Lab on apps development for tablets, smartphones and smartwatches

Week 2: State and interactivity

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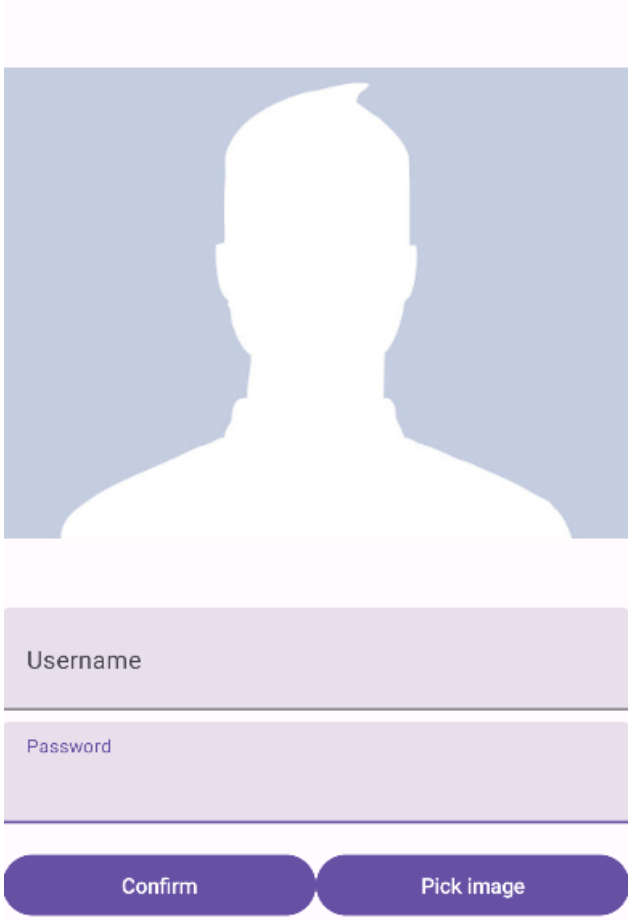
Class outline

- **Handling events**
  - Buttons and Composables click events
- Managing State in Jetpack Compose
  - State hoisting
- Communicating with other applications
  - Listening for results



Kotlin Activity classes

- Activity classes manage the UI and the interaction with user actions
- Activity classes extend ComponentActivity / WearableActivity
- OnCreate() callback
  - call to super
  - inflate layout
  - inflate theme
  - ***Interactivity?***

simple Activity class

```
class MainActivity : ComponentActivity() {
    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContent {
            MaterialTheme {
                MyApp(modifier = Modifier.fillMaxSize())
            }
        }
    }
}
```

Interactive apps

- User generate events by interacting with the GUI → with composables
  - e.g. clicks/longClicks on buttons
- The apps should appropriately respond to user actions
- We specify the app behavior wrt events in Composable functions by specifying function parameters
  - Kotlin lambdas/functions attached to events

Buttons

- Buttons have an onClick function parameter
  - defined inside the parentheses

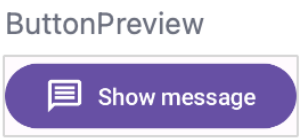
```
Button(onClick = { /*TODO*/ }) {

}
```

- The button appearance is defined inside of the curly brackets

```
Button(onClick = { /*TODO*/ }) {
    Image(
        imageVector = Icons.Outlined.Message,
        contentDescription = null,
        colorFilter = ColorFilter.tint(Color.White),
        modifier = Modifier
            .padding(end = 8.dp)

    )
    Text(text = stringResource(R.string.button_text))
}
```



Buttons

- Implementing onClick (example: toast message)

```
ConstraintLayout(modifier = modifier.fillMaxSize()) { this: ConstraintLayoutScope
    val (button) = createRefs()
    val context = LocalContext.current

    Button(
        onClick = {
            Toast.makeText(
                context,
                context.getString(R.string.toast_message_text),
                Toast.LENGTH_LONG
            ).show()
        },
        modifier = Modifier.constrainAs(button) { this: ConstrainScope
            top.linkTo(parent.top)
            bottom.linkTo(parent.bottom)
            start.linkTo(parent.start)
            end.linkTo(parent.end)
        }
    ) { this: RowScope
```

Making a composable Clickable

- Click event can be added to any composable through modifiers
  - Clickable
  - CombinedClickable
    - also longpress, doublepress, ...

```
Row(
    modifier
        .fillMaxWidth()
        .background(Color.Cyan)
        .clickable {
            Toast
                .makeText(
                    context,
                    context.getString(R.string.toast_message_text)
                    Toast.LENGTH_LONG
                )
                .show()
        }
```

Using a callback functions to handle events

- Callback → function called in response to an event
  - defined outside of the composable

```
@Composable
fun Message() {
   val context = LocalContext.current
   Row(modifier = Modifier.clickable {
      clickHandlerFunction(context)
   }) {
      …
   }
}
```

Callback

```
fun clickHandlerFunction(context: Context) {
   Toast.makeText(context,
         context.getText(R.string.toast_message_text),
         Toast.LENGTH_LONG)
      .show()
}
```

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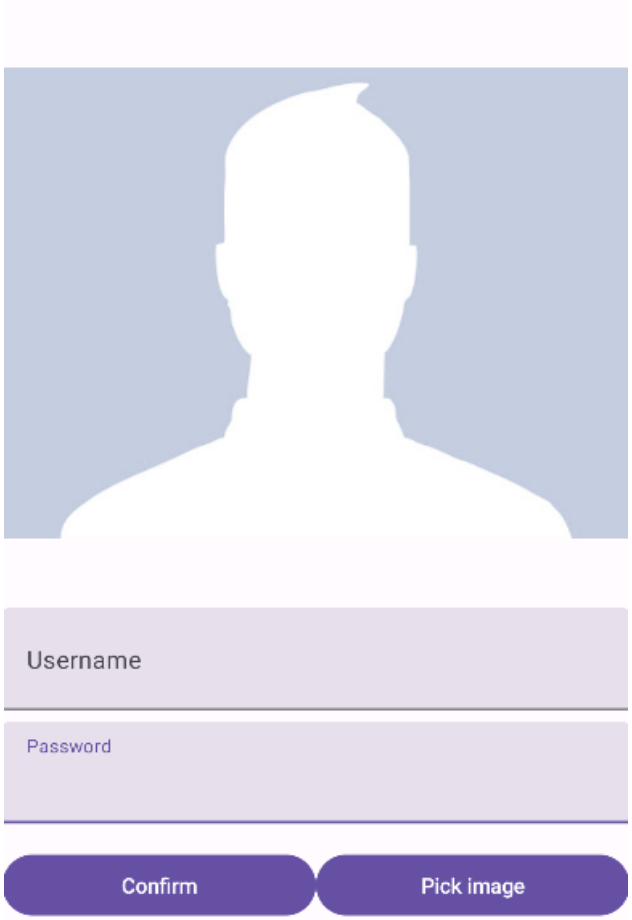
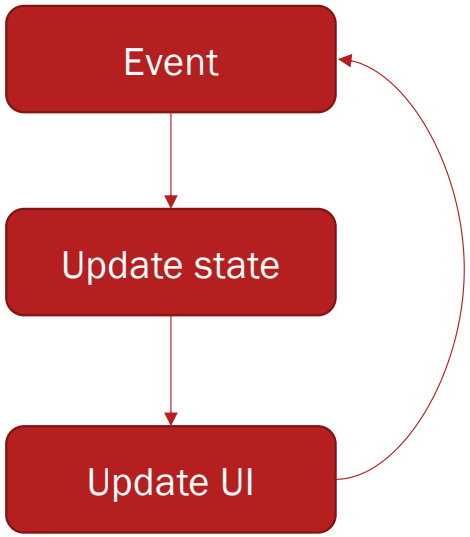


State

- State in an app is any value that can change over time
  - State determines what is shown in the UI at any particular time
  - State changes trigger recomposition
    → redrawing of UI

- Recomposition flow:



MutableState and remember

- MutableState types make state observable variables
  - can wrap any other type
  - changes in observable variables trigger recomposition
  - often, state must be remembered across recomposition

- Initializing a state object:

```
var count: MutableState<Int> = remember { mutableStateOf( value: 0) }
```

- Updating a state object:

```
Button(onClick = { count.value++ })
```

- Reading a state object:

```
Text(text = "Counter: ${count.value}")
```

Delegated properties

- Using by keyword when initializing the state
  - asks the remember API to initalize a mutableState variable

- Initializing a state object:

```
var count by remember { mutableStateOf( value: 0) }
```

- Updating a state object:

```
Button(onClick = { count++ }) {
```

- Reading a state object:

```
Text(text = "Counter: ${count}")
```

more about delegated properties:
kotlinlang.org/docs/delegated-properties.html

no need to write ".value" when using the variable

rememberSaveable

- Remember retains state across recomposition, not across configuration changes
  - Example: Screen rotation from portrait to landscape

- rememberSaveable retains state across recomposition, and across configuration changes
  - Large objects may affect performance
    - Viewmodels are a better alternative in those cases (next lectures)

```
var count by rememberSaveable { mutableStateOf( value: 0) }
```

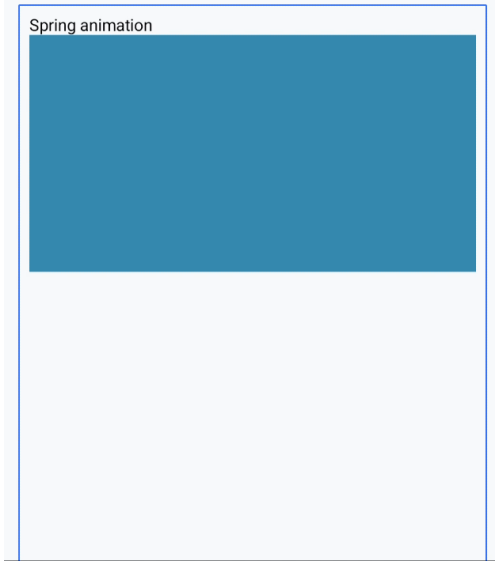
Animate composable

- Android offers many nice animations using state and Modifiers
  - change position/size/color appearance…

```
fun AnimateSizeChange_Specs() {
    var expanded by remember { mutableStateOf(false) }

    Column(
        modifier = Modifier
            .padding(8.dp)
            .fillMaxSize()
    ) {
        Text("Spring animation")
...
```

```
...
Box(
        modifier = Modifier
            .background(colorBlue)
            .animateContentSize(
                spring(
                    stiffness = Spring.StiffnessLow,
                    dampingRatio = Spring.DampingRatioHighBouncy
                )
            )
            .height(if (expanded) 300.dp else 200.dp)
            .fillMaxSize()
            .clickable{
                expanded = !expanded
            })}}
```

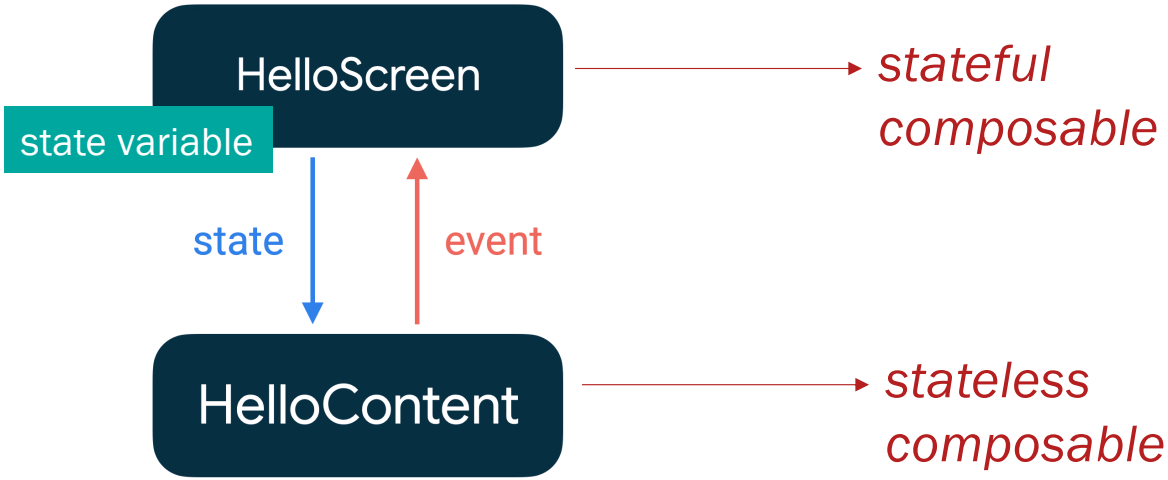


- Many animation examples available here:

https://github.com/android/snippets/blob/a9a6a55f7e35738873eee76178d06cf39871834c/compose/snippets/src/main/java/com/example/compose/snippets/animations/AnimationQuickGuide.kt

Values and events

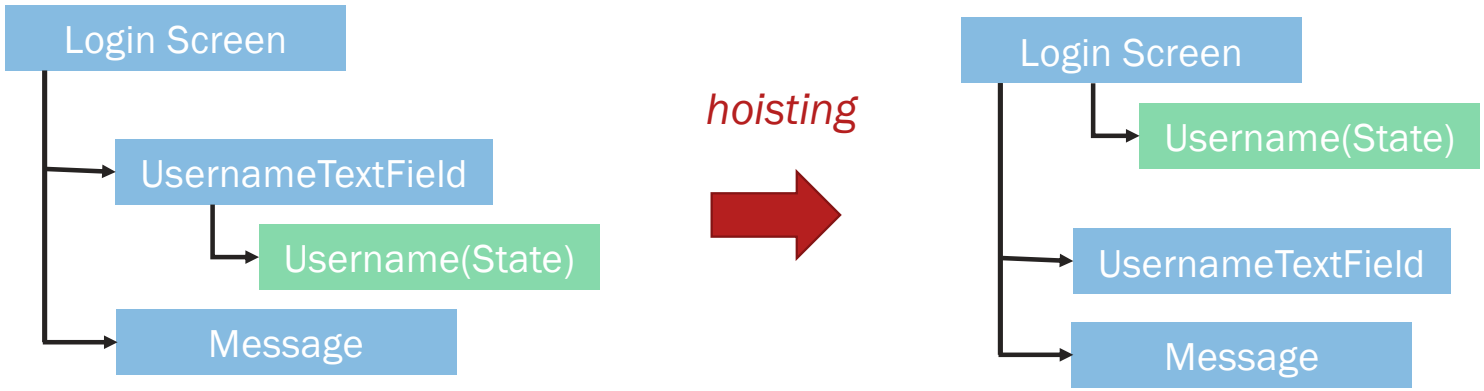
- In Composables hierarchies
  - State values are propagated downward
  - State events are propagated upward
    - events: everything that may change the value of a state variable



State hoisting

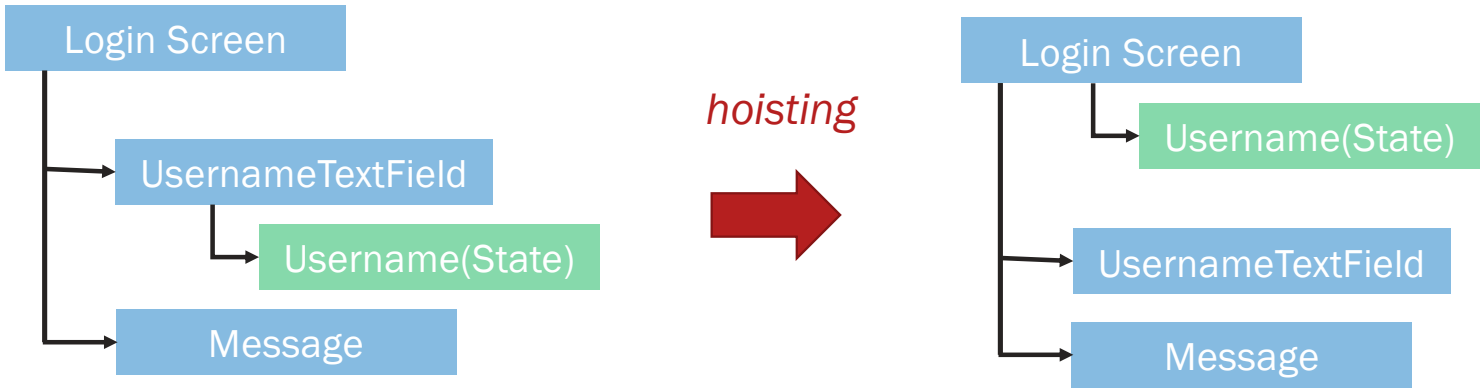
- A State variable should be held by the lowest common ancestor between all composable that write and/or read it

- State hoisting elevates the state variable declarations in a composable hierarchy



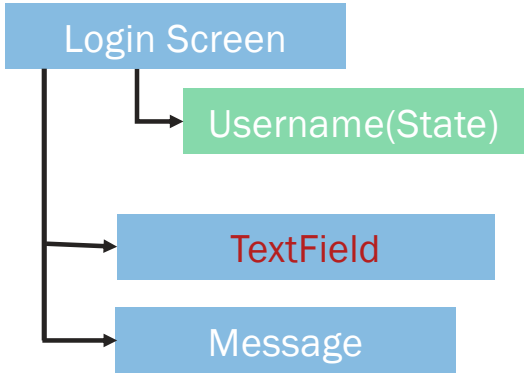
State hoisting

- Hoisting replaces the state variable with two parameters in the composable function:
  - Value → the current value to display
  - onEvent() → function to update the value when an event occurs



State hoisting

- Example1




```
@Composable
fun LoginScreen() {
  var username by rememberSaveable { mutableStateOf("") }

   Column {
      TextField(value = username,
                onValueChange = { newValue ->  username = newValue})

      Text(text = "Picked username: ${username}")
   }
}
```

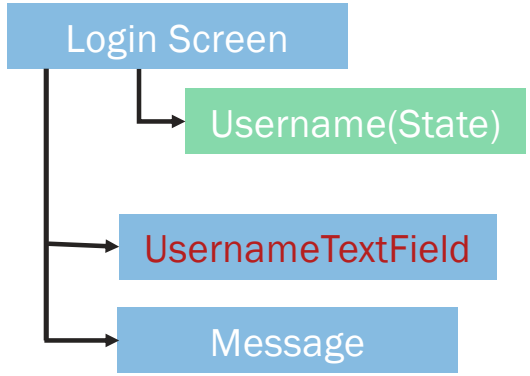
hosted state variable

value parameter

event parameter

State hoisting

- Example2



hosted state variable

```
@Composable
fun LoginScreen() {
  var username by rememberSaveable { mutableStateOf("") }

   Column {
      UsernameTextField(
         username = username,
         onUsernameChanged = { username = it }
      )
      Text(text = "Picked username: ${username}")
   }
}
```

```
@Composable
fun UsernameTextField(username: String,
                      onUsernameChanged: (String) -> Unit) {
  TextField(value = username,
            onValueChange = { newValue ->
                onUsernameChanged(newValue)})
}
```

or: { onUsernameChanged(**it**) }
or: onUsernameChanged

Class outline

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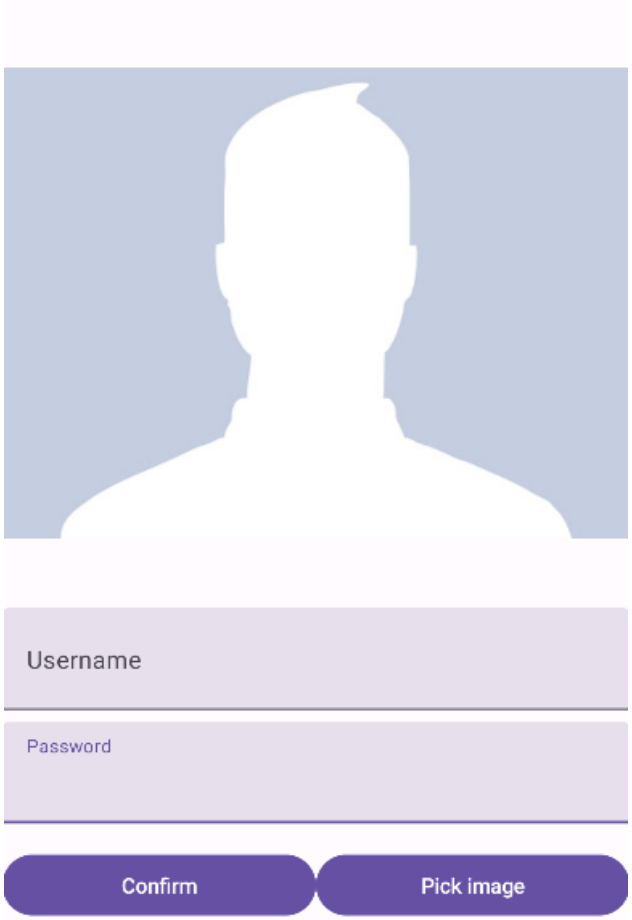
- **Communicating with other applications**
  - Listening for results

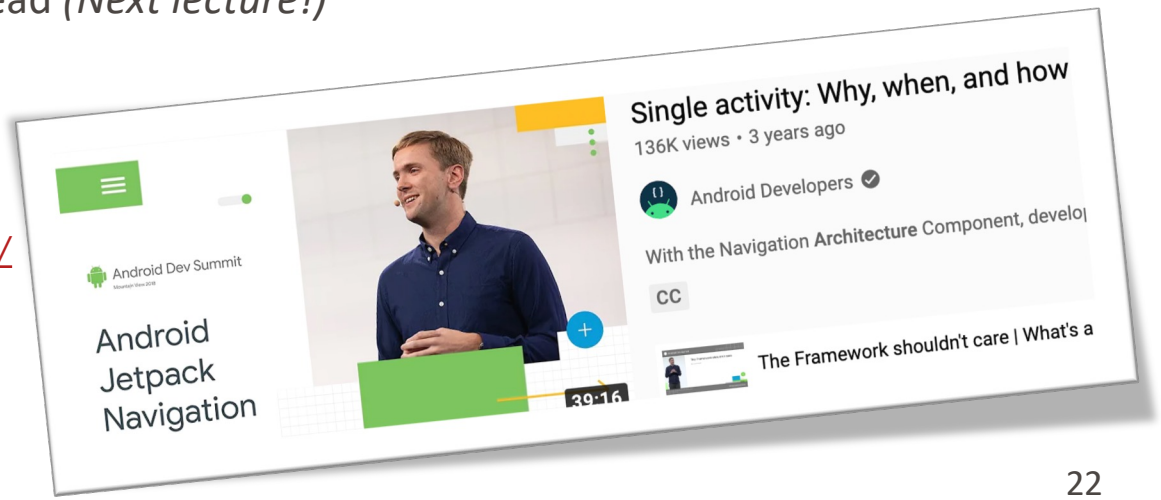


Interfacing with other applications

- You can use functionalities from other activities using Intents
- Intents: message objects among Android components

- Explicit Intent: message to a specific target
  - Usually employed for communicating among different activities in an App
  - Multi-activity app now discouraged
    → we will use Navigation instead *(Next lecture!)*

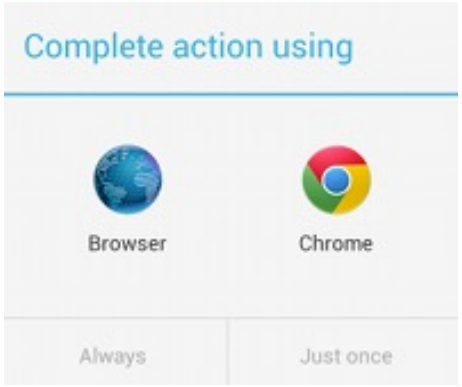
https://www.youtube.com/watch?v=2k8x8V77CrU



Interfacing with other applications

- You can use functionalities from other activities using Intents
- Intents: message objects among Android components

- Explicit Intent: message to a specific target
- Implicit Intent: the app does not know the recipient
  - only what is must be accomplished:
    open a website, start a call, etc…
  - User presented with a chooser if multiple applications
    can handle a task

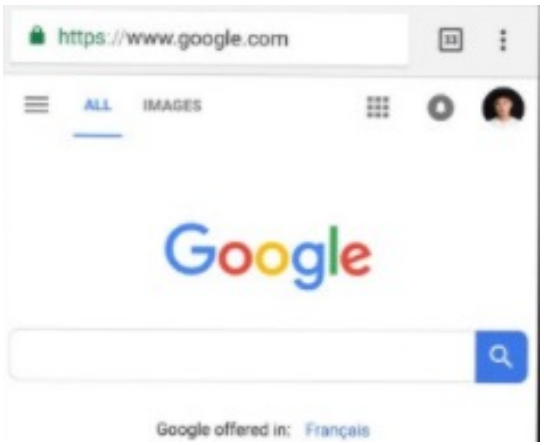


- (Much) more on Intents:
  https://developer.android.com/guide/components/intents-filters

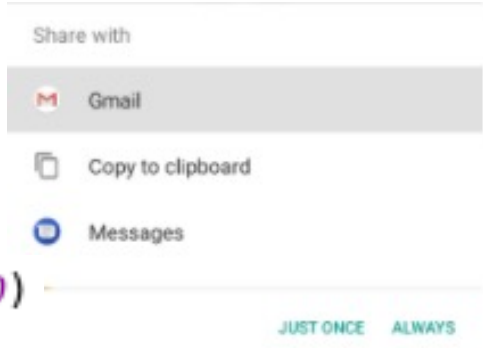
Defining an implicit Intent

- Implicit intent must provide Action to be done
  - ACTION_VIEW, ACTION_DIAL, ACTION_SEND
- Depending on the Action, they can also provide
  - A single Data content, specified either as URI or a data Type
  - Multiple EXTRAs specified as key-value pairs

```
val webIntent: Intent = Intent(Intent.ACTION_VIEW)
webIntent.setData(Uri.parse("https://www.google.com"))
```




```
val shareIntent = Intent(ACTION_SEND)
shareIntent.setType("text/plain")
        .putExtra("KEY","VALUE")
```



Intents examples

- Make a phone call

```
val callIntent: Intent = Intent(Intent.ACTION_DIAL)
callIntent.setData(Uri.parse("tel:5551234"))
```

- Send an e-mail

```
val mailIntent: Intent = Intent(Intent.ACTION_SEND)
mailIntent.setType("text/plain")
mailIntent.putExtra(Intent.EXTRA_EMAIL,"jan@example.com")
mailIntent.putExtra(Intent.EXTRA_SUBJECT, "Email subject")
mailIntent.putExtra(Intent.EXTRA_TEXT, "Email message text")
mailIntent.putExtra(Intent.EXTRA_STREAM,
Uri.parse("content://path/to/email/attachment"))
```

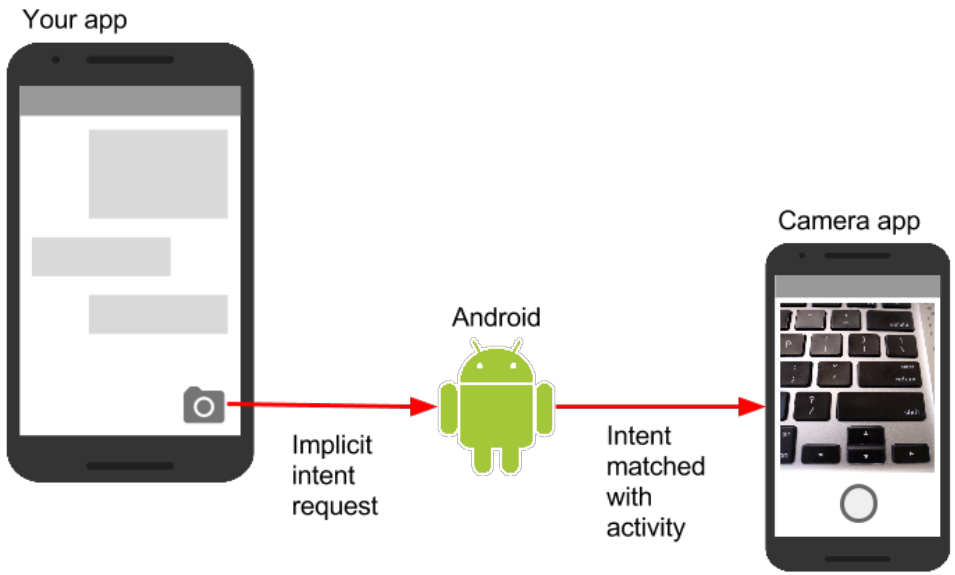
- complete list of Actions:
  https://developer.android.com/reference/kotlin/android/content/Intent

Starting the external activity

- In all cases, the Intent message is `startActivity(myIntent)`

- myIntent → intent message
  - describing Action, Data, Extras etc…

- the app that executes startActivity() goes in background
- the one that manages the intent (or a chooser) comes in foreground



Receiving implicit intents

- The receiving app advertises which intents can process
  - Intent Filters in Android Manifest

```
<activity android:name="ShareActivity">
    <intent-filter>
        <action android:name="android.intent.action.SEND"/>
        <category android:name="android.intent.category.DEFAULT"/>
        <data android:mimeType="text/plain"/>
    </intent-filter>
</activity>
```

- Retrieves the intent content in onCreate()

```
val bundle: Bundle? = intent.extras
val name: String? = bundle?.getString("key")
```

Request data from other apps

- Interfacing external apps not always a one-way street
  - sometimes, we expect Intents to provide data back
  - examples
    - select a picture from gallery (→ today's Lab!)
    - select a contact

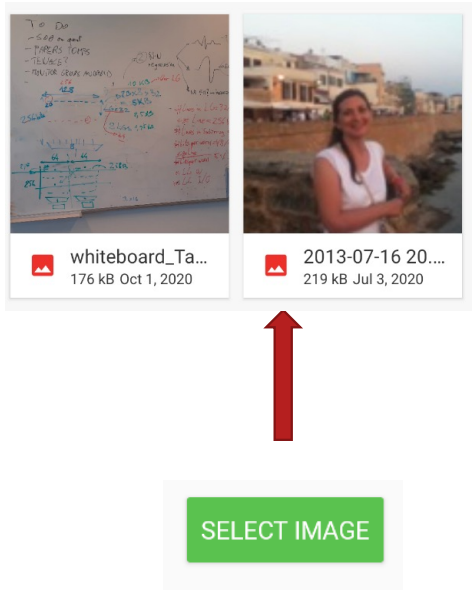
- Starting the external activity and getting the result are decoupled
  - Requesting Apps may be destroyed/recreated while waiting for results

- Enabled by adding proper dependencies to gradle file
  - And update it to the latest version

```
implementation 'androidx.activity:activity-compose:1.8.0'
```

Request data from other apps

1. External apps are still invoked via Intents
   - Created and started e.g. in the event listener of a Composable
   - With the appropriate Action, type etc…
   - launch() instead of startActivity()




```
HomeContent(imageUri, onButtonClicked = {
    val intent = Intent(Intent.ACTION_GET_CONTENT)
    intent.setType("image/*")
    imagePicker.launch(intent)
})
```

Request data from other apps

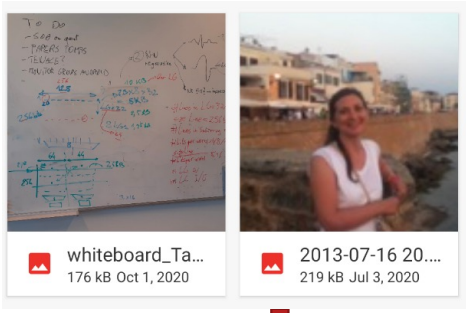
2. The callback is defined as property of a launcher class variable
   - defined in the class, outside methods
   - initialized with rememberLauncherForActivityResult(), with:
     - Contract
     - lambda function implementing callback

```
var imageUri by remember { mutableStateOf<Uri?>( value: null) }

val imagePicker = rememberLauncherForActivityResult(
    contract = ActivityResultContracts.StartActivityForResult(),
    onResult = { result ->
        if (result.resultCode == Activity.RESULT_OK) {
            val uri = result.data?.data
            imageUri = uri
        }
    }
)
```

Callback updating the state

non-specific contract



Request data from other apps

- Specialized contracts allow to simplify code
  - getContent() contract directly returns the Uri of the image
  - does not require to explicitly write Intent
    - action is always ACTION_GET_CONTENT
    - data type is passed as argument to launch()

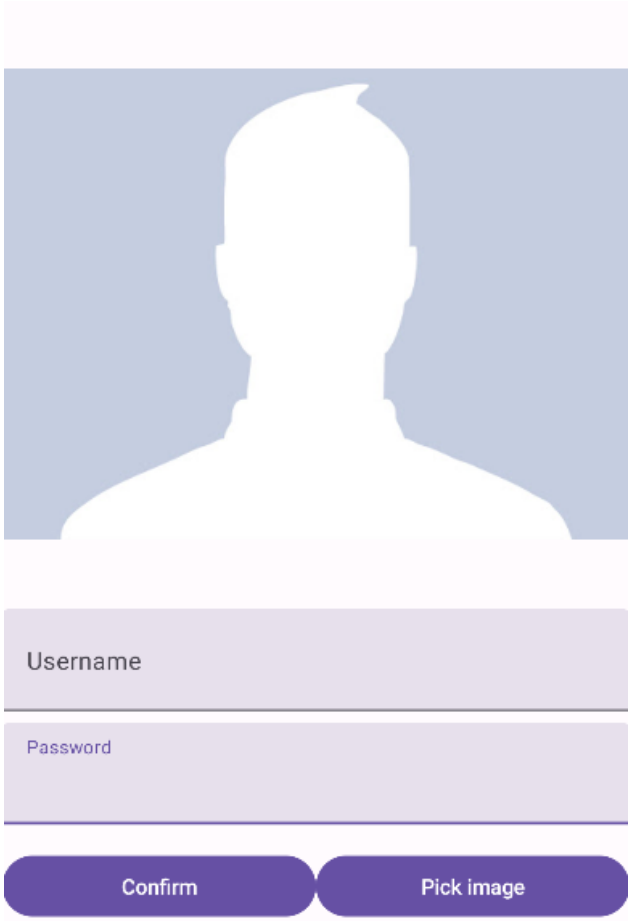
1.
```
HomeContent(imageUri, onButtonClicked = { imagePicker.launch( input: "image/*") })
```

2.
```
val imagePicker = rememberLauncherForActivityResult(
    contract = ActivityResultContracts.GetContent(),
    onResult = { uri ->
        imageUri = uri
    }
)
```

- Complete list of Android Contracts: https://developer.android.com/reference/androidx/activity/result/contract/ActivityResultContracts

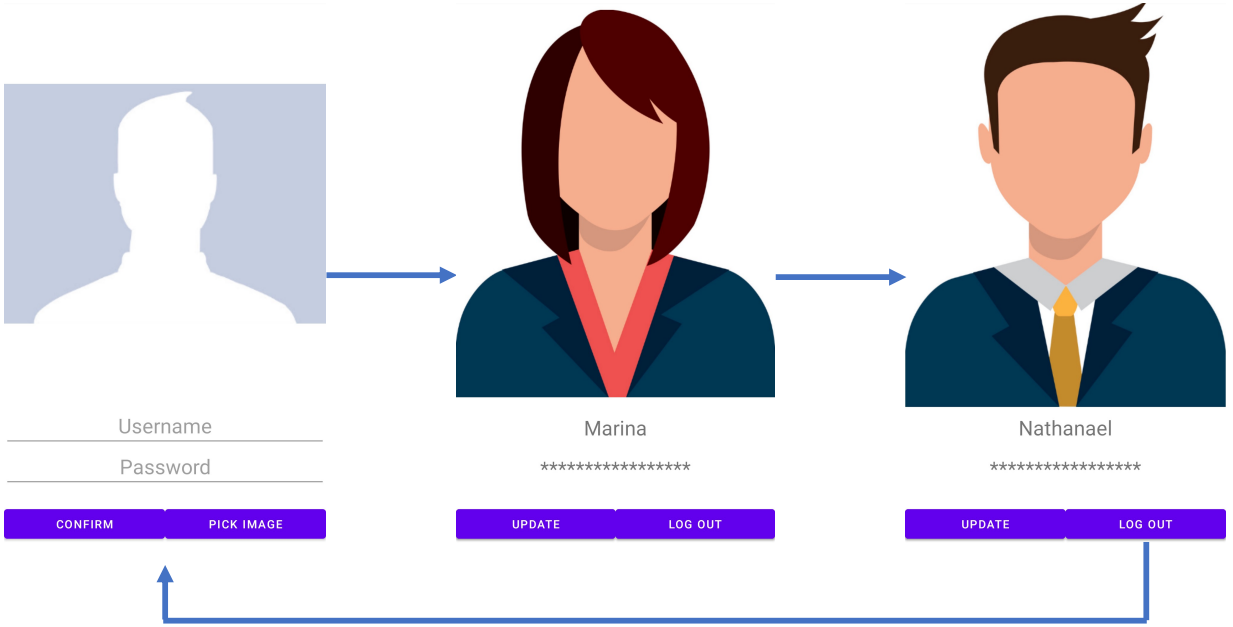
Class outline

- Handling events
  - Kotlin and XML callbacks
- Accessing Resources in Kotlin
  - View Binding
- Communicating with other applications
  - Listening for results
- **Lab of Today**



Today's Lab

- Tablet application that reacts to the users' actions
- Login credentials and user picture



Announcements

- Groups and material
  - Form your group if you haven't already done so
  - Each group gets a tablet, smartwatch and HR sensor
- Solutions to the labs on Moodle
  - We make them available before each lecture
- Projects:
  - Groups can request projects using the googleForm (link on Moodle)
  - First assignment of students to projects on Moodle this week
  - Information on gitLab on Moodle

Midterm Exam: Information

- **Individual** assessment → 35% of the course evaluation
- Covers all content of the course from week 0 to week 8

- Where: MED 2 2419, MED 2 2519
  - You will be randomly assigned to one of the two classes
- When: **Tuesday November 18th at 14.15pm,** 90 mins duration
  - Exit the class when you finish the exam

Mid-term Exam: Logistics

- Exam with Android Studio and the Android emulator
  - You can do the exam with your laptop, or with the computers in the lab
  - No real devices needed

- Two parts
  1. Replying to short questions in Moodle
  2. Mini app: we will give you a template app, you need to implement missing features

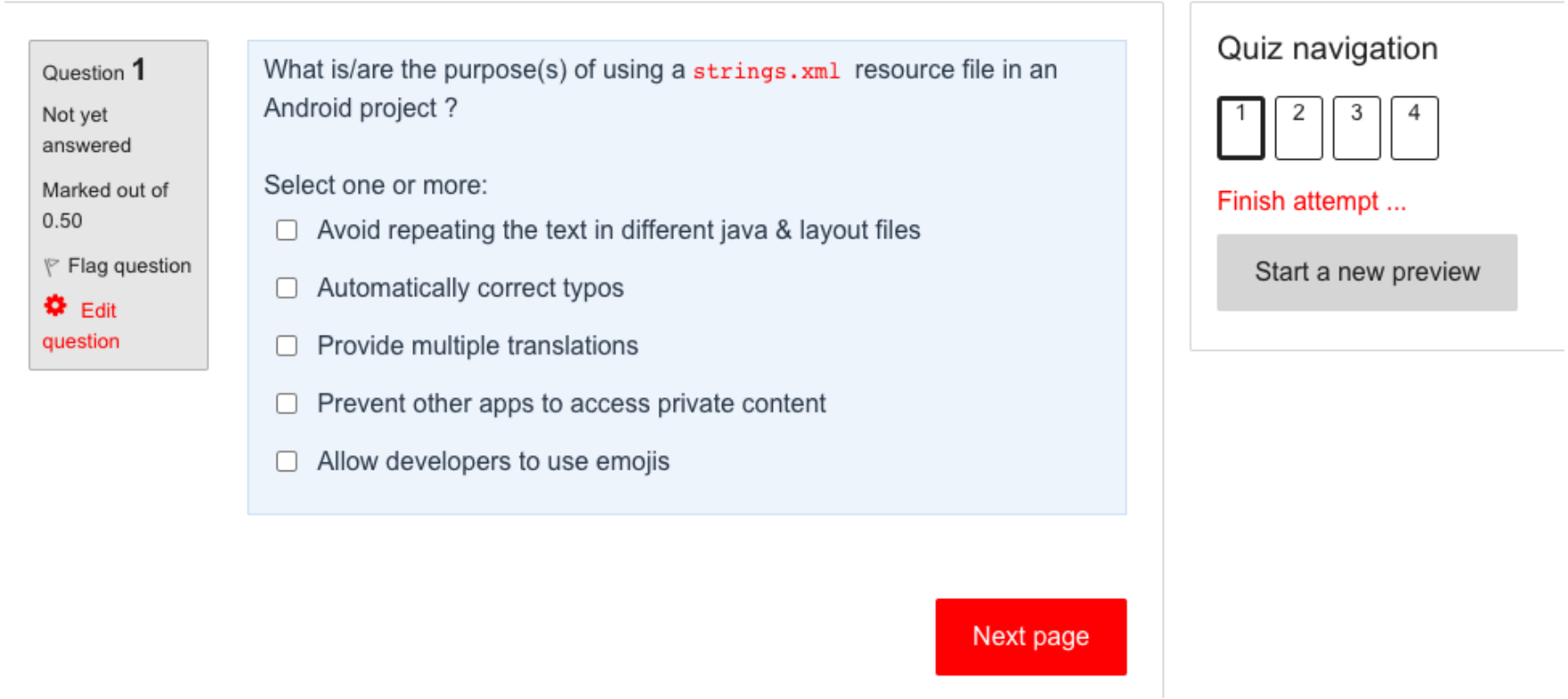
Mid-term Exam: Material

- Only the following online material will be allowed during the mid-term:
  - Moodle lecture slides, labs, etc.
  - Android developers website
  - You can also bring
    - lectures/labs printed
    - your own notes

- Use of mobile phones and AI assistants is **not allowed** in any case

Part1: Questions on Moodle

- ~4 questions
- one attempt



Part2: Mini-app

- You will be given a draft of an App project (as we do with labs)
- You will be tasked to implement some features

- Examples:

1. App crashes, fix the issue explaining how you did it
2. Something should be performed in response to a button press

- At the end of each task, you will call us to verify that the functionality is working
  - When you raise your hand, the emulator must be already started and the app launched

Questions?