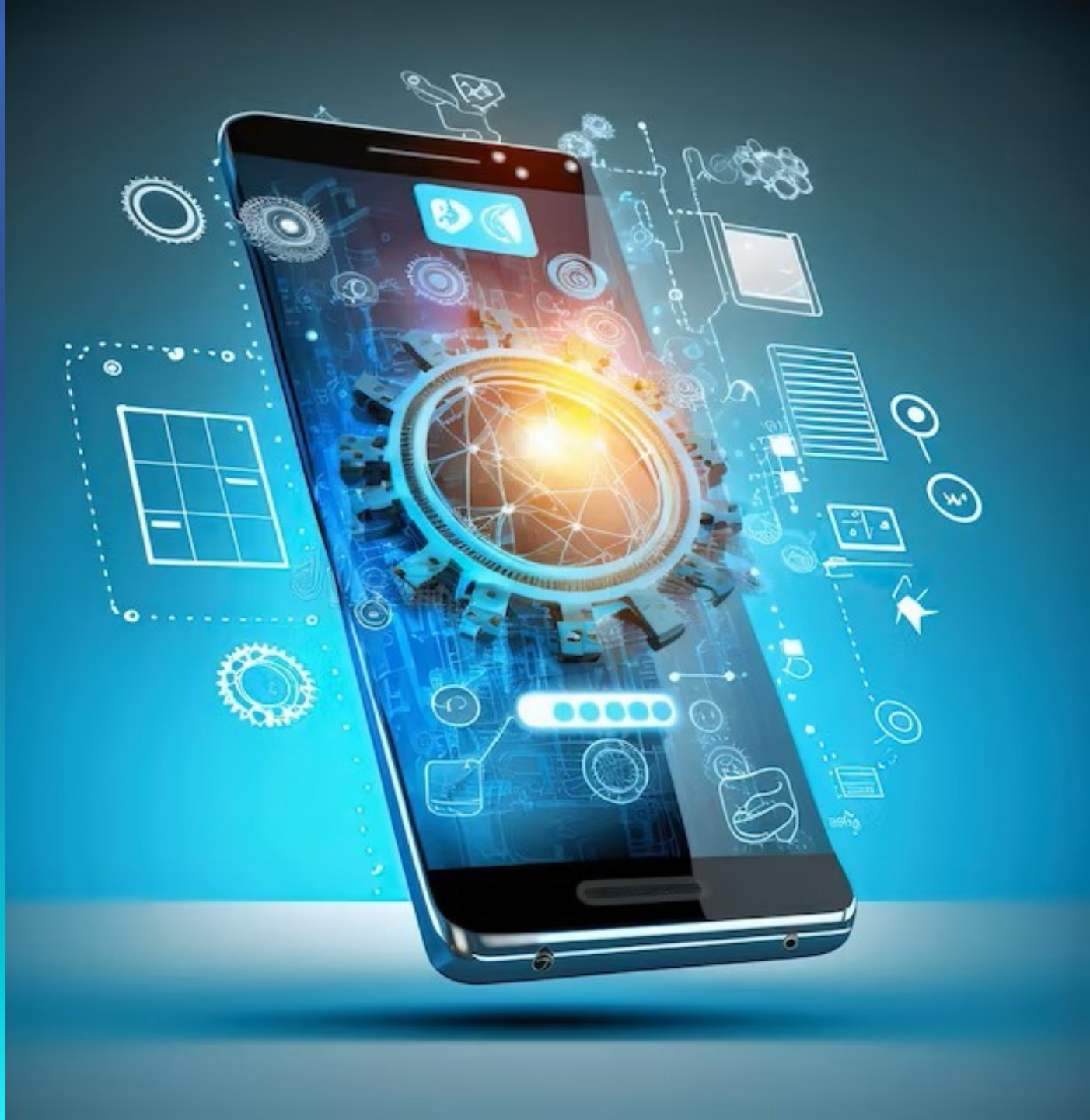


# I/O, State and Lists



# Objectives

- I/O with State
  - TextField
  - "Forms"
- State
  - State Sharing
  - State Hoisting
  - Stateless vs Stateful Components
- Lists
  - LazyColumn and LazyRow
  - Mutable state with lists

# Course Schedule

- ~~Sep 7 – Assignment #1 due at midnight~~
- ~~Sep 11 (Today) – Quiz Kahoot #1 on Kotlin~~
- ~~Sep 13 (Wednesday) – Milestone #1 due before class. Presentations in class.~~
- Sep 21 – Assignment #2 due midnight -> **Sep 24**
- Sep 25 – Quiz Kahoot #2 on Compose [Week 6] -> **Sep 27**
- Oct 5 – Assignment #3 due midnight (**not extended**)
- Oct 11 [Monday Schedule] – Quiz #3 on State/Event Handling
- Oct 16 – Quiz Kahoot #4 on Navigation/Routing
- Oct 18 – Milestone #2 due (Project design and Initial setup). Presentations in class.
- Oct 26 – Quiz Kahoot #5 on Coroutines/Flow/Storage [Week 10]
- Nov 1: Sprint 1 ends; In-class review with Teacher
- Nov 6 – Quiz Kahoot #6 on Authentication/TBD
- (Tues Nov 14 is Monday schedule)
- Nov 15: Sprint 2 ends; Milestone #3 due (Project design update, Preliminary code/demo)
- Nov 29: Sprint 3 ends; In-class review with Teacher
- Dec 6 [Last class]: Final project due and presentations.

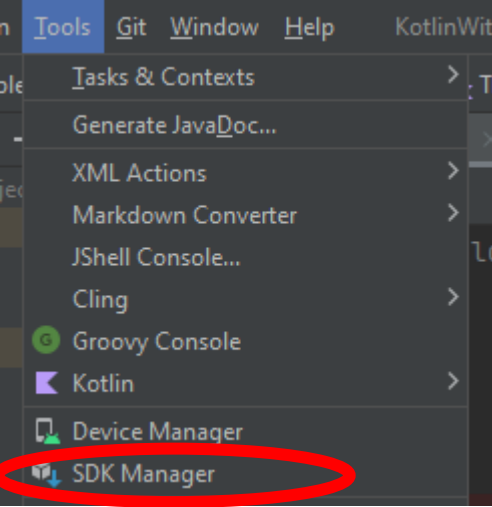
# TextField

- TextField is a Material composable for getting textual input from the user
  - <https://m3.material.io/components/text-fields/overview>
  - <https://developer.android.com/reference/kotlin/androidx/compose/material3/package-summary#textfield>
- To make a good, usable text field, you want to make sure that the field shows the current value typed in by the user and that the component remembers that value in state.
- It is also good usability to provide a placeholder for the text field before the user enters any information
- The TextField component issues a ValueChange event every time the user changes the information in the text field.
- E.g.,

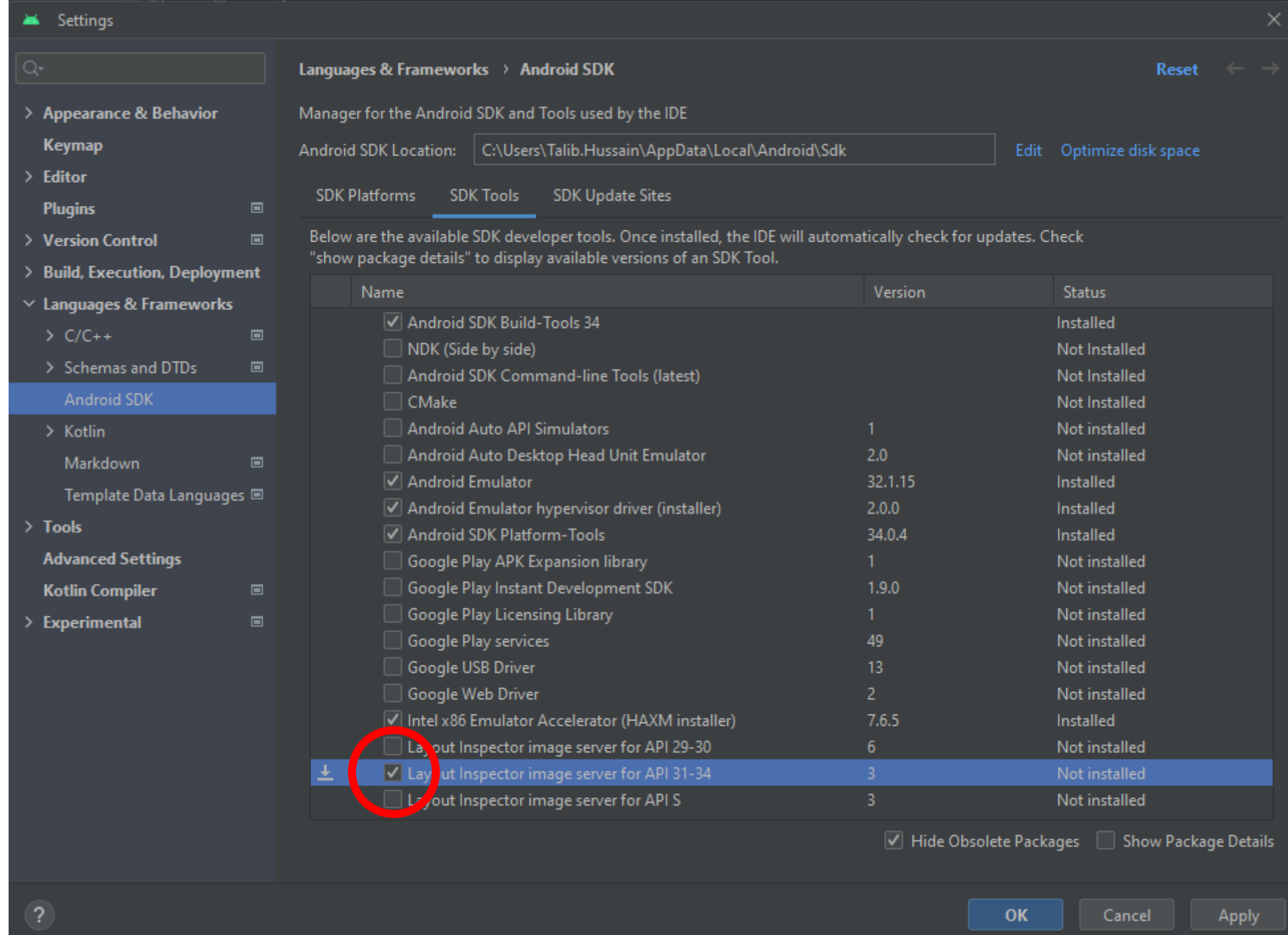
```
var name by rememberSaveable { mutableStateOf("") }
```

```
TextField(  
    value = name,  
    onChange = { name = it },  
    textStyle = TextStyle(textAlign = TextAlign.Center),  
    label = { Text(text = "Please enter your name")}  
)
```

- Note: For some reason, my IDE didn't find the import for TextStyle. If you have the same issue, it is:
  - `import androidx.compose.ui.text.TextStyle`
- Material also has an OutlinedTextField



- If you get errors using Layout Inspector, then it may not be installed.
- Go to Tools -> SDK Manager
- Select the SDK Tools tab
- Check the box next to Layout Inspector for API 31-34 and click OK.



# Try It! (State)

- Try the following codelab, up to the end of #8
  - <https://developer.android.com/codelabs/jetpack-compose-state#1>

# onClickable

- You can turn most components into the equivalent of buttons using Modifier.

```
Modifier.clickable(onClick = {count-- },  
                  onClickLabel = "Decrement count")
```

- Note: The optional onClickLabel is for accessibility purposes. It does not actually display on the screen.

# Conditional Content

- You can change whether a particular component is displayed or not using a conditional statement
- Combined with a state variable, this lets you toggle visibility when, say, a user clicks a clickable.

- E.g.,

```
var showImage by remember { mutableStateOf(true) }
```

```
Column() {
```

```
    ...
```

```
    if (showImage) {
```

```
        Image( ... )
```

```
    }
```

```
    ...
```

```
... in another composable:
```

```
    onClick = { showImage = !showImage }
```

```
}
```



# Form

- We can create a form in our app using several TextFields and a Button to complete/"submit" the form.
- There are a variety of things we can do here:
  - Include logic to check the validity of the values entered in a text field
    - E.g., check that a given entry is long enough
  - Make the "submit" button appear only once something has been entered in all the text fields
    - Simply check the values of all the state variables associated with the text fields to make sure they are non-empty and "valid"
- Once the submit button is clicked, several things can be done:
  - All state values should be appropriately handled.
    - At this early stage, we can just put all those values into an object and save it to state.
  - The form elements should go away (i.e., gated content) or limited so that the user cannot change the values
  - The submit button should be disabled to prevent multiple submissions.
  - Perhaps pop-up a message (e.g., using Snack Bar) thanking them for submitting their information

# Sample Form

@Composable

```
fun MyForm() {
    var nameValue by rememberSaveable { mutableStateOf("") }
    var passwordValue by rememberSaveable { mutableStateOf("") }
    var ageValue by rememberSaveable { mutableStateOf("") }
    var loggedInStatus by rememberSaveable { mutableStateOf(false)}

    Column {
        if (!loggedInStatus) {
            TextField(
                value = nameValue,
                onChange = { nameValue = it },
                textStyle = TextStyle(textAlign = TextAlign.Center),
                label = { Text(text = "Please enter your username (Must be non-empty)") }
            )
            Spacer(modifier = Modifier.height(20.dp).width(20.dp))
            TextField(
                value = passwordValue,
                onChange = { passwordValue = it },
                textStyle = TextStyle(textAlign = TextAlign.Center),
                label = { Text(text = "Please enter your password (Must be at least 8 characters long)") }
            )
            Spacer(modifier = Modifier.height(20.dp).width(20.dp))
            TextField(
                value = ageValue,
                onChange = { ageValue = it },
                textStyle = TextStyle(textAlign = TextAlign.Center),
                label = { Text(text = "Please enter your age (Must be 18 or older)") }
            )

            if (!nameValue.isEmpty() && !passwordValue.isEmpty()
                && passwordValue.length >= 8 && !ageValue.isEmpty()
                && ageValue.toInt() >= 18
            ) {
                Button(onClick = { loggedInStatus = true }) {
                    Text("Signup")
                }
            }
        } else {
            Text("Welcome $nameValue. You are $ageValue years old.")
        }
    }
}
```

# Try It!

- Create appropriate event handling for the onClick of your buttons and Card from earlier
  - Create appropriate state variables
  - Convert at least one component into a clickable and add event handling to it.
  - Make at least one component display only if a certain Boolean variable is true.
  - Toggle that variable in one of your buttons/clickables.
- Capture user textual input using a text field and display that information elsewhere on the screen
- Generally, play around with adding basic event handling to your screen and making it behave in a dynamic fashion based on the user's actions.
- Create a dynamic form with at least two text fields.

# Some Refactoring

- Now that we have gotten our coding feet wet and figured out some Compose basics, let's start getting into good coding habits
- We want to be able to break up our components into separate files.
- One simple approach is to have one composable per file
- So, take a few minutes to break out your code into separate files.

# Password Entry...

- We really don't want to see the password in the text field...

- Add the following property to TextField:

```
visualTransformation = PasswordVisualTransformation(),
```

- We also don't want the keyboard to reveal what has been typed.

- Add the following property to TextField or OutlinedTextField

```
keyboardOptions = KeyboardOptions(  
    keyboardType = KeyboardType.Password,  
    imeAction = ImeAction.Done  
),
```

- Make these changes as part of your refactor (if you had a password request). Otherwise, add a composable with a TextField that requests a password and use this approach.

```
TextField(  
    value = passwordValue,  
    onChange = { passwordValue = it },  
    textStyle = TextStyle(textAlign = TextAlign.Center),  
    label = { Text(text = "Please enter your password") },  
    visualTransformation = PasswordVisualTransformation(),  
    keyboardOptions = KeyboardOptions(  
        keyboardType = KeyboardType.Password,  
        imeAction = ImeAction.Done  
    )  
)
```

- There are a variety of options with regards to the keyboard that you can explore at the following links:

- <https://developer.android.com/reference/kotlin/androidx/compose/foundation/text/KeyboardOptions>
  - <https://developer.android.com/reference/kotlin/androidx/compose/ui/text/input/KeyboardType>

# Sharing State

- Now, we quickly run into an issue
  - What if we want to pass state information to a child component and have them change it?
- We need to pass down the value and a callback function to change the value separately.
  - This enables the child to call the callback function to make the desired change.
- To pass a function, we usually pass down a lambda function such as:  
`childComponent(count, setCount = { count = it })`
- To accept a function as a parameter, we use this notation  
`fun childComponent(count: Int, setCount: (Int) -> Unit)`
- To pass both the getter and setter from the parent, call:  
`childComponent(count, setCount = { count = it })`
- To accept those parameters in the child, we use this notation  
`fun childComponent(count: Int, setCount: (Int) -> Unit)`
- Inside the child function, we can call the callback (i.e., `setCount`), and this will cause the state in the parent to change. That change in turn will lead to a recomposition.

# Passing value and setter

- At parent level:

```
ImageCard(showImage = showImage, setShowImage = { showImage = it },  
          count = count, setCount = { count = it })
```

- At child level:

```
fun ImageCard(showImage: Boolean, setShowImage: (Boolean) -> Unit,  
              count: Int, setCount: (Int) -> Unit)  
...  
onClick = { setShowImage(!showImage); setCount(count - 1) },  
...  
Text("Clickable ${count} ${showImage}", Modifier.align(Alignment.Center))
```

# State Hoisting

- When writing code with multiple components, it is important to declare the state variable at the highest necessary point in the component tree.
  - i.e., if several components in a branch of the component tree need to use a given variable, then that state variable should be defined in their shared ancestor (i.e., the root of the branch they are all part of).
- State that is hoisted this way has some important properties:
  - <https://developer.android.com/jetpack/compose/state#state-hoisting>
  - Single source of truth: By moving state instead of duplicating it, we're ensuring there's only one source of truth. This helps avoid bugs.
  - Encapsulated: Only stateful composables can modify their state. It's completely internal.
  - Shareable: Hoisted state can be shared with multiple composables. If you wanted to read name in a different composable, hoisting would allow you to do that.
  - Interceptable: callers to the stateless composables can decide to ignore or modify events before changing the state.
  - Decoupled: the state for the stateless ExpandingCard may be stored anywhere. For example, it's now possible to move name into a ViewModel.
- <https://www.kodeco.com/30172122-managing-state-in-jetpack-compose>



# Stateless vs Stateful Components

- Another good design principle is to create stateless components wherever possible.
- This lets us separate the logic for displaying the data from the source of the data
  - We can do this by hoisting state.
- In turn, this lets us
  - Re-use the display component for multiple different sources of data.
  - "preview" the stateless component
    - @preview to preview in Studio, but can't take any parameters
    - To be discussed later
  - Perform easier testing
- As you develop reusable Composables, you often want to expose both a Stateful and a Stateless version of the same composable
  - This results in pairs of similarly named components. One that holds state and one that doesn't
  - One naming technique for a given pair is to use the exact same component name (but parameters will vary).
  - Another is to use similar but different names, and be consistent across your components.
  - You can also explicitly use the word Stateless or Stateful in the component name for clarity.
    - Note: In Flutter, this is the naming approach used.
- Links:
  - <https://developer.android.com/jetpack/compose/state#stateful-vs-stateless>
  - <https://peterchege.hashnode.dev/stateful-and-stateless-components-in-jetpack-compose>

# Example: Stateful vs Stateless

```
/* Stateful Component */  
  
@Composable  
fun HelloScreen() {  
    var name by rememberSaveable { mutableStateOf("") }  
  
    HelloContent(name = name, onNameChange = { name = it })  
}
```

```
/* Stateless Component */  
  
@Composable  
fun HelloContent(name: String, onNameChange: (String) -> Unit) {  
    Column(modifier = Modifier.padding(16.dp)) {  
        Text(  
            text = "Hello, $name",  
            modifier = Modifier.padding(bottom = 8.dp),  
            style = MaterialTheme.typography.bodyMedium  
        )  
        OutlinedTextField(value = name, onValueChange = onNameChange, label = { Text("Name") })  
    }  
}
```

# Read It!

- Read through the following article. It gives a very good set of examples DOs and DON'Ts related to state in Compose
  - <https://medium.com/@takahirom/jetpack-compose-state-guideline-494d467b6e76>

# Displaying Lists: LazyColumn and LazyRow

- If you need to display a large number of items, or a list of unknown length, then using a layout such as Column can result in performance issues
  - ALL of the items will be composed and laid out whether or not they are visible on the device screen
  - Note: LazyColumn and LazyRow are equivalent to RecyclerView in Android Views, except entirely new composables are created as the user scrolls through the list.
- LazyColumn and LazyRow are two components that will only compose and layout those items that are current visible on the screen.
- They produce a vertical or horizontal scrolling list.
- These two components are a bit different from most other layouts in Compose.
- Inside the braces, instead of specifying Composables directly, you specify a sequence of specific commands to describe the item contents.
  - Technically this is termed a domain-specific language (DSL)
- <https://developer.android.com/jetpack/compose/lists>
- <https://developer.android.com/reference/kotlin/androidx/compose/foundation/lazy/LazyListScope>
- <https://medium.com/@mal7othify/lists-using-lazycolumn-in-jetpack-compose-c70c39805fbc>

# item() and items()

- The item() function adds a single items to the layout.
- The items(Int) function adds a given number of items to the layout

```
LazyColumn {  
    // Add a single item  
    item {  
        Text(text = "First item")  
    }  
  
    // Add 5 items  
    items(5) { index ->  
        Text(text = "Item: $index")  
    }  
  
    // Add another single item  
    item {  
        Text(text = "Last item")  
    }  
}
```

# items(<list>) & itemsIndexed(<list>)

- A LazyColumn can also accept an existing list
- For example, if myList is a List<String>

```
LazyColumn {  
    items(myList) { item ->  
        Text(text = item)  
    }  
  
}
```

- itemsIndexed can provide access to the item as well as its index.

```
itemsIndexed(myList) { index, item ->  
    Text(text = "#$index: $item")  
}
```

- May need to manually import items/itemsIndexed  
import androidx.compose.foundation.lazy.items  
or  
import androidx.compose.foundation.lazy.itemsIndexed

# Display list from state

- This example shows use a stateful and stateless component.
  - You will need to import `androidx.compose.foundation.lazy.items`

```
/* Stateful */  
@Composable  
fun DisplayList() {  
    val idList = remember { List<String>(100) { "Item $it" } }  
    DisplayGivenList(idList = idList)  
}
```

```
/* Stateless */  
@Composable  
fun DisplayGivenList(idList: List<String>) {  
    LazyColumn {  
        items(items=idList) { id ->  
            Text(text = "" + id)  
        }  
    }  
}
```

A simple Kotlin List does not have `.getValue()` or `.setValue()` functions, so we can't use delegation

# Pass in function to apply to clicked item

- Need to import the right thing

```
import androidx.compose.foundation.lazy.items
```

```
@Composable
```

```
fun ListContent(onItemClick: (String) -> Unit) {
```

```
    val items: List<String> = remember { List(100) { "Item $it" } }
```

```
    LazyColumn {
```

```
        itemsIndexed(items) { index, item ->
```

```
            Text(
```

```
                text = "#$index: $item",
```

```
                modifier = Modifier
```

```
                    .clickable { onItemClick(item) } 
```

```
                    .fillMaxWidth()
```

```
                    .padding(16.dp)
```

```
            )
```

```
        }
```

```
    }
```

```
}
```



# What about changing the displayed list?

## mutableStateListOf

- So far, we have been creating state variables that an unchanging lists
- But, we may want to add or remove elements to the list as the user uses our app
  - You'll need to do this in Assignment #2!
  - <https://medium.com/geekculture/add-remove-in-lazycolumn-list-aka-recyclerview-jetpack-compose-7c4a2464fc9f>
- To accomplish this, we need to use a mutable state with a List
- There are two ways to accomplish this.
  - Call `.toMutableStateList()` on an existing List object
  - Call `mutableStateListOf()` to create a mutable state with an empty List and then add/remove elements to your state
- Caution: Using mutable objects such as `ArrayList<T>` or `mutableListOf()` as state in Compose causes your users to see incorrect or stale data in your app.
  - Mutable objects that are not observable, such as `ArrayList` or a mutable data class, are not observable by Compose and don't trigger a recomposition when they change.
  - Instead of using non-observable mutable objects, the recommendation is to use an observable data holder such as `State<List<T>>` and the immutable `listOf()`.
  - <https://dev.to/zachklipp/two-mutables-dont-make-a-right-2kgp>

# Creating & Using a Mutable State List

- For example, this creates state with a MutableList that is initially empty

```
val todoList = remember { mutableStateListOf<String>() }
```

- These operations allow you to access the list:

```
items (todoList) { item ->
```

```
}
```

or

```
itemsIndexed(todoList) { index, item ->
```

```
}
```

- These operations update the list:

- todoList.add("Information to add")
- todoList.remove(item)
- todoList.removeAt(index)

```
fun ChangingList() {  
    val todoList = remember { mutableStateListOf<String>() }  
  
    LazyColumn {  
        item() {  
            Button(  
                onClick = {todoList.add("Do this ${todoList.size}")},  
            ) {  
                Text(text = "Add Item")  
            }  
        }  
        itemsIndexed(todoList) { index, item ->  
            Text(  
                text = "#$index: $item",  
                modifier = Modifier  
                    .clickable { todoList.remove(item) }  
                    .padding(16.dp)  
            )  
        }  
    }  
}
```

- Tricky error using rememberSaveable with a SnapshotStateList...
  - <https://stackoverflow.com/questions/68885154/using-rememberSaveable-with-mutablestatelistof/68887484#68887484>

- Need to create the following function

@Composable

```
fun <T: Any> rememberMutableStateListOf(vararg elements: T): SnapshotStateList<T> {
```

```
    return rememberSaveable(
```

```
        saver = listSaver(
```

```
            save = { stateList ->
```

```
                if (stateList.isNotEmpty()) {
```

```
                    val first = stateList.first()
```

```
                    if (!canBeSaved(first)) {
```

```
                        throw IllegalStateException("${first::class} cannot be saved. By default only types which can be stored in the Bundle class can be saved.")
```

```
                    }
```

```
                }
```

```
                stateList.toList()
```

```
            },
```

```
            restore = { it.toMutableStateList() }
        )
    ) {
```

```
        elements.toList().toMutableStateList()
    }
}
```

- Then use like:

```
val names = rememberMutableStateListOf<String>()
```

# Try It!

- Continue working on the following codelab. Complete # 9, 10 & 11
  - This shows you how to do a checkbox list
  - <https://developer.android.com/codelabs/jetpack-compose-state#8>
- Optional: This codelab provides additional practice (including animating a list)
  - <https://developer.android.com/codelabs/jetpack-compose-basics#8>

# Practice It!

- Complete the following codelab, which challenges you to display a list using Cards and Material Theming
  - <https://developer.android.com/codelabs/basic-android-kotlin-compose-practice-superheroes?hl=en#0>
  - Note: Solution code is provided at the end for reference. But, try to do this on your own before looking.
- You now know everything you need to do Assignment #2


# Misc.

- LazyGrid
  - See <https://developer.android.com/jetpack/compose/lists>
- Advanced form operations
  - <https://www.section.io/engineering-education/jetpack-compose-forms/>
- More on Text Styling
  - <https://semicolonspace.com/jetpack-compose-text/>
- Returning multiple values from functions
  - <https://www.baeldung.com/kotlin/returning-multiple-values>
- Destructuring declarations
  - [https://www.tutorialspoint.com/kotlin/kotlin\\_destructuring\\_declarations.htm](https://www.tutorialspoint.com/kotlin/kotlin_destructuring_declarations.htm)

# Misc.: Interfaces

- The colon : is used to indicate "implements an interface"
  - i.e., not just for "extends"
- <https://kotlinlang.org/docs/interfaces.html#implementing-interfaces>

## Interfaces

 [Edit page](#) Last modified: 14 June 2023

Interfaces in Kotlin can contain declarations of abstract methods, as well as method implementations. What makes them different from abstract classes is that interfaces cannot store state. They can have properties, but these need to be abstract or provide accessor implementations.

An interface is defined using the keyword `interface` :

```
interface MyInterface {  
    fun bar()  
    fun foo() {  
        // optional body  
    }  
}
```

## Implementing interfaces

A class or object can implement one or more interfaces:

```
class Child : MyInterface {  
    override fun bar() {  
        // body  
    }  
}
```



# Assignment #2: Single Screen, Interactive Compose App

- Worth 7% of grade. Due Sep 24 by midnight. This is an individual assignment.
  - Estimated Level of Effort: 6 hours – 1 hour class time and 5 hours homework.
- For this assignment, you will create a single screen mobile app that runs on an emulated Android, interacts with the user and uses state.
- The topic of the app is of your choice
  - Recommendation: Choose a screen/subject that may align with your eventual project. Try to focus on something different than your teammates.
- The app must:
  - Be programmed in Kotlin and use Jetpack Compose for the UI
  - Use Material design
  - Contain multiple components and show good attention to layout
  - Show reasonable attention to styling/theming
  - Get user input (button and/or text input)
  - Update what is on the screen based on user input (using mutableState)
  - Display at least one list of information that the user has entered
  - Be robust to rotating the device
- The code must be documented internally and contain a Readme file
  - The internal documentation should be informative and meaningful (i.e., not vacuous)
  - The Readme should give a high-level indication of what the product is and how to use it. If there are any known issues, they should be described/explained in the Readme. The Readme file should live at the root level of the project.
- Code documentation must include work breakdown structure (WBS), level of effort (LOE) estimates and summary of actual time worked
  - Breakdown the assignment into at least 3 distinct subtasks. Make an initial estimate of the time you expect each subtask will take.
  - While programming, keep track of how long each subtask actually took you.
  - Submit a summary of the subtasks, the initial effort estimates and the actual effort. If the actual was significantly different than the estimate, provide a sentence or two with your thoughts on why the difference occurred (e.g., task was easier than expected, hit several unexpected bugs, misunderstood what was expected, etc.)
- The code must compile and run.
  - If you submit something with compile errors or that shows no meaningful output, a high penalty will be assessed, as appropriate.
- The app should be usable – with clear wording/instructions and understandable, easy-to-use interface

# Assignment #2: Single Screen, Interactive Compose App

- Marking Scheme:
  - 40% Functionality
  - 20% Styling/Layout
  - 20% Documentation (including WBS, LOE estimates and actuals, with explanations as appropriate)
  - 20% Usability/Design
- Submission:
  - Submit zip file of entire project on Lea.
- Late Penalty:
  - Late submissions lose 10% per day to a maximum of 3 days
  - Nothing accepted after 3 days without prior arrangement and a grade of zero may be given.
  - Strong Recommendation: Submit incomplete version ON TIME with explanation of what is not done. Submit completed version later with explanation of what changed. This may result in a lower penalty than just submitting late.
- Original work!
  - "Your submitted work must be clear, complete, and YOUR OWN. You must be prepared to explain any of your work to me in person. Failure to be able to defend your work, or do a similar question in front of me in person can/will void any grade you get on this assignment."
  - Any code snippets copied or "highly inspired" from a 3<sup>rd</sup> party source or ChatGPT must be explicitly indicated (with source identified) in the code documentation or README.
    - The total amount of such non-original code should be a small portion of your code (rule of thumb is < 20%).
    - 3<sup>rd</sup> party code should not be used for key algorithmic capabilities that this assignment is focused on. They should rather be used for more rote/simple parts of the code. Credit for that portion of the project may not be given if it is key.
    - If excessive 3<sup>rd</sup> party contributions are used, your grade may be based proportionally only on the portion that is original. (e.g., if 50% is original and that is worth a grade of 80% based on the marking scheme, then a total grade of 40% may be given).
    - If in any doubt regarding a 3<sup>rd</sup> party contribution – ask IN ADVANCE. Ideally in writing so we both have backup if there are any questions later on.

# Next

- Navigating Multiple Screens