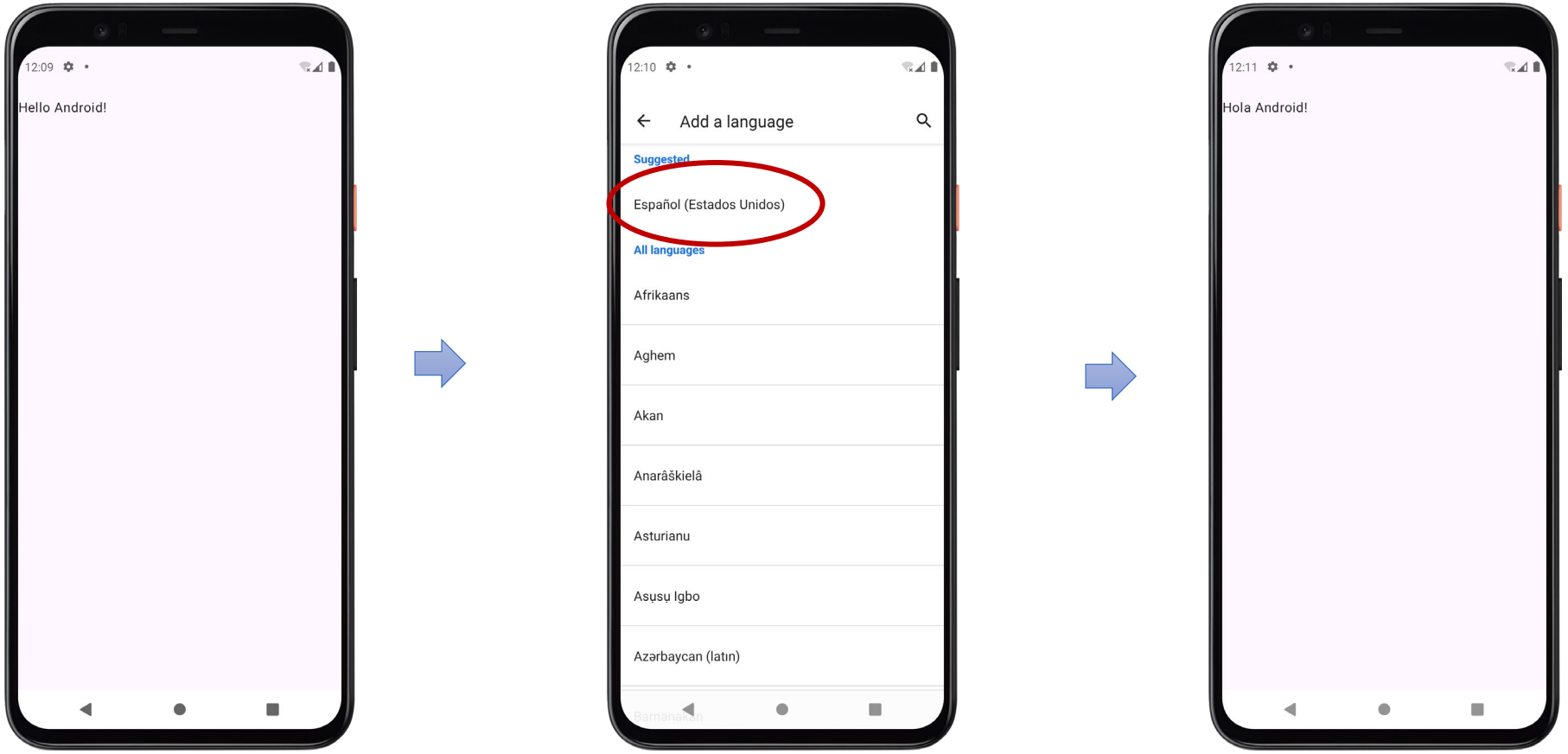


Table of contents

8. Layouts

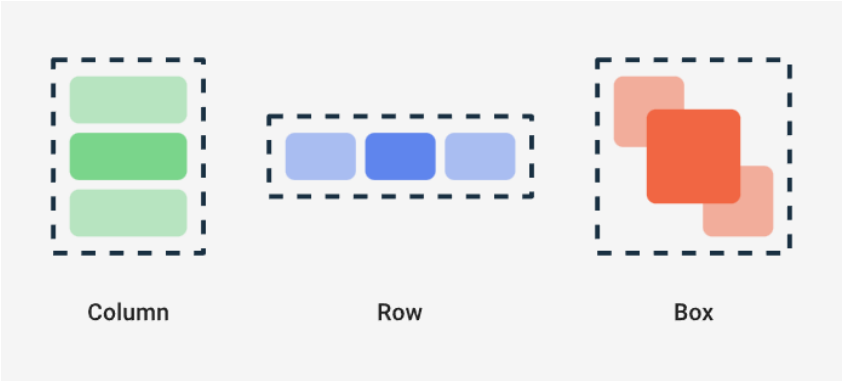
- If we don’t provide some guidance to organize our UI elements, they are arranged in the screen in a way we don’t like
  - To avoid this problem, we to organize the UI elements using a layout

```
@Composable
fun DevCard() {
    Text("John Doe")
    Text("Developer")
}
```

- A **layout** refers to the arrangement and organization of visual elements within a screen and determines how components are positioned relative to each other

8. Layouts

- Compose provides a collection of built-in **layouts** to help us arrange our UI elements. The basic composable layouts are:
  - `Column` to place items vertically on the screen
  - `Row` to place items horizontally on the screen
  - `Box` to put elements on top of another
  - `Spacer` to add empty space between composables



https://developer.android.com/develop/ui/compose/layouts/basics

8. Layouts

Column layout

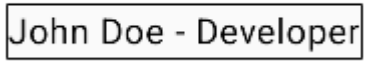
```
@Composable
fun DevCardColumn() {
    Column {
        Text("John Doe")
        Text("Developer")
    }
}
```

ColumnPreview

Row layout

```
@Composable
fun DevCardRow() {
    Row {
        Text("John Doe")
        Text(" - ")
        Text("Developer")
    }
}
```

RowPreview



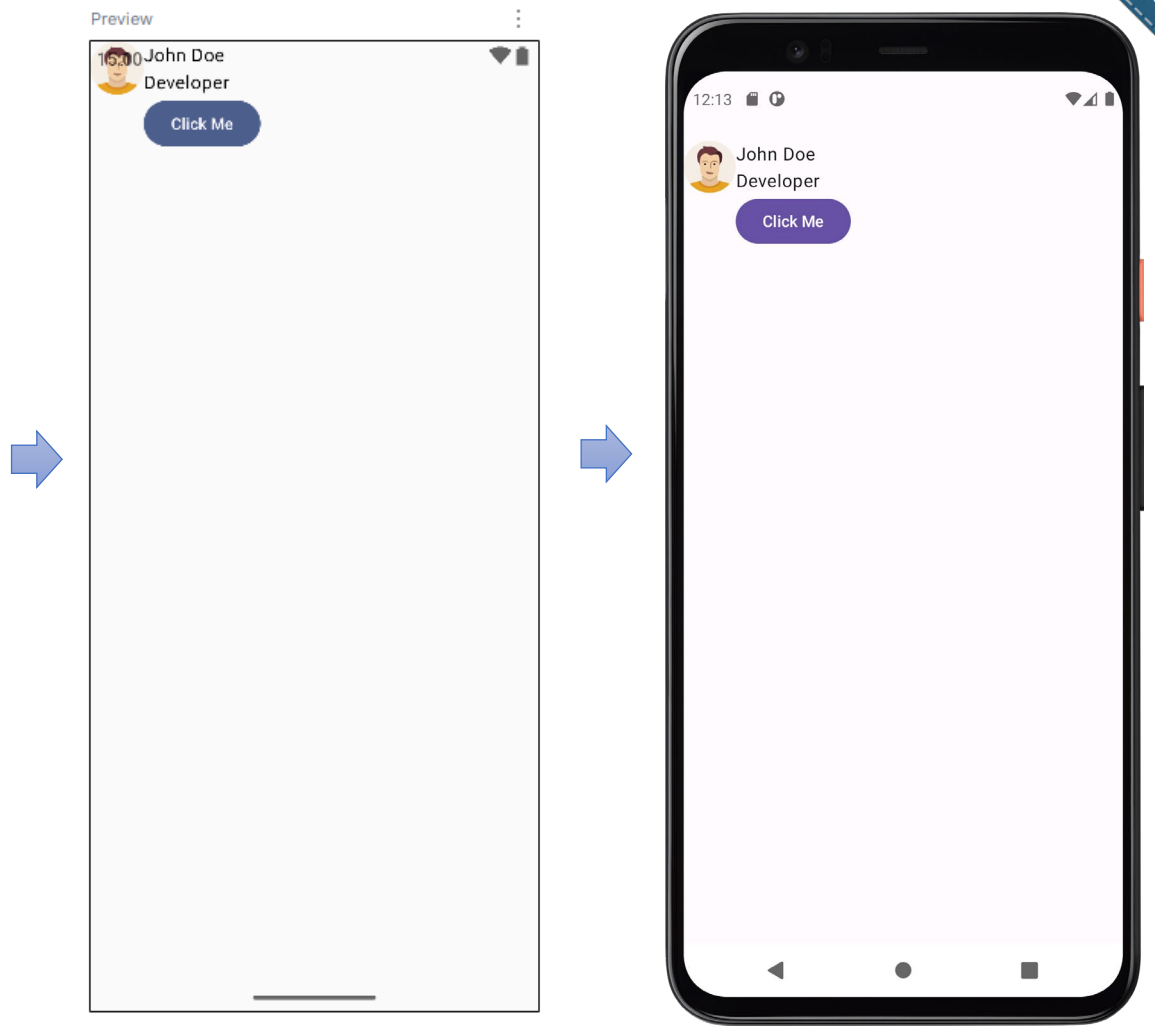
Box layout

```
@Composable
fun DevCardBox() {
    Box {
        Image(
            bitmap = ImageBitmap.imageResource(R.drawable.user_icon),
            contentDescription = "Developer image"
        )
        Icon(
            imageVector = ImageVector.vectorResource(R.drawable.outline_add_24),
            contentDescription = "Edit user"
        )
    }
}
```

BoxPreview

8. Layouts

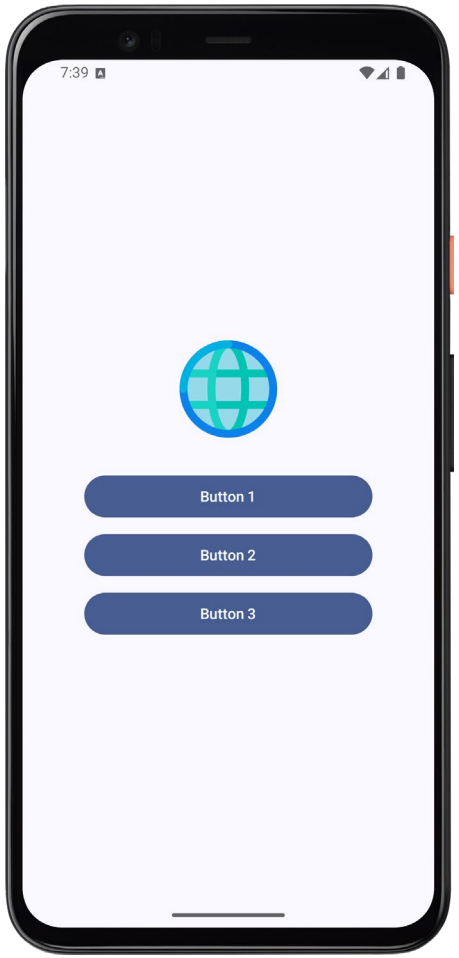

```
data class Developer(var name: String, var role: String)

@Composable
fun DevLayout(developer: Developer) {
    Row {
        Image(
            bitmap = ImageBitmap.imageResource(R.drawable.user_icon),
            contentDescription = "Developer image"
        )
        Column {
            Text(developer.name)
            Text(developer.role)
            Button(
                onClick = {
                    Log.d("MainActivity", "Button clicked")
                },
                content = {
                    Text("Click Me")
                }
            )
        }
    }
}


@Preview(showBackground = true, showSystemUi = true)
@Composable
fun Preview() {
    MyAppTheme {
        DevLayout(Developer("John Doe", "Developer"))
    }
}
```



8. Layouts

- The following example shows a more elaborated layout using basic elements:

```
@Composable
fun MyLayout(modifier: Modifier = Modifier) {
    Row {
        // Left spacer (15% width)
        Spacer(
            modifier = modifier
                .weight(0.15f)
                .fillMaxHeight()
        )

        // Middle content (70% width)
        Box(
            modifier = modifier
                .weight(0.7f)
                .fillMaxHeight(),
            contentAlignment = Alignment.Center
        ) {
            Column(
                horizontalAlignment = Alignment.CenterHorizontally
            ) {
                // Logo and buttons
            }
        }

        // Right spacer (15% width)
        Spacer(
            modifier = modifier
                .weight(0.15f)
                .fillMaxHeight()
        )
    }
}
```



8. Layouts - Constraint layout

- `ConstraintLayout` is a layout that allows you to place composables relative to other composables on the screen
  - It is an alternative to using multiple nested `Row`, `Column`, and `Box`
  - It is usually used when implementing responsive layouts with complicated alignment requirements
- To use `ConstraintLayout`, we need the following dependency:

build.gradle.kts

```
dependencies {
    implementation(libs.androidx.constraintlayout.compose)
}
```

libs.version.toml

```
[versions]
constraintlayoutCompose = "1.1.1"

[libraries]
androidx-constraintlayout-compose = { module = "androidx.constraintlayout:constraintlayout-compose", version.ref = "constraintlayoutCompose" }
```

https://developer.android.com/develop/ui/compose/layouts/constraintlayout

8. Layouts - Constraint layout

- We define constraints (e.g., `start`, `end`, `top`, `bottom`) between composables to position them relative to each other or to the parent
  - It also allows us to create barriers (dynamic boundaries) and guidelines (fixed or percentage-based lines) for advanced layouts
- Let's see the following example:

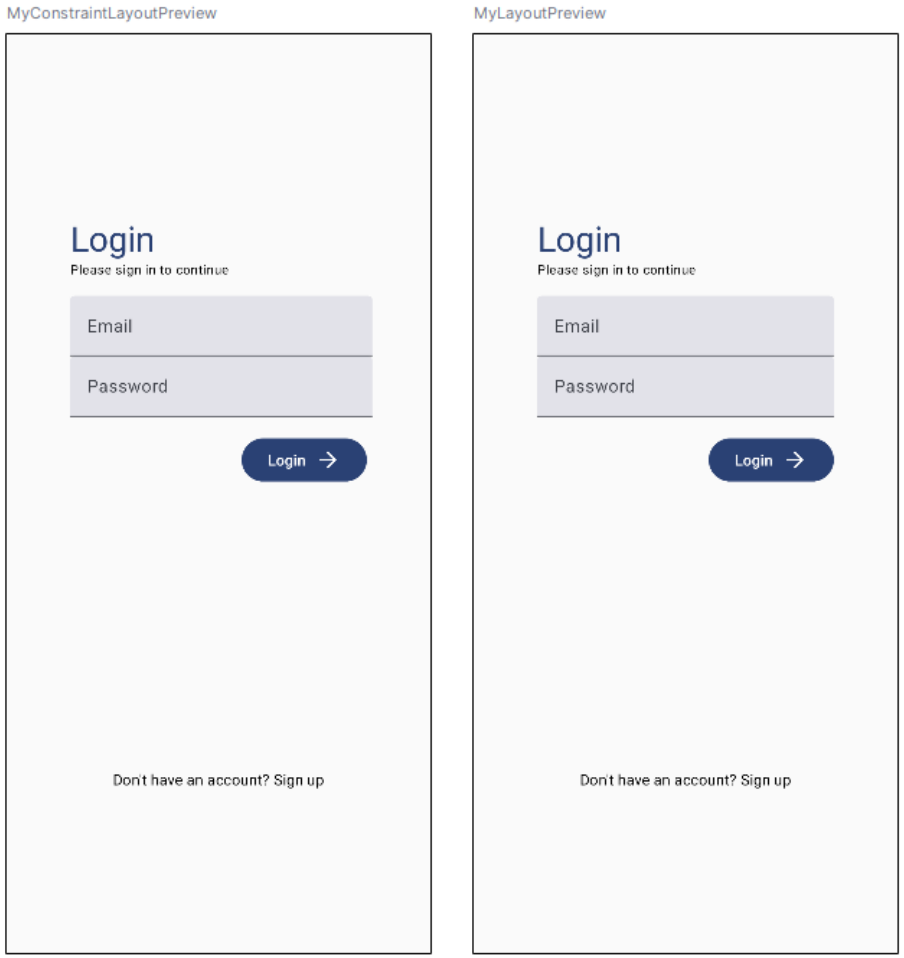
8. Layouts - Constraint layout

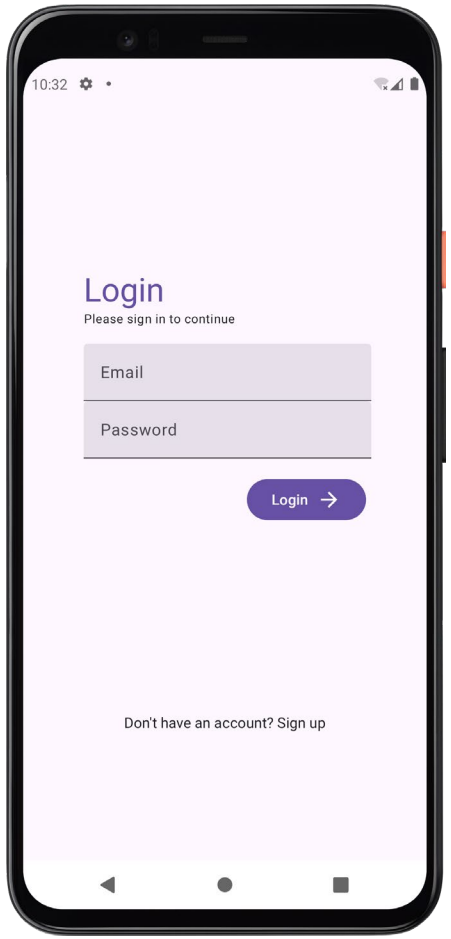

```
@Composable
fun MyConstraintLayout(modifier: Modifier = Modifier) {
    ConstraintLayout(
        modifier = modifier
    ) {
        // Create references for the components
        val (text, button) = createRefs()

        // Text component
        Text(
            text = stringResource(R.string.hello_msg),
            modifier = Modifier
                .constrainAs(text) {
                    top.linkTo(parent.top, margin = 16.dp)
                    start.linkTo(parent.start, margin = 16.dp)
                }
        )

        // Button component
        Button(
            onClick = {
                // TODO: Handle click
            },
            modifier = Modifier
                .constrainAs(button) {
                    top.linkTo(text.bottom, margin = 16.dp)
                    start.linkTo(parent.start, margin = 16.dp)
                }
        ) {
            Text(stringResource(R.string.button_msg))
        }
    }
}
```

8. Layouts - Constraint layout

- The following example contains a more elaborated layout using constraints:

This example also contains the equivalent layout but using the nested `Row`, `Column`, and `Box`





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9. Theme

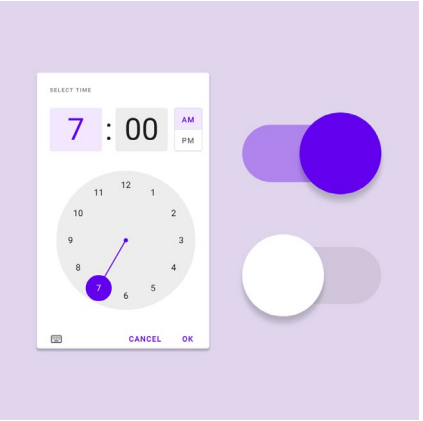
- A **theme** defines the overall visual style of an app (colors, typography, shapes, and other visual attributes)
  - *Theming* is the process of applying a consistent visual style across the app
- The main purposes of theming are:
  - Consistency: ensures a uniform look and behavior across screens and components
  - Branding: reflects the app's identity through colors, fonts, and shapes
  - Adaptability: supports light/dark mode and different device configurations
  - Maintainability: centralizes style definitions, making global updates easier

https://developer.android.com/design/ui/mobile/guides/styles/themes

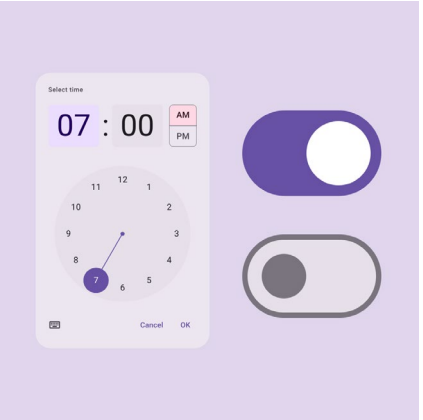
9. Theme

- **Material Design** is Google's design system for creating consistent, intuitive, and accessible UIs
  - It defines guidelines, principles, and UI components to ensure a unified look and feel across apps and devices
  - It was introduced in 2014 and has become a standard for designing Android applications, web applications, and other digital products
- Material Design 3 is applied by default when creating Android projects in Android Studio

https://material.io/



Material Design 2



Material Design 3
(a.k.a. Material You or M3)

9. Theme

- In Android, theming can be applied in two main ways:

1. Android view system:
   - XML-based
   - Theming is done using XML files in the res/values directory

https://developer.android.com/develop/ui/views/theming/themes

2. Jetpack Compose:
   - Programmatic
   - Theming is done using Kotlin

Even if we use Jetpack Compose for the UI, we also need to consider the traditional XML-based system

https://developer.android.com/develop/ui/compose/designsystems

9. Theme - Android view system

- In the traditional Android view system, theming is done using XML files in the `res/values` directory

```xml
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <style name="Theme.MyApp" parent="android:Theme.Material.Light.NoActionBar" />
</resources>
```

Themes are declared in the file `res/values/themes.xml`

```xml
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <color name="purple_200">#FFBB86FC</color>
    <color name="purple_500">#FF6200EE</color>
    <color name="purple_700">#FF3700B3</color>
    <color name="teal_200">#FF03DAC5</color>
    <color name="teal_700">#FF018786</color>
    <color name="black">#FF000000</color>
    <color name="white">#FFFFFFFF</color>
</resources>
```

Colors (in RGBA) are declared in the file `res/values/colors.xml`

9. Theme - Android view system

- The XML theme is declared in the manifest:

AndroidManifest.xml

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

    <application
        android:icon="@mipmap/ic_launcher"
        android:label="@string/app_name"
        android:roundIcon="@mipmap/ic_launcher_round"
        android:theme="@style/Theme.MyApp">
        <activity
            android:name=".MainActivity"
            android:exported="true">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>

</manifest>
```

res/values/themes.xml

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <style name="Theme.MyApp" parent="android:Theme.Material.Light.NoActionBar" />
</resources>
```

9. Theme - Android view system

- We can change the XML parent theme:
  - Theme.Material.Light
  - Theme.Material.Light.NoActionBar
  - Theme.Material.Light.NoActionBar.Fullscreen
  - Theme.Material.Dialog
  - Theme.Material.Settings
  - Theme.Material.InputMethod
  - Theme.Material.NoActionBar
  - Theme.Material.Panel
  - Theme.Material.Voice
  - Theme.Material.Wallpaper

This one is used by default in the projects created with Android Studio

For example, we can change the following in any app demo (e.g., in the hello-world)

```
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <style name="Theme.MyApp" parent="android:Theme.Material.Light" />
</resources>
```

9. Theme - Android view system

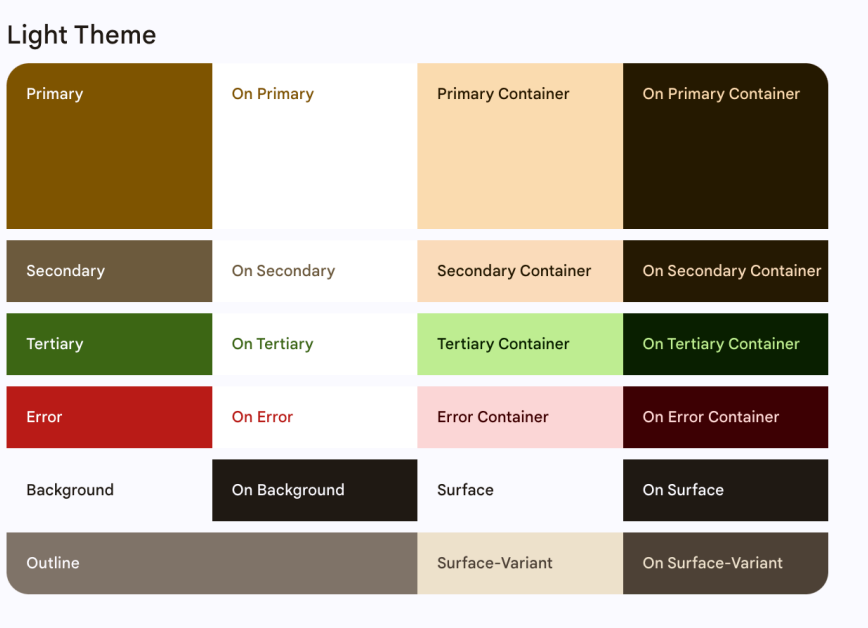
- Also, we can customize the XML theme by overriding the default values for colors, typography, and shapes

```xml
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <style name="Theme.MyApp" parent="android:Theme.Material.Light.NoActionBar">
        <!-- Customize theme here -->
        <item name="android:colorPrimary">@color/purple_200</item>
    </style>
</resources>
```

9. Theme - Jetpack Compose

- Jetpack Compose provides an implementation of Material Design 3 using a composable called **`MaterialTheme`**
  - This composable provides a consistent way to define and apply colors, typography, and shapes throughout our app
  - For that, it includes pre-defined components for:
    - Colors: Primary, secondary, background, surface, etc.
    - Typography: Headlines, body text, captions, etc.
    - Shapes: Small, medium, and large components

All composables inside **`MaterialTheme`** inherit these values



https://developer.android.com/develop/ui/compose/designsystems/material3

9. Theme - Jetpack Compose

- A common practice for theming with Jetpack Compose is to customize `MaterialTheme` by overriding its default values using Kotlin:
  - **`Color.kt`**: to define the color palette
    - Defined through global constants to ensure consistency and reusability
    - Examples: *`primary`*, *`secondary`*, *`background`*, *`surface`*, etc.
  - **`Type.kt`**: to define the typography
    - It includes text styles for different UI elements (e.g., headlines, body text, captions)
    - Examples: `bodyLarge`, `titleMedium`, `headlineSmall`, etc.
  - **`Shape.kt`**: To define the default shapes
    - It specifies the rounded corners to be applied to Material components
    - Examples: `extraSmall`, `small`, `large`, `extraLarge`, etc.
  - **`Theme.kt`**: To define the theme
    - Combines the color palette, typography, and shapes into a single theme that can be applied to the entire app
    - Typically supports light and dark color schemas by defining separate color schemes

https://developer.android.com/codelabs/jetpack-compose-theming

9. Theme - Jetpack Compose

<namespace>/ui/theme/Color.kt

```
val Purple80 = Color(0xFFD0BCFF)
val PurpleGrey80 = Color(0xFFCCC2DC)
val Pink80 = Color(0xFFEFB8C8)

val Purple40 = Color(0xFF6650a4)
val PurpleGrey40 = Color(0xFF625b71)
val Pink40 = Color(0xFF7D5260)
```

<namespace>/ui/theme/Type.kt

```
val Typography = Typography(
    bodyLarge = TextStyle(
        fontFamily = FontFamily.Default,
        fontWeight = FontWeight.Normal,
        fontSize = 16.sp,
        lineHeight = 24.sp,
        letterSpacing = 0.5.sp
    )
)
```

Material Design 3 introduces dynamic color, which allows the app's theme to adapt to the user's wallpaper or system settings

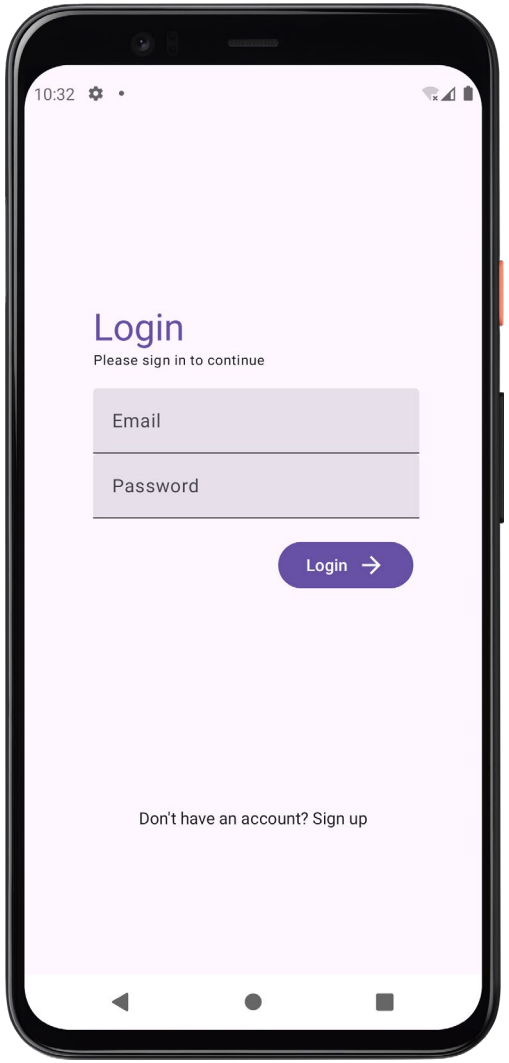
<namespace>/ui/theme/Theme.kt

```
private val DarkColorScheme = darkColorScheme(
    primary = Purple80,
    secondary = PurpleGrey80,
    tertiary = Pink80
)

private val LightColorScheme = lightColorScheme(
    primary = Purple40,
    secondary = PurpleGrey40,
    tertiary = Pink40
)

@Composable
fun MyAppTheme(
    darkTheme: Boolean = isSystemInDarkTheme(),
    dynamicColor: Boolean = true,
    content: @Composable () -> Unit
) {
    val colorScheme = when {
        dynamicColor && Build.VERSION.SDK_INT >= Build.VERSION_CODES.S -> {
            val context = LocalContext.current
            if (darkTheme) dynamicDarkColorScheme(context) else dynamicLightColorScheme(context)
        }

        darkTheme -> DarkColorScheme
        else -> LightColorScheme
    }

    MaterialTheme(
        colorScheme = colorScheme,
        typography = Typography,
        content = content
    )
}
```

9. Theme - Jetpack Compose

We can apply different `MaterialTheme` styles for example as follows:

```
Text(
    text = stringResource(R.string.login_label),
    style = MaterialTheme.typography.headlineLarge,
    color = MaterialTheme.colorScheme.primary
)
Text(
    text = stringResource(R.string.sign_in_to_continue),
    style = MaterialTheme.typography.bodySmall
)
```



9. Theme - Jetpack Compose

<namespace>/ui/theme/Color.kt

```
val md_theme_light_primary = Color(0xFF825500)
val md_theme_light_onPrimary = Color(0xFFFFFFFF)

// ...
```

<namespace>/ui/theme/Type.kt

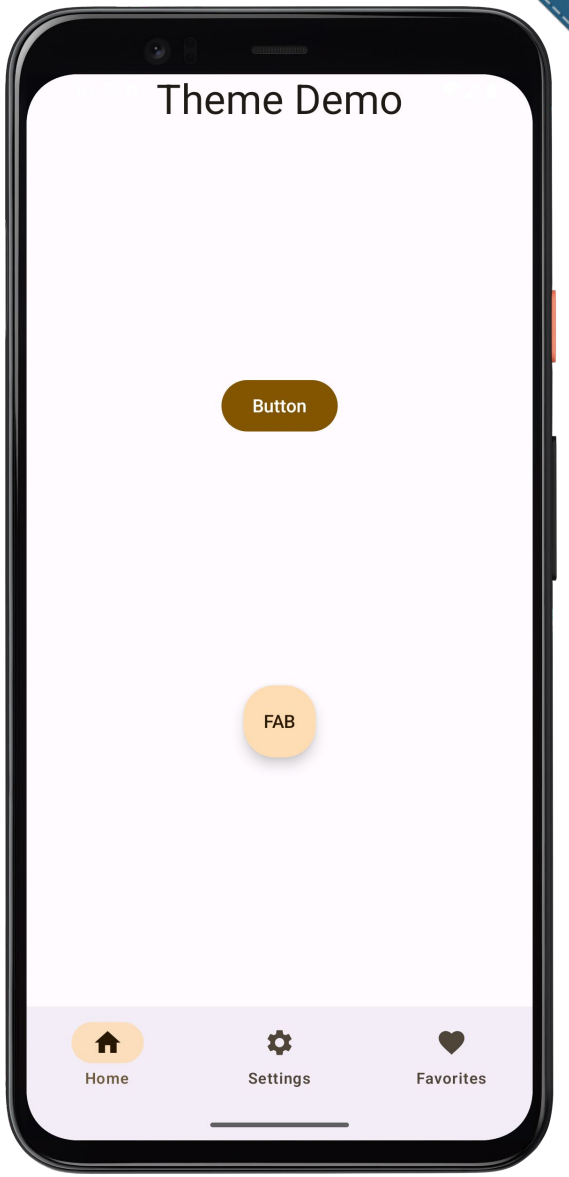
```
val typography = Typography(
    headlineSmall = TextStyle(
        fontWeight = FontWeight.SemiBold,
        fontSize = 24.sp,
        lineHeight = 32.sp,
        letterSpacing = 0.sp
    ),

    // ...

)
```

<namespace>/ui/theme/Shapes.kt

```
val shapes = Shapes(
    extraSmall = RoundedCornerShape(4.dp),
    small = RoundedCornerShape(8.dp),
    medium = RoundedCornerShape(16.dp),
    large = RoundedCornerShape(24.dp),
    extraLarge = RoundedCornerShape(32.dp)
)
```

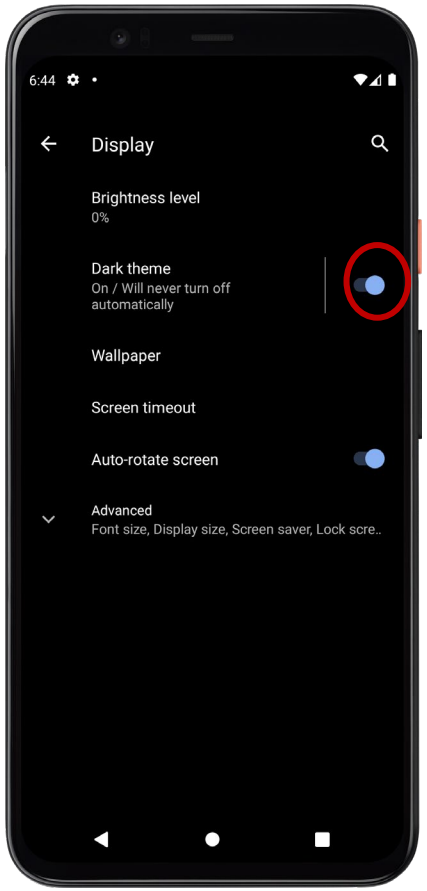
<namespace>/ui/theme/Theme.kt

```
private val LightColors = lightColorScheme(
    primary = md_theme_light_primary,
    onPrimary = md_theme_light_onPrimary,

    // ...
)


private val DarkColors = darkColorScheme(
    primary = md_theme_dark_primary,
    onPrimary = md_theme_dark_onPrimary,

    // ...
)

@Composable
fun MyAppTheme(
    useDarkTheme: Boolean = isSystemInDarkTheme(),
    content: @Composable() () -> Unit
) {
    val colors = if (!useDarkTheme) {
        LightColors
    } else {
        DarkColors
    }

    MaterialTheme(
        colorScheme = colors,
        typography = typography,
        shapes = shapes,
        content = content
    )
}
```



9. Theme - Dark mode

- We can enable the dark mode In the Android configuration (Settings → Display)

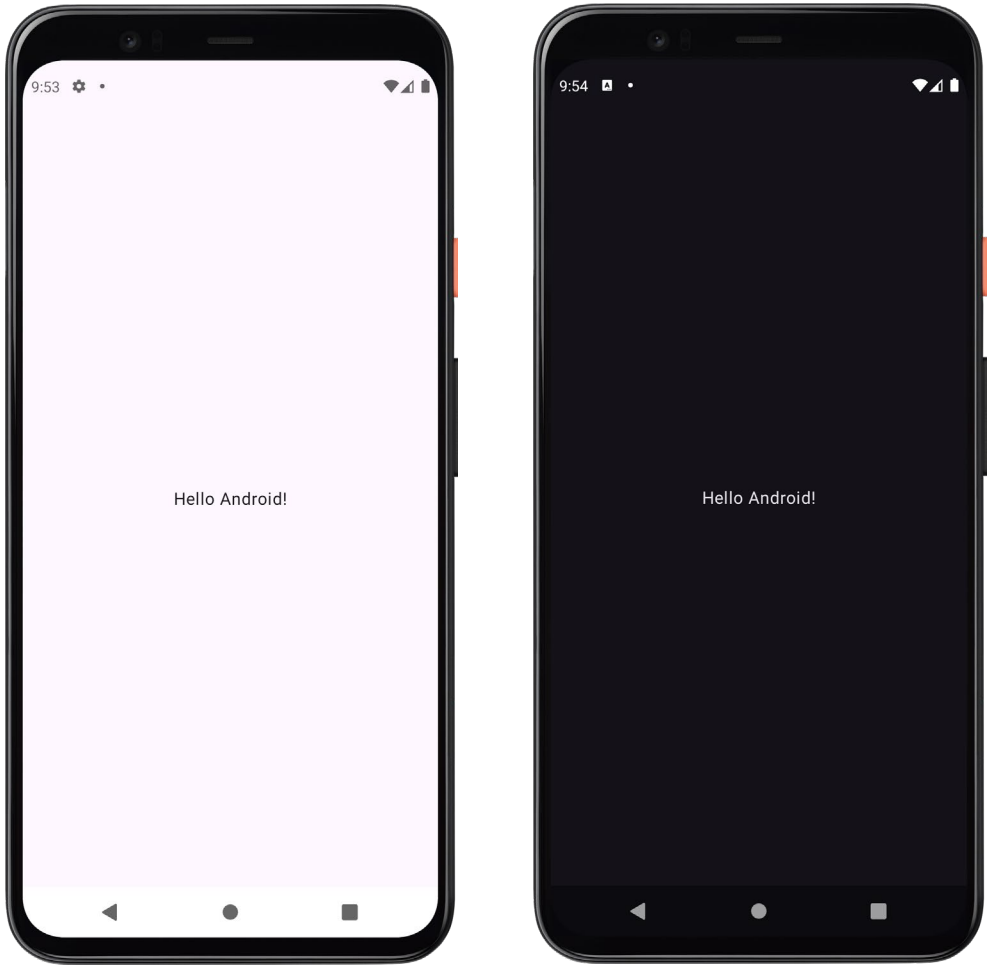


In Jetpack Compose, `MaterialTheme` flows down the composition tree, but Material containers like `Scaffold` or `Surface` are needed to apply it correctly; without them, UI components may render with incorrect or default styling.

9. Theme - Dark mode

- The following example is a modified version of the hello-world app using `Surface` instead of `Scaffold`:

```
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        enableEdgeToEdge()
        setContent {
            MyAppTheme {
                Surface(
                    modifier = Modifier.fillMaxSize(),
                    color = MaterialTheme.colorScheme.background
                ) {
                    Greeting(name = "Android")
                }
            }
        }
    }
}

@Composable
fun Greeting(name: String) {
    Column(
        horizontalAlignment = Alignment.CenterHorizontally,
        verticalArrangement = Arrangement.Center
    ) {
        Text(text = "Hello $name!")
    }
}
```



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10. Material components

- Jetpack Compose offers an implementation of the Material components a collection of composable functions
- The following slides reviews the most relevant material components
- If you need to use some of the following, it is recommended to check the official documentation for code examples:

  https://developer.android.com/develop/ui/compose/components

- Also, the following site provides a good reference of Material composables:

  https://composables.com/material/

10. Material components

- App bar:
  - Containers that provide the user access to key features and navigation items

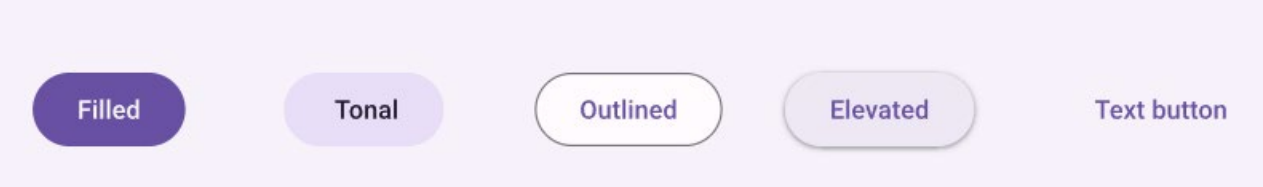
https://developer.android.com/develop/ui/compose/components/app-bars
https://composables.com/app-bars

- Badge:
  - Small visual element to denote status or a numeric value on another composable

https://developer.android.com/develop/ui/compose/components/badges
https://composables.com/badges

10. Material components

- Button:
  - Fundamental components that allow the user to trigger a defined action



https://developer.android.com/develop/ui/compose/components/button
https://composables.com/buttons

- Segmented button:
  - Let users choose from a set of options

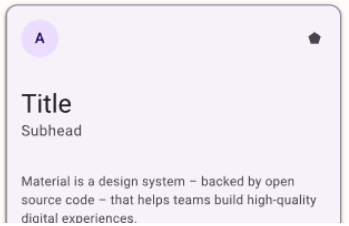
https://developer.android.com/develop/ui/compose/components/segmented-button

10. Material components

- Bottom sheet:
  - Supplementary content that are anchored to the bottom of the screen

https://developer.android.com/develop/ui/compose/components/bottom-sheets
https://composables.com/sheets

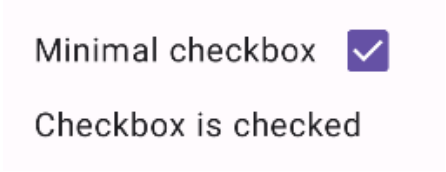
- Card:
  - Container for our UI. Cards typically present a single coherent piece of content

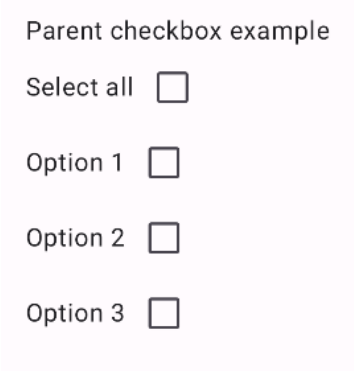


https://developer.android.com/develop/ui/compose/components/card
https://composables.com/cards

10. Material components

- Checkbox:
  - Elements that let users select one or more items from a list





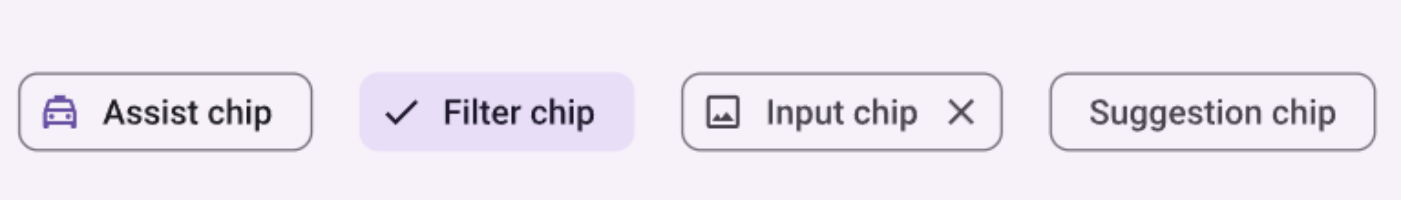
https://developer.android.com/develop/ui/compose/components/checkbox
https://composables.com/checkboxes

- Radio button:
  - To select only one option from a list

https://developer.android.com/develop/ui/compose/components/radio-button
https://composables.com/radio-buttons

10. Material components

- Chip:
  - Represents complex entities like a contact or tag, often with an icon and label



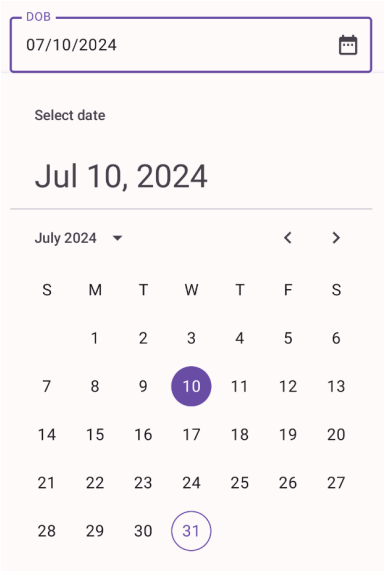
https://developer.android.com/develop/ui/compose/components/chip
https://composables.com/chips

- Switch:
  - To toggle between two states (checked and unchecked)

https://developer.android.com/develop/ui/compose/components/switch
https://composables.com/switches

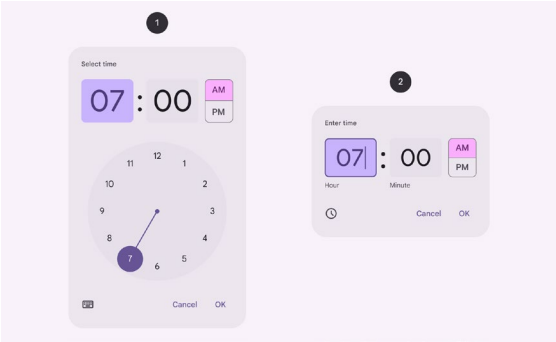
10. Material components

- Date picker:
  - To select a date, a date range, or both



https://developer.android.com/develop/ui/compose/components/datepickers
https://composables.com/date

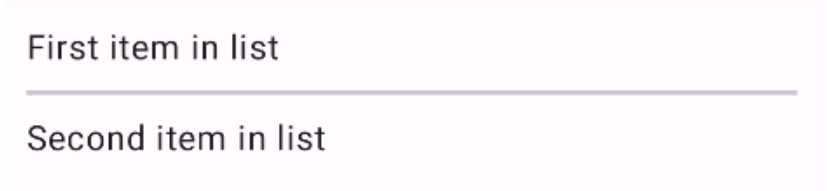
- Time picker:
  - To select a time



https://developer.android.com/develop/ui/compose/components/time-pickers
https://composables.com/time

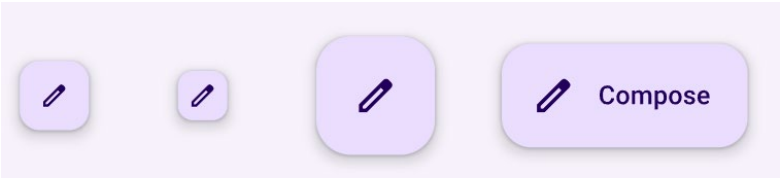
10. Material components

- Divider:
  - Thin lines that separate items in lists or other containers



https://developer.android.com/develop/ui/compose/components/divider
https://composables.com/dividers

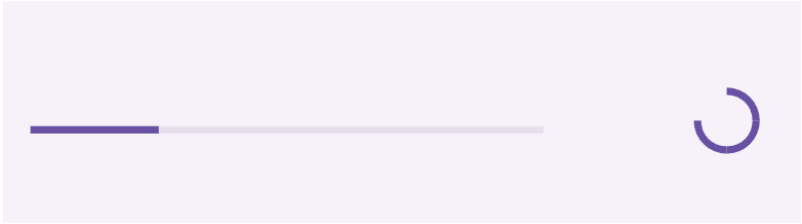
- Floating action button (FAB):
  - High-emphasis button that lets the user perform a primary action in an application



https://developer.android.com/develop/ui/compose/components/fab
https://composables.com/floating-action-buttons

10. Material components

- Progress indicator:
  - Visually represent the status of an operation



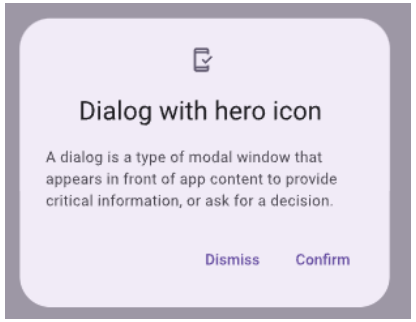
https://developer.android.com/develop/ui/compose/components/progress
https://composables.com/progress-indicators

- Slider:
  - To make selections from a range of values

https://developer.android.com/develop/ui/compose/components/slider
https://composables.com/sliders

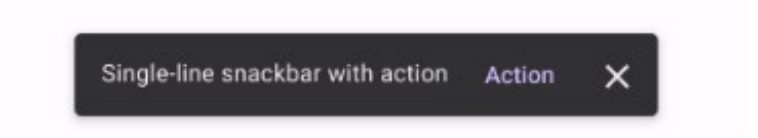
10. Material components

- Dialog:
  - Component that displays pop up messages or requests user input



https://developer.android.com/develop/ui/compose/components/dialog
https://composables.com/dialogs

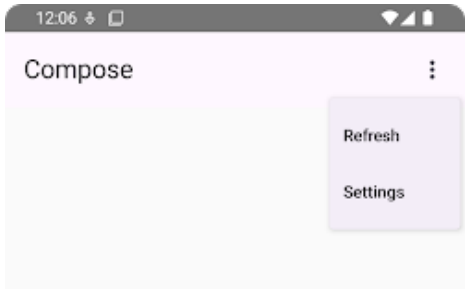
- Snackbar:
  - Transient notification that appears at the bottom of the screen



https://developer.android.com/develop/ui/compose/components/snackbar
https://composables.com/snackbars

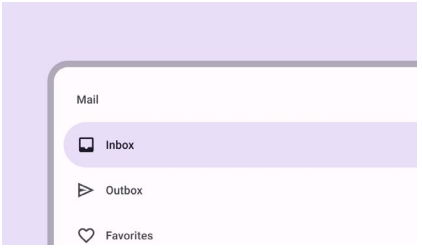
10. Material components

- Drop-down menus
  - Let users select from a list of options on a temporary surface



https://developer.android.com/develop/ui/compose/components/menu
https://composables.com/dropdown-menus

- Navigation drawer:
  - Slide-in menu that lets users navigate to various sections of your app



https://developer.android.com/develop/ui/compose/components/drawer
https://composables.com/drawers

10. Material components - Scaffold

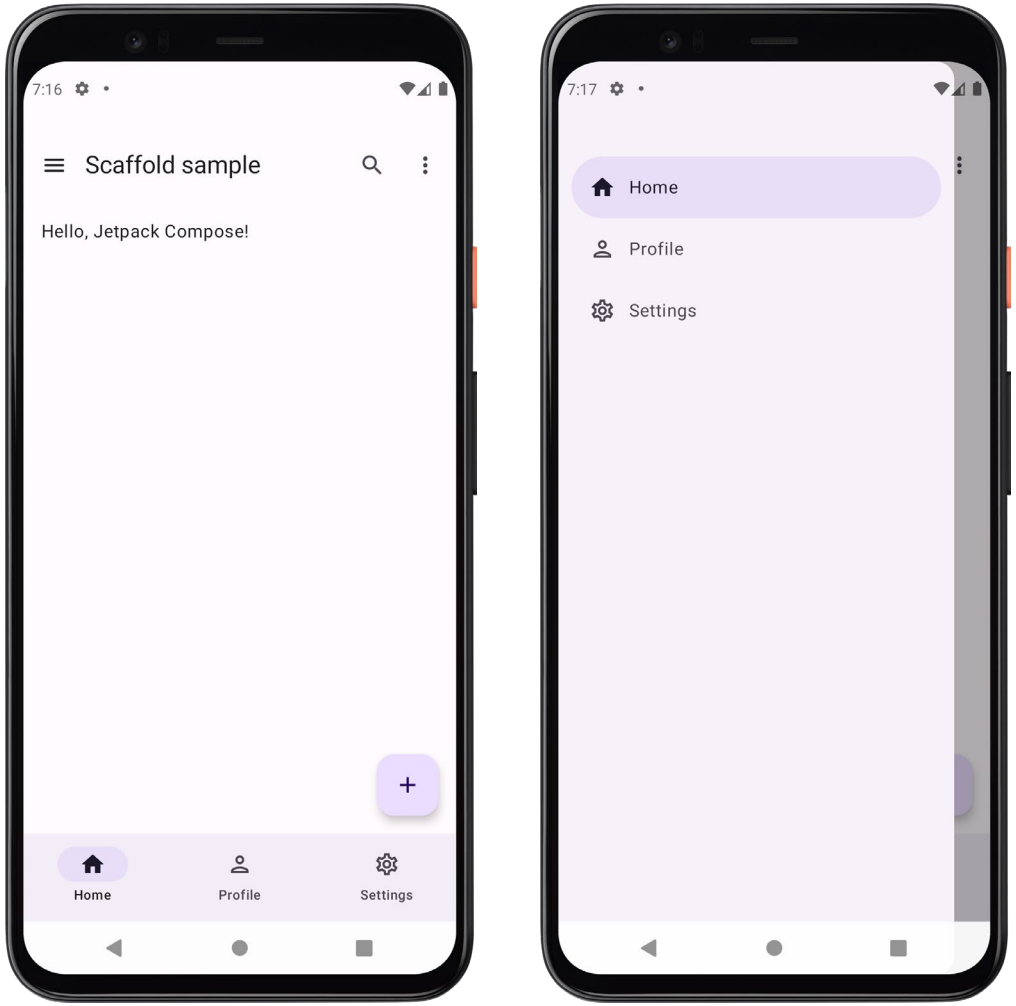
- Scaffold is a pre-built composable In Jetpack Compose that provides a high-level structure for implementing Material Design layouts
  - It simplifies the process of creating common UI patterns by offering slots for components like top bars, bottom bars, floating action buttons, snackbars, and content
- Scaffold provides slots for the following components:
  - Top bar: For app bars (e.g., `TopAppBar`)
  - Bottom bar: For bottom navigation bars (e.g., `BottomAppBar`)
  - Floating action buttons: A prominent button for primary actions
  - Snackbar: For displaying short messages at the bottom of the screen
  - Content: The main content of the screen (e.g., a `Column`, `LazyColumn`, or other composables)
  - Drawer: For navigation drawers (e.g., `ModalDrawer`)

10. Material components - Scaffold


```
@Composable
fun MyScreen() {

    // ...

    ModalNavigationDrawer(
        drawerState = drawerState,
        drawerContent = {
            MyDrawerContent(items, scope, drawerState)
        },
    ) {
        Scaffold(
            topBar = {
                MyTopAppBar(scope, drawerState)
            },
            floatingActionButton = {
                MyFloatingActionButtons()
            },
            content = { innerPadding ->
                MyContent(Modifier.padding(innerPadding))
            },
            bottomBar = {
                MyNavigationBar(items)
            }
        )
    }
}
```



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11. State management

- Jetpack Compose is a declarative UI framework. This means:
  - The UI is a function of state
  - When state changes, the UI is re-drawn automatically
- **State** represents data that can change over time and affects the UI. For example:
  - A counter value
  - Text entered by the user
  - Whether a dialog is visible
  - Loading or error status

11. State management

- To manage state correctly, we must distinguish between:

1. Recomposition (changes in Jetpack Compose)
   - Recomposition occurs when a state value changes
   - Only the affected composables are re-executed
   - The Activity is not recreated
2. Configuration changes (changes in the Android system)
   - A configuration change occurs (e.g., screen rotation, language change, dark mode)
   - The Activity is recreated
   - The entire composition restarts

11. State management

- Jetpack Compose provides use the following mechanisms for state management

1. Recomposition:
   - `remember`: Retains a state instance across recompositions
   - `mutableStateOf`: Creates observable state. When the value changes, it triggers recomposition.
2. Configuration changes:
   - `rememberSaveable`: Retains state across configuration changes (e.g., screen rotation). It also uses `mutableStateOf` to creates observable states
   - `ViewModel`: For managing complex state that survives configuration changes

https://developer.android.com/develop/ui/compose/state

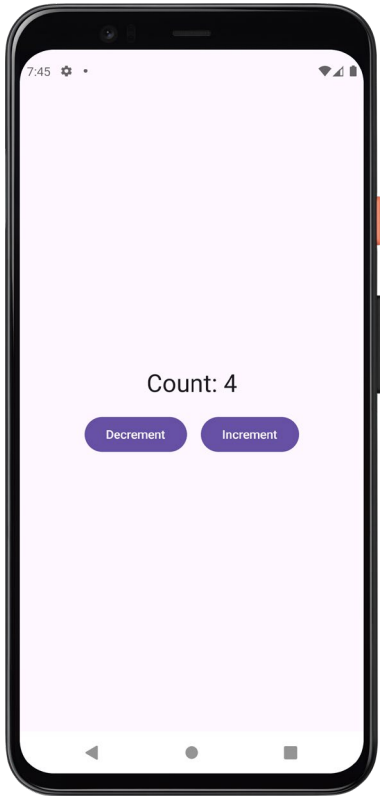
11. State management - Stateful composables

- A composable that uses `remember` to store an object creates internal state, making the composable **stateful**
  - Example: A counter app where the UI updates whenever the count changes

In this example, we use the specialized function for creating a mutable state for integers (*mutableIntStateOf*) to create a **state variable** called count

```
@Composable
fun Counter() {
    // State is managed internally within the composable
    var count by remember { mutableIntStateOf(0) }

    Column(
        modifier = Modifier.fillMaxSize(),
        verticalArrangement = Arrangement.Center,
        horizontalAlignment = Alignment.CenterHorizontally
    ) {
        Text(
            text = "Count: $count",
            style = MaterialTheme.typography.headlineMedium
        )
        Spacer(modifier = Modifier.height(16.dp))
        Row(
            horizontalArrangement = Arrangement.spacedBy(16.dp)
        ) {
            Button(onClick = { count++ }) {
                Text(stringResource(R.string.increment))
            }
            Button(onClick = { count-- }) {
                Text(stringResource(R.string.decrement))
            }
        }
    }
}
```



11. State management - Stateless composables

- A **stateless** composable is a composable that doesn't hold any state
  - An easy way to achieve stateless is by using state hoisting
- **State hoisting** is a pattern where the state is moved to a higher-level composable, making the composable reusable
  - The state owner exposes to consumers the state and events to modify it
- The benefits of state hoisting are:
  - Improves reusability and testability
  - Centralizes state management

https://developer.android.com/develop/ui/compose/state#stateful-vs-stateless
https://developer.android.com/develop/ui/compose/state-hoisting

11. State management - Stateless composables

- The following example shows the stateless version of the previous counter:

```
@Composable
fun CounterApp() {
    // State is hoisted to the parent composable
    var count by remember { mutableIntStateOf(0) }

    // Stateless Counter composable
    Counter(
        count = count,
        onIncrement = { count++ },
        onDecrement = { count-- },
    )
}
```

The parent composable exposes the state (`count`) and events to modify it (`onIncrement` and `onDecrement`)

```
@Composable
fun Counter(
    count: Int, // State passed as a parameter
    onIncrement: () -> Unit, // Event callback for increment
    onDecrement: () -> Unit // Event callback for decrement
) {
    Column(
        modifier = Modifier.fillMaxSize(),
        verticalArrangement = Arrangement.Center,
        horizontalAlignment = Alignment.CenterHorizontally
    ) {
        Text(
            text = "Count: $count",
            style = MaterialTheme.typography.headlineMedium
        )
        Spacer(modifier = Modifier.height(16.dp))
        Row(
            horizontalArrangement = Arrangement.spacedBy(16.dp)
        ) {
            Button(onClick = onDecrement) {
                Text(stringResource(R.string.decrement))
            }
            Button(onClick = onIncrement) {
                Text(stringResource(R.string.increment))
            }
        }
    }
}
```

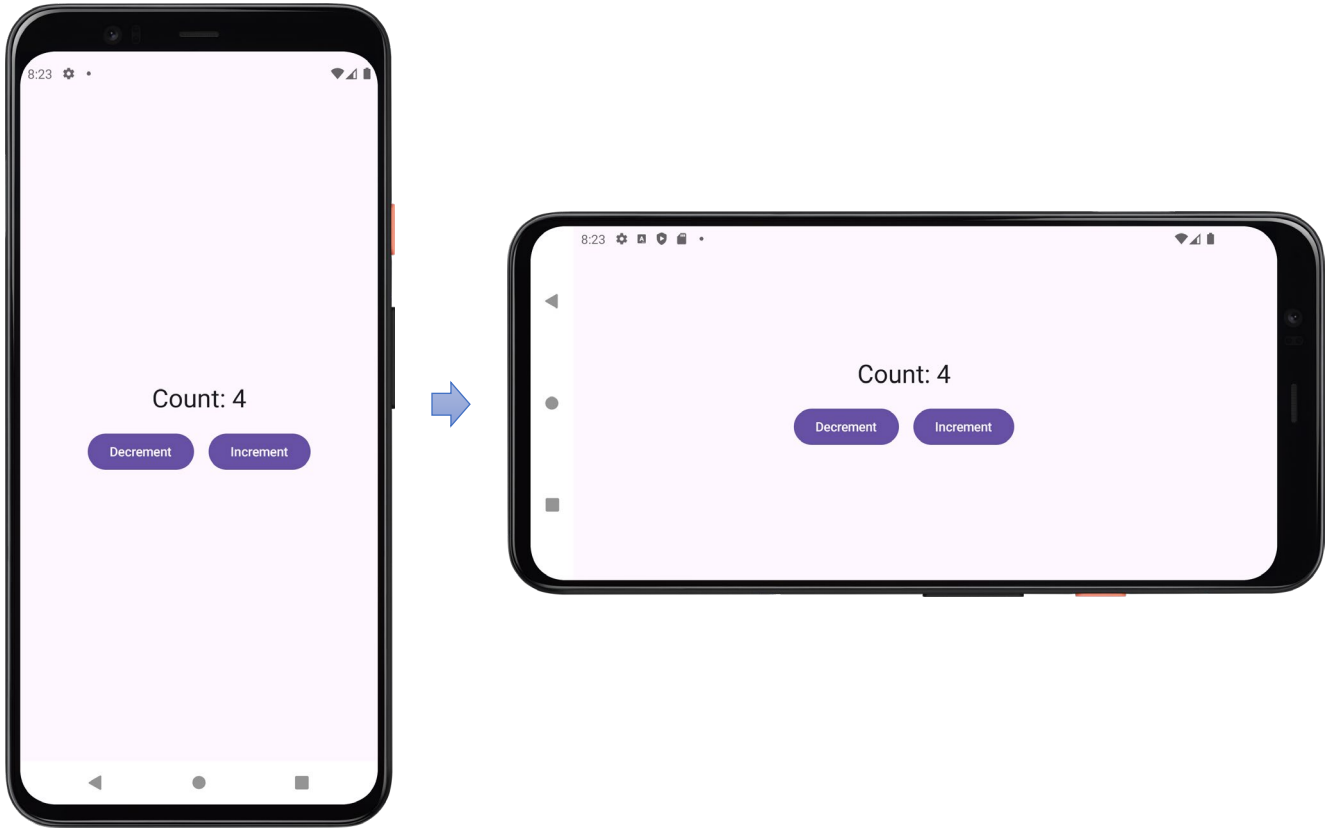
`() -> Unit` → This represents a function that takes no arguments and returns nothing

11. State management - Surviving configuration changes

- To restore state across configuration changes (e.g., screen rotation), we use `rememberSaveable` instead of `remember`
  - It can be use both in stateful and stateless composables

```
@Composable
fun CounterApp() {
    // State is hoisted to the parent composable
    var count by rememberSaveable { mutableIntStateOf(0) }

    // Stateless Counter composable
    Counter(
        count = count,
        onIncrement = { count++ },
        onDecrement = { count-- }
    )
}
```



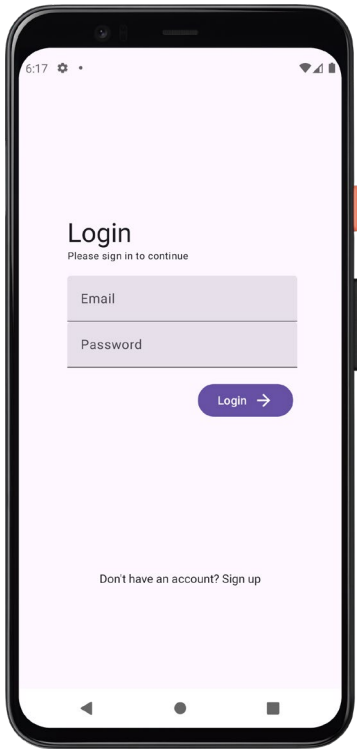
11. State management - Surviving configuration changes

- We typically use these type of state variables when form fields:

```
var login by rememberSaveable { mutableStateOf("") }
var password by rememberSaveable { mutableStateOf("") }

TextField(
    value = login,
    onValueChange = { login = it },
    modifier = Modifier
        .constrainAs(loginField) {
            top.linkTo(text2.bottom, margin = 16.dp)
            start.linkTo(startGuideline)
        },
    placeholder = {
        Text(stringResource(R.string.email_edit_text))
    },
    keyboardOptions = KeyboardOptions(keyboardType = KeyboardType.Email)
)
TextField(
    value = password,
    onValueChange = { password = it },
    modifier = Modifier
        .constrainAs(passwordField) {
            top.linkTo(loginField.bottom)
            start.linkTo(startGuideline)
        },
    placeholder = {
        Text(stringResource(R.string.password_edit_text))
    },
    visualTransformation = PasswordVisualTransformation(),
    keyboardOptions = KeyboardOptions(keyboardType = KeyboardType.Password)
)
```

- `value = login`: Binds the text field's value to the login state variable
- `onValueChange = { login = it }`: Updates the login state whenever the user types in the field (**`it`** is the *implicit name* of a single parameter in lambda expressions)
- `placeholder`: Displays a hint when the field is empty
- `keyboardOptions`: Sets the keyboard type to `Email` (for easier email input) and `Password` for secure input
- `visualTransformation`: Masks the input with `PasswordVisualTransformation()` (to show dots instead of text)



https://developer.android.com/develop/ui/compose/text/user-input

11. State management - `remember` vs `rememberSaveable`

- `remember` is used when the state survive recomposition, e.g.:
  - Dropdown expanded state
  - Animation progress
  - Snackbar visibility
- `rememberSaveable` is used when the state should survive configuration changes, e.g.:
  - Text field input
  - Selected tab index
  - Form values
- If the user rotates the device, should this value still exist?
  - Yes → `rememberSaveable`
  - No → `remember`

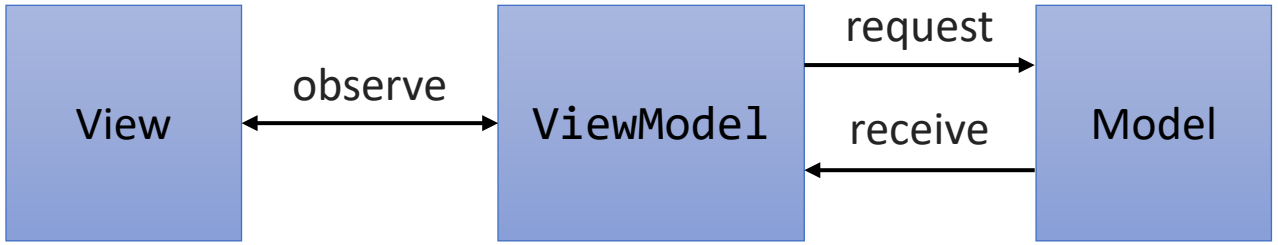
11. State management - View model

- In most modern Android apps, business logic (domain-specific code) and state (application data) are usually handled by *ViewModels*
- A `ViewModel` is a Kotlin class that holds UI state and logic, keeping it separate from the UI and independent of its lifecycle
- The key features of `ViewModel` objects are:
  - They hold state (e.g., using *`mutableIntStateOf`* or other) that survives configuration changes
  - They expose this state and receives events from composables (i.e., composables observe this state and update the UI when the state changes)
  - They are independent of the UI (i.e., they must not reference composables, context, or UI elements)

https://developer.android.com/topic/libraries/architecture/viewmodel

11. State management - View model

- Android apps commonly follow the MVVM architecture:
  - `Model`: This layer represents the data. It interacts with data sources like databases or REST services (network APIs)
  - `View`: This layer handles the user interface (UI) elements and their layout (i.e., the composable functions)
  - `ViewModel`: This layer acts as the intermediary between the `Model` and the `View`. It prepares the data for the View in a consumable way, handles business logic, and exposes observable data streams to the `View`



11. State management - View model

- To use view model, we need the following dependency:

build.gradle.kts

```
dependencies {
    implementation(libs.androidx.lifecycle.viewmodel.compose)
}
```

libs.version.toml

```
[versions]
lifecycleRuntimeKtx = "2.10.0"

[libraries]
androidx-lifecycle-viewmodel-compose = { group = "androidx.lifecycle",
  name = "lifecycle-viewmodel-compose", version.ref = "lifecycleRuntimeKtx" }
```

11. State management - View model

MainActivity.kt

```kotlin
@Composable
fun CounterApp(viewModel: CounterViewModel = viewModel()) {
    // Observe the state from the ViewModel
    val count by viewModel.count.asIntState()

    // Stateless Counter composable
    Counter(
        count = count,
        onIncrement = { viewModel.increment() },
        onDecrement = { viewModel.decrement() }
    )
}
```

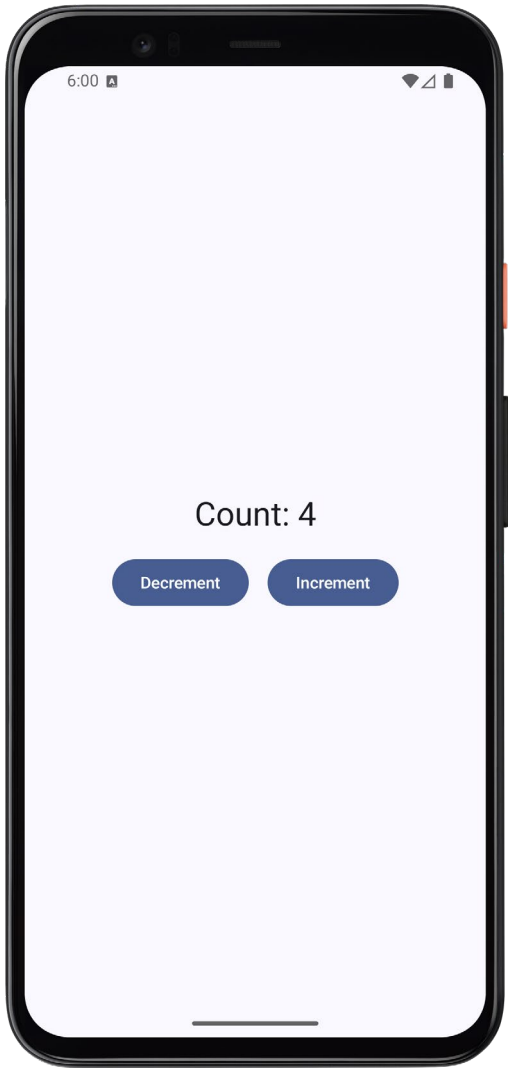
CounterViewModel.kt

```kotlin
class CounterViewModel : ViewModel() {
    private val _count = mutableIntStateOf(0) // Mutable state
    val count: State<Int> get() = _count

    fun increment() {
        _count.intValue++
    }

    fun decrement() {
        _count.intValue--
    }
}
```

The type `State<T>` read-only observable state type used by Compose



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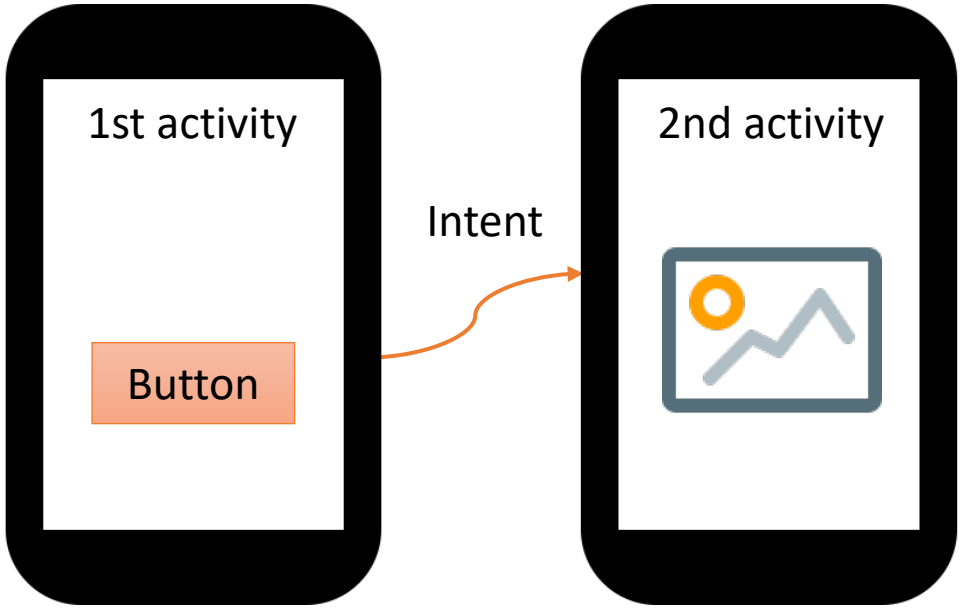
12. Navigation

- Navigation refers to the interactions that let users navigate across, into, and back out from the different pieces of the UI
- The traditional Android view system (XML-based UI) was based on navigation between different activities using **intents**
  - An Intent is a messaging object you can use to request an action from another app component (e.g., from an activity to other)
- Jetpack Compose uses the **Navigation Component**, which is part of Android Jetpack
  - The Navigation Component is a library designed to work seamlessly with Compose's declarative UI model
  - With this component we implement single-activity apps with different screens implemented as composable functions

12. Navigation - Intents



Let's see an example of an app composed by two activities which uses an (explicit) intent to start the second activity

AndroidManifest.xml

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

    <application
        android:icon="@mipmap/ic_launcher"
        android:label="@string/app_name"
        android:roundIcon="@mipmap/ic_launcher_round"
        android:theme="@style/Theme.MyApp">
        <activity
            android:name=".MainActivity"
            android:exported="true">
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />
                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
        <activity
            android:name=".SecondActivity"
            android:exported="false" />
    </application>

</manifest>
```

https://developer.android.com/reference/android/content/Intent

12. Navigation - Intents

MainActivity.kt

```
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        enableEdgeToEdge()
        setContent {
            MyAppTheme {
                Scaffold(modifier = Modifier.fillMaxSize()) { innerPadding ->
                    MyLayout(modifier = Modifier.padding(innerPadding))
                }
            }
        }
    }
}

@Composable
fun MyLayout(modifier: Modifier = Modifier) {
    var text by rememberSaveable { mutableStateOf("") }
    val context = LocalContext.current

    Column(modifier = modifier) {
        Text(text = stringResource(R.string.text_msg))
        TextField(
            value = text,
            onValueChange = { text = it },
            modifier = Modifier.fillMaxWidth()
        )
        Button(
            onClick = {
                val intent = Intent(context, SecondActivity::class.java).apply {
                    putExtra("name", text)
                }
                context.startActivity(intent)
            },
        ) {
            Text(stringResource(R.string.button_msg))
        }
    }
}
```

12. Navigation - Intents

SecondActivity.kt

```
class SecondActivity : ComponentActivity() {

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        enableEdgeToEdge()
        setContent {
            MyAppTheme {
                Scaffold(modifier = Modifier.fillMaxSize()) { innerPadding ->
                    val name = intent.getStringExtra("name")
                    val hello = String.format(stringResource(R.string.hello_msg), name)
                    MyLayout(modifier = Modifier.padding(innerPadding), hello)
                }
            }
        }
    }

}

@Composable
fun MyLayout(modifier: Modifier = Modifier, text: String) {
    Text(text = text, modifier = modifier)
}
```

Although this type of navigation is possible, in Jetpack Compose it is preferred single-activities apps using the Navigation library

12. Navigation - Navigation Component

- The Navigation component is a library that enables declarative navigation between screens in a Jetpack Compose apps
- The key concepts of the Navigation Component are the following:
  - `NavController`: Object that manages navigation between composables. It keeps track of the back stack and the current destination
  - `NavHost`: Composable that acts as container to hosts the navigation graph and displays the current destination
  - Navigation graph: A collection of *`composable`* destinations that maps out all the screens in your app and the paths (*routes*) that users can take to navigate between them

https://developer.android.com/develop/ui/compose/navigation

12. Navigation - Navigation Component

- To use Navigation Component, first we need to setup the following dependency in our Android project:

build.gradle.kts

```
dependencies {
    implementation(libs.androidx.navigation.compose)
}
```

libs.version.toml

```
[versions]
navigationCompose = "2.9.7"

[libraries]
androidx-navigation-compose = { module = "androidx.navigation:navigation-compose", version.ref = "navigationCompose" }
```

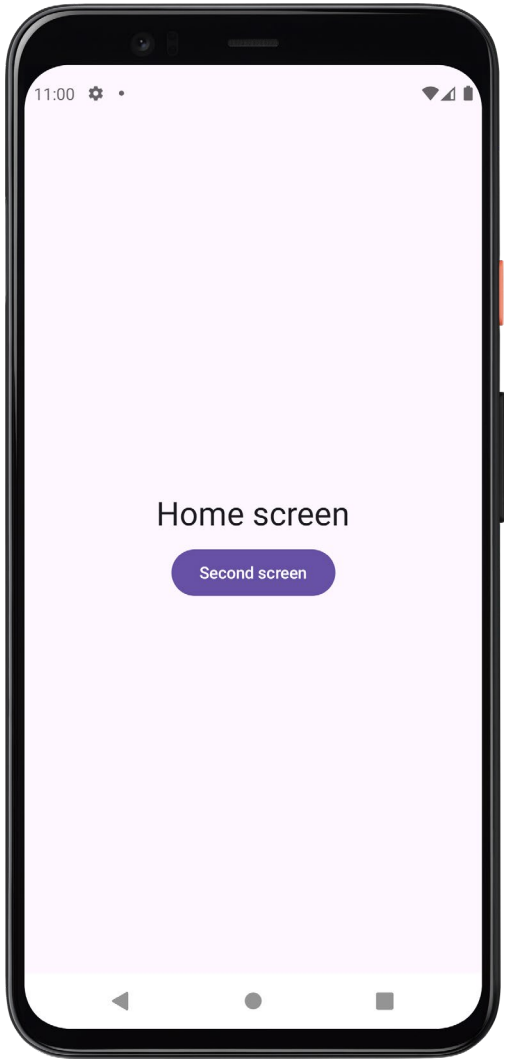
12. Navigation - Navigation Component


```
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        enableEdgeToEdge()
        setContent {
            MyAppTheme {
                Surface(
                    modifier = Modifier.fillMaxSize(),
                    color = MaterialTheme.colorScheme.background
                ) {
                    val navController = rememberNavController()
                    NavHost(
                        navController = navController,
                        startDestination = "home"
                    ) {
                        composable("home") {
                            HomeScreen(navController)
                        }
                        composable("second") {
                            SecondScreen(navController)
                        }
                    }
                }
            }
        }
    }
}
```

- `rememberNavController()` creates a `NavController` object to manage navigation between composables
- `NavHost` is a container for the navigation graph. It hosts the composable destinations (`HomeScreen` and `SecondScreen` in this example)

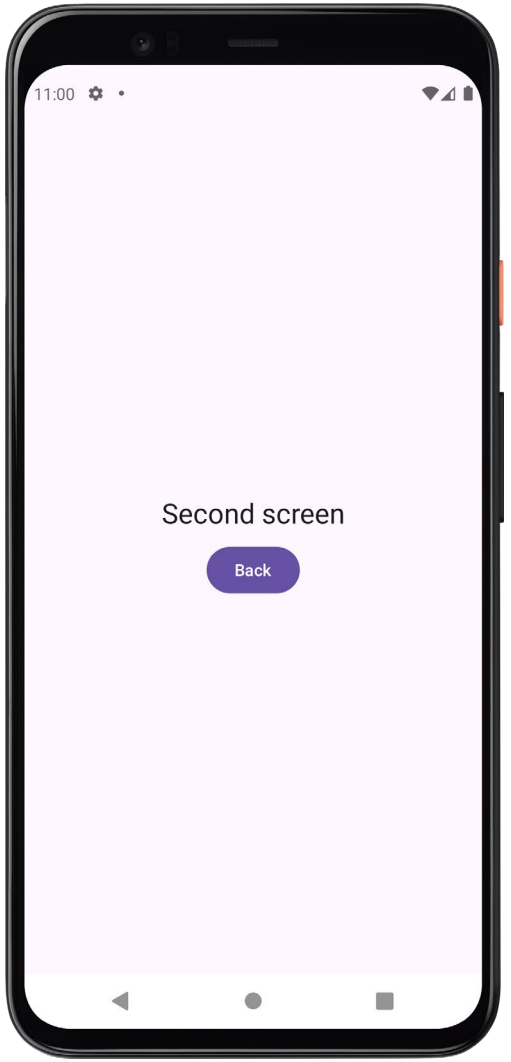
12. Navigation - Navigation Component


```
@Composable
fun HomeScreen(navController: NavController) {
    Column(
        Modifier.fillMaxSize(),
        horizontalAlignment = Alignment.CenterHorizontally,
        verticalArrangement = Arrangement.Center
    ) {
        Text(
            text = stringResource(R.string.home_msg),
            style = MaterialTheme.typography.headlineMedium
        )
        Spacer(Modifier.height(8.dp))
        Button(
            onClick = { navController.navigate("second") },
        ) {
            Text(stringResource(R.string.button_msg))
        }
    }
}
```



12. Navigation - Navigation Component


```
@Composable
fun SecondScreen(navController: NavController) {
    Column(
        Modifier.fillMaxSize(),
        horizontalAlignment = Alignment.CenterHorizontally,
        verticalArrangement = Arrangement.Center
    ) {
        Text(
            text = stringResource(R.string.second_msg),
            style = MaterialTheme.typography.headlineSmall
        )
        Spacer(Modifier.height(8.dp))
        Button(
            onClick = { navController.popBackStack() },
        ) {
            Text(stringResource(R.string.back_msg))
        }
    }
}
```



12. Navigation - Navigation Component

- We can pass arguments between screens using the navigation library. For example:

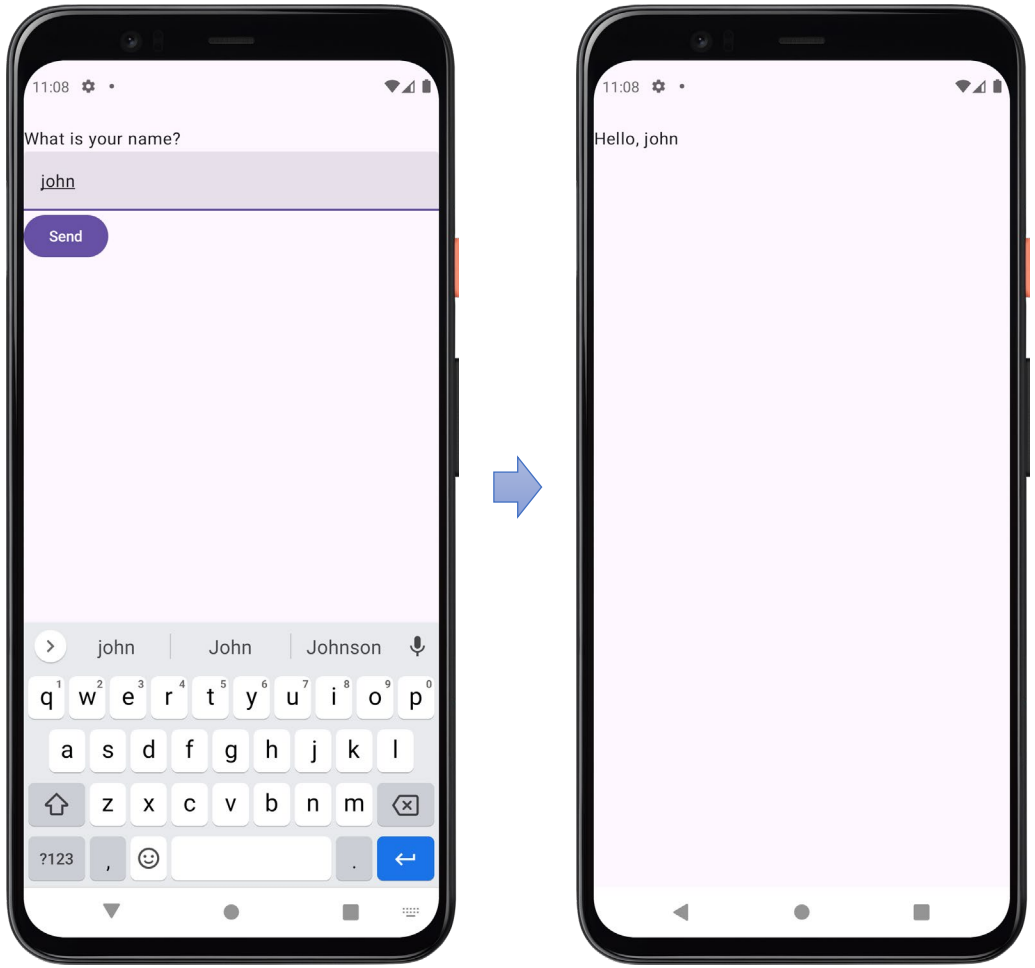
```
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        enableEdgeToEdge()
        setContent {
            MyAppTheme {
                Scaffold(modifier = Modifier.fillMaxSize()) { innerPadding ->
                    val navController = rememberNavController()
                    val modifier = Modifier.padding(innerPadding)
                    NavHost(
                        navController = navController,
                        startDestination = "first"
                    ) {
                        composable("first") {
                            FirstScreen(navController, modifier)
                        }
                        composable(
                            "second/{name}",
                            arguments = listOf(navArgument("name") { type = NavType.StringType })
                        ) { backStackEntry ->
                            val name = backStackEntry.arguments?.getString("name")
                            name?.let { SecondScreen(modifier, it) }
                        }
                    }
                }
            }
        }
    }
}
```

- The second composable defines a route with a dynamic argument (`"second/{name}"`)
- The arguments list ensures that `name` is treated as a String type (`NavType.StringType`)
- `backStackEntry` (object that gives access to the navigation arguments) is used to retrieve the name argument from the navigation back stack. The operator ? is used to safely access `arguments` (if `arguments` is null, name will be also null)
- If name is not null, it is passes to `SecondScreen`

12. Navigation - Navigation Component

- We can pass arguments between screens using the navigation library. For example:

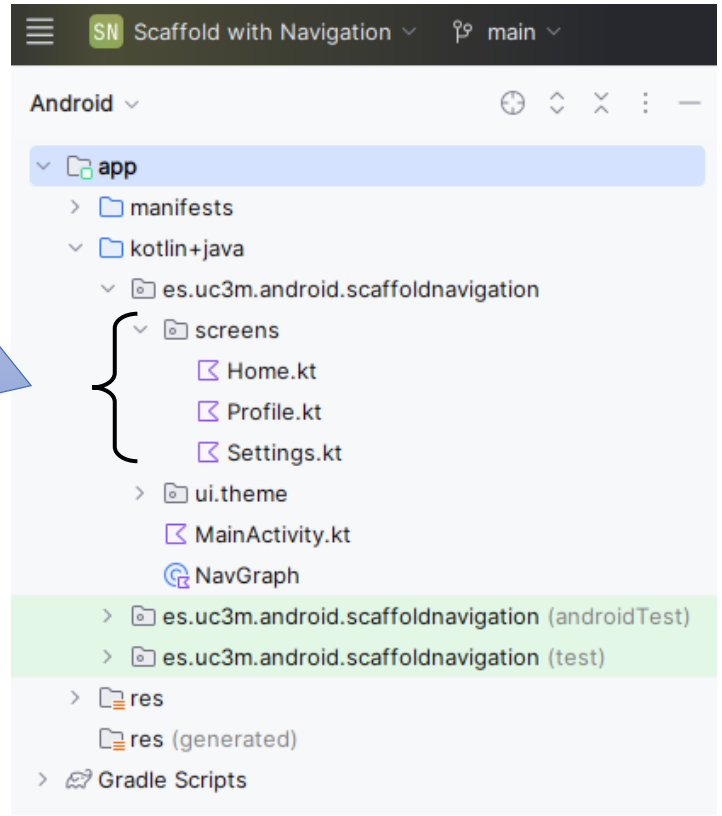
```
@Composable
fun FirstScreen(navController: NavController, modifier: Modifier = Modifier) {
    var text by rememberSaveable { mutableStateOf("") }

    Column(modifier = modifier) {
        Text(text = stringResource(R.string.text_msg))
        TextField(
            value = text,
            onValueChange = { text = it },
            modifier = Modifier.fillMaxWidth()
        )
        Button(
            onClick = { navController.navigate("second/$text") },
        ) {
            Text(stringResource(R.string.button_msg))
        }
    }
}

@Composable
fun SecondScreen(modifier: Modifier = Modifier, name: String = "") {
    val hello = String.format(stringResource(R.string.hello_msg), name)
    Text(text = hello, modifier = modifier)
}
```



12. Navigation - Navigation Component

- The following example combines an Scaffold structure with the use of the navigation component:

This folder contains the composables for the different screens



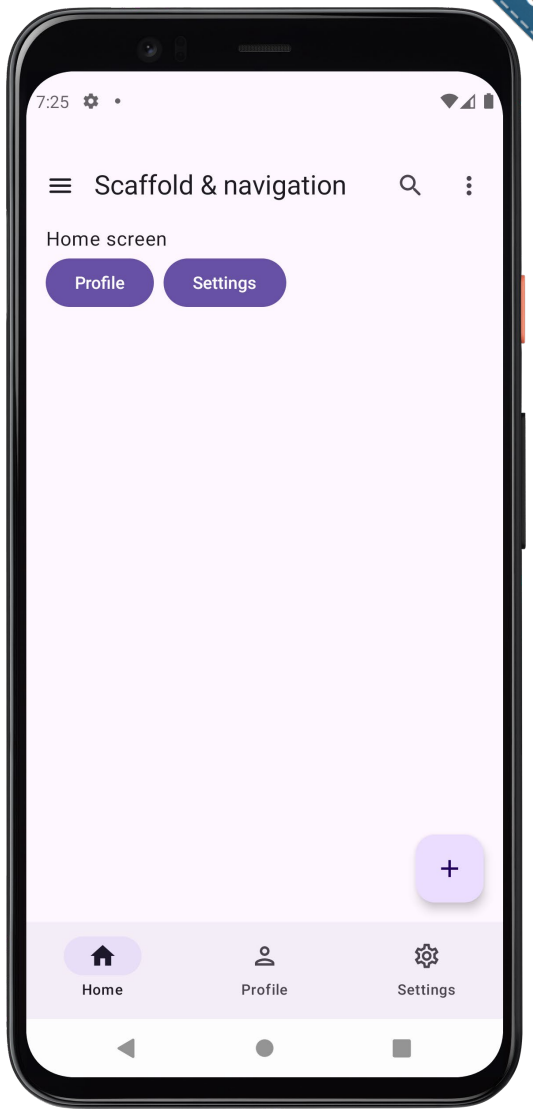
The NavGraph class defines the navigation graph using a *sealed* class (i.e., special type of class in Kotlin that restricts inheritance, used for representing a closed set of types, such as navigation routes in this case). This mechanism is a good practice to avoid hardcoding routes (string values)

```
const val HOME_ROUTE = "home"
const val PROFILE_ROUTE = "profile"
const val SETTING_ROUTE = "settings"

sealed class NavGraph(val route: String) {
    data object Home : NavGraph(HOME_ROUTE)
    data object Profile : NavGraph(PROFILE_ROUTE)
    data object Settings : NavGraph("$SETTING_ROUTE/{source}") {
        // Helper function to create the route with arguments
        fun createRoute(source: String) = "$SETTING_ROUTE/$source"
    }
}
```

12. Navigation - Navigation Component

The content composable defines the NavHost. The navigation controllers is used in all parts that requires to change navigation (e.g., navigation drawer, bottom bar, screen composables)

```
@Composable
fun MyContent(modifier: Modifier = Modifier, navController: NavHostController) {
    NavHost(
        modifier = modifier,
        navController = navController,
        startDestination = NavGraph.Home.route,
    ) {
        composable(NavGraph.Home.route) {
            HomeScreen(navController = navController)
        }
        composable(NavGraph.Profile.route) {
            ProfileScreen(navController = navController)
        }
        composable(
            NavGraph.Settings.route,
            arguments = listOf(navArgument("source") { type = NavType.StringType })
        ) { backStackEntry ->
            val source = backStackEntry.arguments?.getString("source")
            SettingsScreen(navController = navController, source)
        }
    }
}
```



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13. Lists and grids

- In Jetpack Compose, **lists** and **grids** are essential components for displaying collections of items in a structured way
- Jetpack Composes provides different composables handle collections efficiently:
  - `LazyColumn`: For vertical lists
  - `LazyRow`: For horizontal lists
  - `LazyVerticalGrid`: For vertically grids
  - `LazyHorizontalGrid`: For horizontally grids

https://developer.android.com/develop/ui/compose/lists

13. Lists and grids - Lists

- **Lists** are used to display a vertically or horizontally scrollable collection of items
- Jetpack Compose provides two main composables for creating scrollable lists:
  - `LazyColumn`: For vertical lists
  - `LazyRow`: For horizontal lists
- These composables are **lazy**, meaning they only compose and render the items that are currently visible on the screen (*viewport*)
  - This makes them highly efficient for large datasets

https://developer.android.com/develop/ui/compose/lists

13. Lists and grids - Lists

This example defines a composable function that displays a scrollable vertical list of items

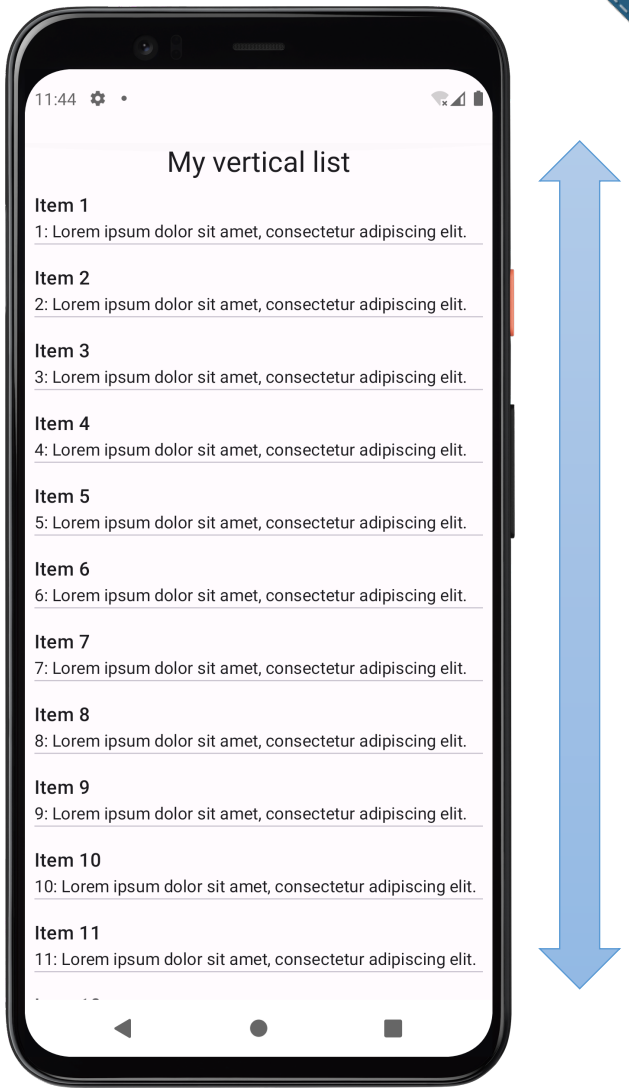
The `rememberLazyListState()` function ensures that the scroll position is not reset when the UI is recomposed

This part adds the `content` of `LazyColumn`, composed by a single item (`Text`) plus a list of items (iterating to create `myList` a `Column` composable for each item)

```
data class Item(val title: String, val description: String)

@Composable
fun MyLazyColumn(modifier: Modifier = Modifier) {
    val title = stringResource(R.string.item_title)
    val description = stringResource(R.string.item_description)
    val myList = (0..20).map {
        Item(
            title = String.format(title, it + 1),
            description = String.format(description, it + 1),
        )
    }

    LazyColumn(
        state = rememberLazyListState(),
        horizontalAlignment = Alignment.CenterHorizontally,
        modifier = modifier,
        content = {
            item {
                Text(
                    text = stringResource(R.string.my_list),
                    style = MaterialTheme.typography.headlineSmall
                )
            }
            items(myList) {
                Column(
                    modifier = Modifier.padding(8.dp)
                ) {
                    Text(
                        text = it.title,
                        style = MaterialTheme.typography.titleMedium
                    )
                    Text(
                        text = it.description,
                        style = MaterialTheme.typography.bodyMedium
                    )
                    HorizontalDivider()
                }
            }
        }
    )
}
```



13. Lists and grids - Lists

This example defines a scrollable horizontal list composed by 10 Text items

```
@Composable
fun MyLazyRow(modifier: Modifier = Modifier) {
    Column(modifier = modifier) {
        Text(
            modifier = Modifier.padding(16.dp),
            text = stringResource(R.string.my_list),
            style = MaterialTheme.typography.headlineSmall,
            textAlign = TextAlign.Start
        )
        LazyRow(
            state = rememberLazyListState(),
            contentPadding = PaddingValues(8.dp),
            verticalAlignment = Alignment.CenterVertically
        ) {
            items(10) { index ->
                Text(
                    text = stringResource(R.string.item_text, index),
                    modifier = Modifier.padding(8.dp),
                    style = MaterialTheme.typography.bodyLarge
                )
            }
        }
    }
}
```

13. Lists and grids - Grids

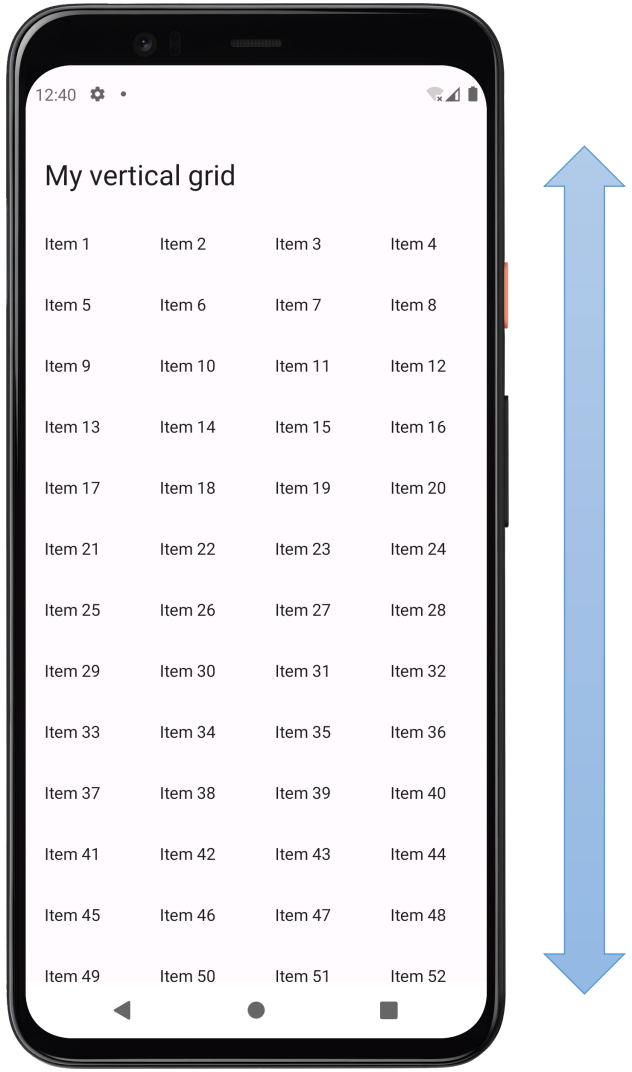
- **Grids** are used to display items in a grid layout (i.e., to organize content into rows and columns)
- Jetpack Compose provides two main composables for creating scrollable grids:
  - `LazyVerticalGrid`: For vertically grids
  - `LazyHorizontalGrid`: For horizontally grids
- Like `LazyColumn` and `LazyRow`, these composables are **lazy** and only render visible items

https://developer.android.com/develop/ui/compose/lists

13. Lists and grids - Grids

This example defines a composable function that displays a scrollable vertical grids of 100 items displayed in a grid of 4 columns

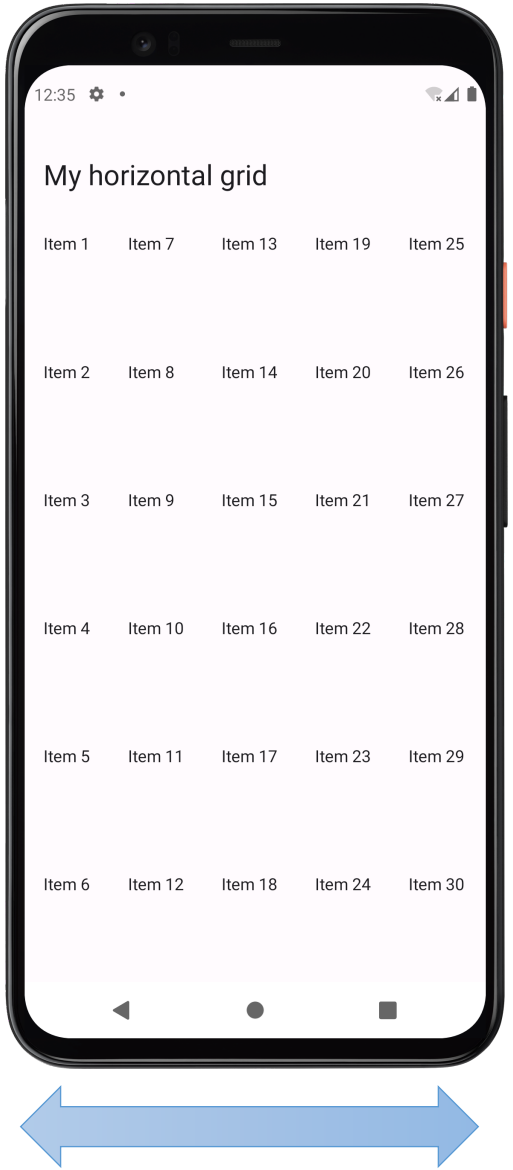
```
@Composable
fun MyVerticalGrid(modifier: Modifier = Modifier) {
    Column(modifier = modifier) {
        Text(
            modifier = Modifier.padding(16.dp),
            text = stringResource(R.string.my_grid),
            style = MaterialTheme.typography.headlineSmall,
            textAlign = TextAlign.Start
        )
        LazyVerticalGrid(
            columns = GridCells.Fixed(4), // 4 columns
            state = rememberLazyGridState()
        ) {
            items(100) { index ->
                Text(
                    text = stringResource(R.string.item_text, index + 1),
                    modifier = Modifier.padding(16.dp),
                    style = MaterialTheme.typography.bodyMedium
                )
            }
        }
    }
}
```



13. Lists and grids - Grids

This example defines a composable function that displays a scrollable horizontal grids of 42 items displayed in a grid of 6 rows

```
@Composable
fun MyHorizontalGrid(modifier: Modifier = Modifier) {
    Column(modifier = modifier) {
        Text(
            modifier = Modifier.padding(16.dp),
            text = stringResource(R.string.my_grid),
            style = MaterialTheme.typography.headlineSmall,
            textAlign = TextAlign.Start
        )
        LazyHorizontalGrid(
            rows = GridCells.Fixed(6), // 6 rows
            state = rememberLazyGridState()
        ) {
            items(42) { index ->
                Text(
                    text = stringResource(R.string.item_text, index + 1),
                    modifier = Modifier.padding(16.dp),
                    style = MaterialTheme.typography.bodyMedium
                )
            }
        }
    }
}
```



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14. Animations

- Jetpack Compose provides built-in support for common animations, such as:
  - Visibility: appearance and disappearance
  - Content size changes
  - Transition between composables
- Some of these functions are:
  - `AnimatedVisibility`: to hide or show content
  - `AnimatedContent`: to animate between different contents
  - `animate*()`: to animate an individual property
  - `animate*AsState()`: to carry out state-drive animations
  - `Transition`: to animate multiple values at once
  - `InfiniteTransition`: to animate properties continuously

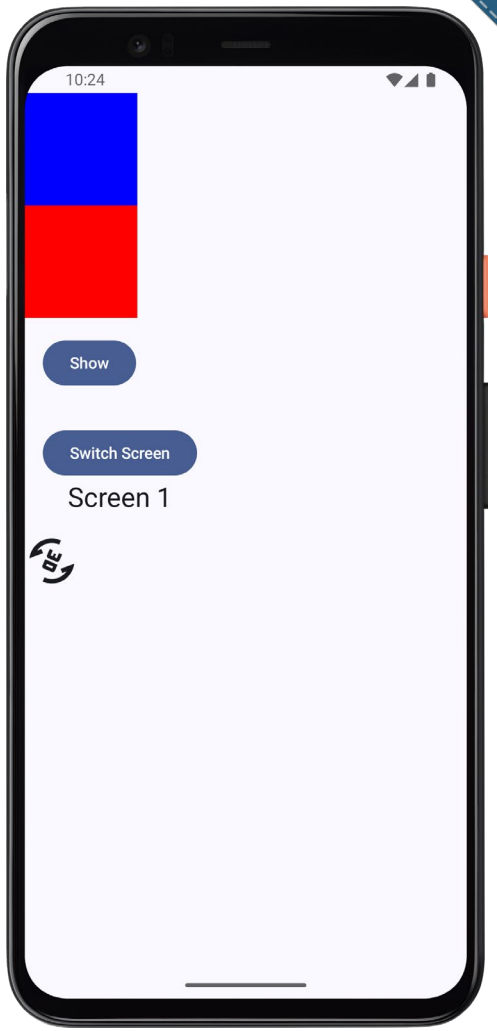
https://developer.android.com/develop/ui/compose/animation/introduction

14. Animations


```
@Composable
fun ChangeSize() {
    var expanded by remember { mutableStateOf(false) }
    val size by animateDpAsState(targetValue = if (expanded) 200.dp else 100.dp)

    Box(
        modifier = Modifier
            .size(size)
            .background(Color.Blue)
            .clickable { expanded = !expanded }
    )
}
```

Animations are triggered by state changes




```
@Composable
fun ChangeSizeAndColor() {
    var toggled by remember { mutableStateOf(false) }
    val transition = updateTransition(targetState = toggled)

    val color by transition.animateColor(label = "color") { state ->
        if (state) Color.Green else Color.Red
    }
    val size by transition.animateDp(label = "size") { state ->
        if (state) 150.dp else 100.dp
    }

    Box(
        modifier = Modifier
            .size(size)
            .background(color)
            .clickable { toggled = !toggled }
    )
}
```

```
@Composable
fun ToggleVisibility() {
    var visible by remember { mutableStateOf(false) }

    Column(
        horizontalAlignment = Alignment.CenterHorizontally,
        modifier = Modifier.padding(16.dp)
    ) {
        Button(onClick = { visible = !visible }) {
            Text(if (visible) "Hide" else "Show")
        }

        AnimatedVisibility(visible) {
            Box(
                modifier = Modifier
                    .size(100.dp)
                    .background(Color.Blue)
            )
        }
    }
}
```

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15. Takeaways

- Jetpack Compose is a modern UI toolkit for building native Android apps using Kotlin
  - It simplifies UI development by using a declarative approach, allowing us to define an app's UI as composable functions
  - This eliminates the need for XML layouts and reduces boilerplate code, making UI development faster and more intuitive
- Composables are the building block of Jetpack Compose
  - Composables are annotated with `@Composable` and describes how a portion of the UI should look based on the current state
  - Jetpack Compose offers an implementation of the Material components a collection of composable functions