Application Development II

420-5A6-AB

Instructor: Talib Hussain

Day 19-20:

ViewModels, Coroutines, Flows

Objectives

- ViewModel
- Coroutines
- Side-effects
- Flow
- Data Storage
- Work on Assignment #3 / Milestone 2

Parcelize

- In order to use a custom data class in rememberSaveable, it needs to be “parcelable”.
  - This is like Serializable in Java.
- To do this, you add an annotation and type to the data class declaration

```
import android.os.Parcelable
import kotlinx.parcelize.Parcelize

@Parcelize
data class myDataClass(var foo: String, var goo: Int) : Parcelable
```

- In gradle, you also need to add a plugin (in the plugin section at the top).

```
id(“kotlin-parcelize”)
```

- Don’t forget to sync gradle

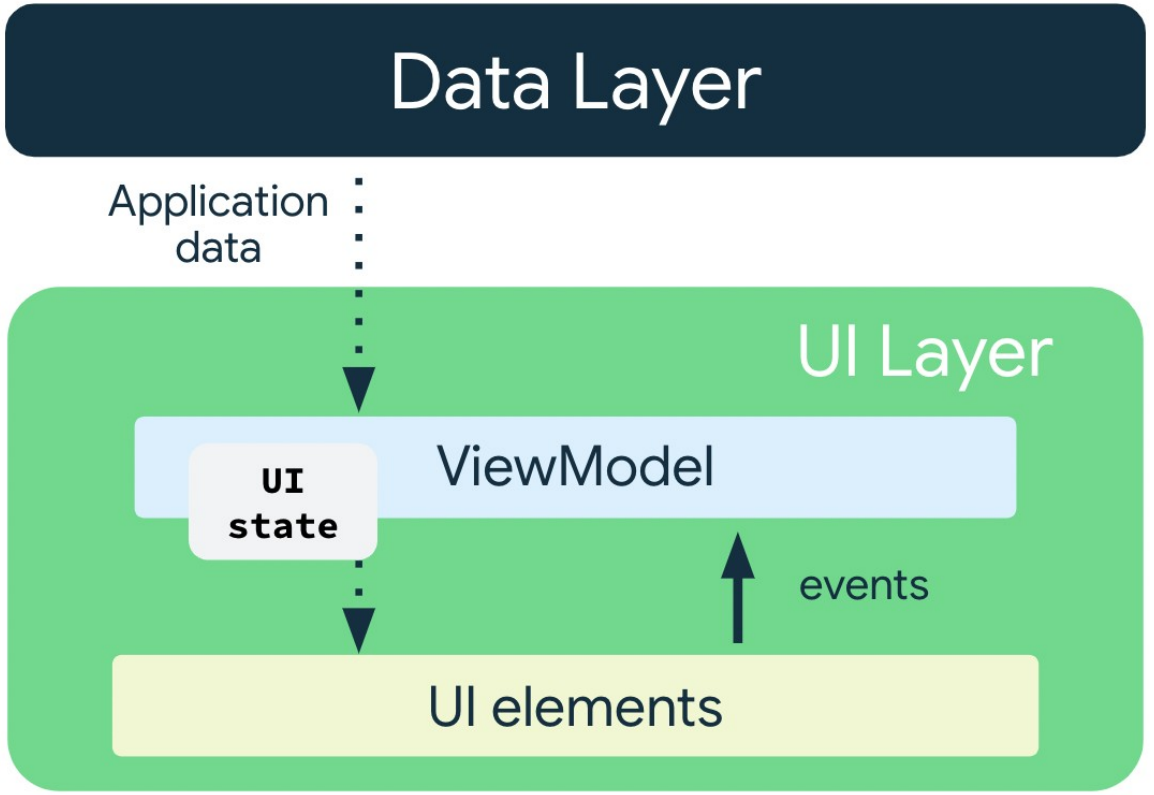
Course Schedule

- ~~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 24 – Assignment #2 due midnight~~
- ~~Sep 27 – Quiz Kahoot #2 on Compose [Week 6]~~
- ~~Sep 27 – Assignment #3a WBS+LOEs due by midnight~~
- **Sep 29 – Assignment #3b Git/local setup confirmation due by midnight**
- Oct 5 – Assignment #3c due midnight
- **Oct 7 – Sprint 1: Milestone #2a due midnight (Initial project setup)**
- Oct 11 [Monday Schedule] – Quiz #3 on State/Event Handling
- Oct 16 – Quiz Kahoot #4 on Navigation/Routing
- **Oct 18 – Sprint 2: Milestone #2b due before class (Project design and Risk Management Plan). Presentations in class.**
- Oct 26 – Quiz Kahoot #5 on Coroutines/Flow/Storage [Week 10]
- Nov 1: Sprint 3 ends; In-class review with Teacher
- Nov 6 – Quiz Kahoot #6 on Authentication/TBD
- (Tues Nov 14 is Monday schedule)
- Nov 15: Sprint 4 ends; Milestone #3 due (Project design update, Preliminary code/demo)
- Nov 29: Sprint 5 ends; In-class review with Teacher
- Dec 6 [Last class]: Final project due and presentations.

Note: Assignment #4 needs to be fit in here. Likely will make it support Milestone 3.

ViewModel

- So far, we have declared state variables within composables and used remember/ rememberSaveable to persist state
- An alternative approach is to define a ViewMode to hold the state to be displayed by the UI
  - A ViewModel is a class
  - A ViewModel stores the app-related data that isn' destroyed when the activity is destroyed and recreated by the Android framework
  - The ViewModel provides the UI with access to the other layers, like the business and data layers.
  - The app automatically retains ViewModel objects during configuration changes so that the data they hold is immediately available after the recomposition.
- The state in a ViewModel will persist across configuration changes such as phone rotation



ViewModel

- ViewModels are recommended to be used at screen-level composables, that is, close to a root composable called from an activity or destination of a Navigation graph.
  - E.g., YYYViewModel to support YYYScreen

- ViewModels should never be passed down to other composables, instead you should pass only the data they need and functions that perform the required logic as parameters.
  - E.g., if storing a list in a ViewModel, then the associated Screen should pass that list to a DisplayList composable
  - It should NOT pass the viewModel to the DisplayList composable.

- ViewModels are not part of the Composition. Therefore, you should not hold state created in composables (for example, a remembered value) because this could cause memory leaks.
  - i.e., define the state in the ViewModel, then use that state in the composable

Defining a ViewModel

- Add the following to gradle:
  - implementation("androidx.lifecycle:lifecycle-viewmodel-compose:{latest_version}")
- Create a new folder called viewmodels
- Define a new view model class. It must extend ViewModel

```
class MySimpleViewModel : ViewModel() {
}
```

- Let's create a simple counter that will be used by our view
- To do this, we want to define a private mutable variable in our view model
  - This is because we only want to be able to directly modify it within that class

```
private var _count by mutableStateOf(0)
```

- We can then define a public immutable field and override its getter. This essentially makes the value of our private state variable publicly readable.

```
val count: Int
        get() = _count
```

- Finally, let's define a function that will update our private counter.

```
fun increment() { _count +=1  }
```

```
class MySimpleViewModel : ViewModel() {
    // Declare private mutable variable that can only be modified
    // within the class it is declared.
    private var _count by mutableStateOf(0)

    // Declare a public immutable field and override its getter method.
    // Return the private property's value in the getter method.
    // When count is accessed, the get() function is called and
    // the value of _count is returned.
    val count: Int
        get() = _count

   fun increment() {
        _count +=1
    }
}
```

Using a ViewModel

- To use the viewModel in our screen, we can create it using the `viewModel()` function
- The view model is passed into our screen as a parameter
  - Or, we can create it within the constructor of our Screen. (This is somewhat easier)

```
@Composable
fun MySimpleScreen(myViewModel: MySimpleViewModel = viewModel()) {
}
```

- Within our screen, we can access the public values/functions of our view model
  - E.g., myViewModel.increment() or myViewModel.count

- Try it – Create a Screen that will display the latest count value and let the user increment the value by pressing a button
  - Once you have it working, rotate the phone – the state should persist.

```
/* Composable that gets all state information from its view model. */
@Composable
fun MySimpleScreen(myViewModel: MySimpleViewModel = viewModel()) {
    Column {
        Button(
            onClick = { myViewModel.increment() },
        ) {
            Text(text = "Increment")
        }
        Text("Total items added by user: ${myViewModel.count}")
}
```

Let's Try a List...

```
 private val _items = mutableStateListOf<String>()
 val items: List<String>
        get() = _items

fun add(String? item) {
        _items.add(item)
}

fun remove(item: String) {
        _items.remove(item)
}
```

- Note: We need to use a MutableStateList, not a MutableList.

- If our screen needs to pass details of the view model to a child composable, such as to display or change the list, it should not pass the viewModel.
  - E.g.,

```
DisplayChangingList(theList = myViewModel.items, add = myViewModel::add, remove =
myViewModel::remove)
```

  - And,in turn,

```
@Composable
fun DisplayChangingList(theList: List<String>,
                        add:(String?) -> Unit,
                        remove:(String) -> Unit) {

}
```

```
class MySimpleViewModel : ViewModel() {
    // Declare private mutable variable that can only be modified
    // within the class it is declared.
    private var _count by mutableStateOf(0)
    private val _items = initialList().toMutableStateList()

    // Declare a public immutable field and override its getter method.
    // Return the private property's value in the getter method.
    // When count is accessed, the get() function is called and
    // the value of _count is returned.
    val count: Int
        get() = _count
    val items: List<String>
        get() = _items

    fun increment() {
        _count +=1
    }
    fun add() {
        _items.add("Item # ${count+10}") // add initial size of list
        _count++
    }
    fun remove(item: String) {
        _items.remove(item)
    }

}
```

```
@Composable
fun MySimpleScreen(myViewModel: MySimpleViewModel = viewModel())
{
    Column {
        Text("Total items added by user: ${myViewModel.count}")
        DisplayChangingList(theList = myViewModel.items, add =
myViewModel::add,
            remove = myViewModel::remove)
    }
}
```

```
@Composable
fun DisplayChangingList(theList: List<String>,
                        add:() -> Unit,
                        remove:(String) -> Unit) {


    LazyColumn {
        item() {
            Button(
                onClick = {add()},
            ) {
                Text(text = "Add Item")
            }
        }
        itemsIndexed(theList) { index, item ->
            Text(
                text = "#$index: $item",
                modifier = Modifier
                    .clickable { remove(item) }
                    .padding(16.dp)
            )
        }
    }
}
```

Try It!

- Step 12 of the codelab we worked on previously introduces the use of a simple ViewModel.
  - Complete the earlier codelab (you may have stopped at step 9)
  - https://developer.android.com/codelabs/jetpack-compose-state#11

- Optional: The following codelab also introduces a ViewModel, but uses some Kotlin language features (e.g., coroutines, flows) that we haven't learned yet.
  - https://developer.android.com/codelabs/basic-android-kotlin-compose-viewmodel-and-state#3

- https://developer.android.com/courses/android-basics-compose/course
  - Unit 5

- https://www.kodeco.com/books/kotlin-coroutines-by-tutorials/v3.0/chapters/1-what-is-asynchronous-programming#toc-chapter-007-anchor-008

Kotlin Coroutine

- Coroutines offer asynchronous programming support at the language level in Kotlin.
- A *coroutine* is an instance of suspendable computation.
  - It is conceptually similar to a thread, in the sense that it takes a block of code to run that works concurrently with the rest of the code.
  - However, a coroutine is not bound to any particular thread. It may suspend its execution in one thread and resume in another one.
  - Coroutines can be thought of as light-weight threads.
- Compose offers APIs that make using coroutines safe within the UI layer
- The rememberCoroutineScope function returns a CoroutineScope with which you can create coroutines in event handlers and call Compose suspend APIs.
- Try this:

```
fun main() = runBlocking { // this: CoroutineScope
    launch { // launch a new coroutine and continue
        delay(1000L) // non-blocking delay for 1 second (default time unit is ms)
        println("World!") // print after delay
    }
    println("Hello") // main coroutine continues while a previous one is delayed
}
```

Try It!: Coroutines

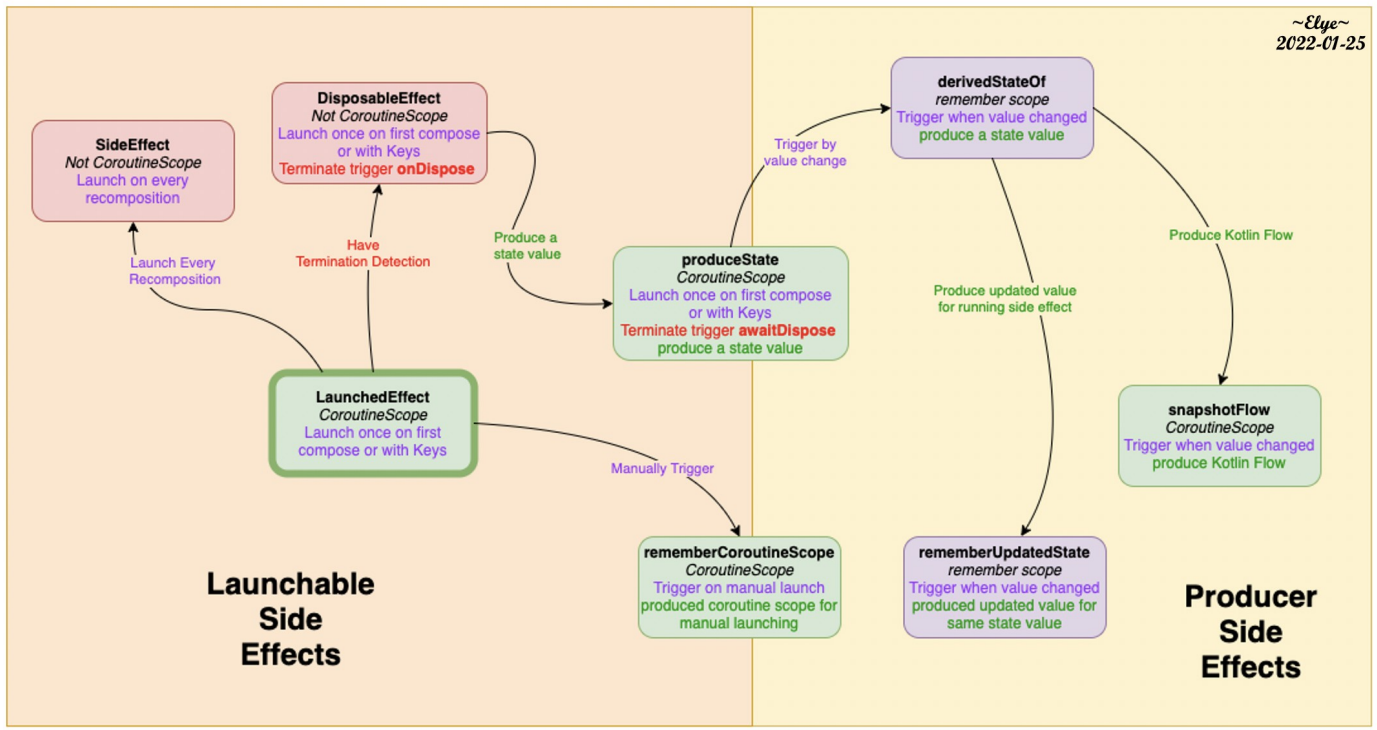
- Visit the following two web pages. Read the pages in detail and try out each code example in an IDE. Play around with it a bit to get a sense of how coroutines and flows work.
  - https://kotlinlang.org/docs/coroutines-basics.html
- Then, complete as much of these three codelabs as possible during remaining classtime.
  - https://developer.android.com/codelabs/basic-android-kotlin-compose-coroutines-kotlin-playground#3
  - https://developer.android.com/codelabs/basic-android-kotlin-compose-coroutines-android-studio
    - Don't do step 7 (unit tests)
- Other available labs/links:
  - https://developer.android.com/codelabs/kotlin-coroutines (not Compose)
  - https://www.baeldung.com/kotlin/coroutines

Side-Effects

- Side-effects: https://developer.android.com/jetpack/compose/side-effects
- https://medium.com/@mortitech/exploring-side-effects-in-compose-f2e8a8da946b
- https://proandroiddev.com/mastering-side-effects-in-jetpack-compose-b7ee46162c01

- https://www.composables.com/tutorials/side-effects

Jetpack Compose Side Effects (relating)



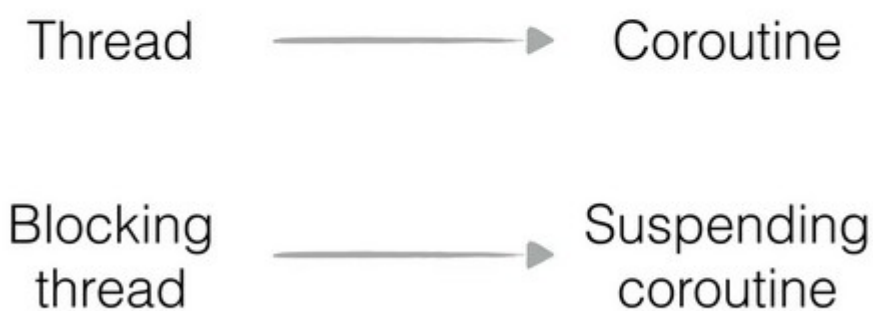
Flow

- Read:
  - https://kotlinlang.org/docs/flow.html#flows-are-cold

- Codelab:
  - https://developer.android.com/codelabs/jetpack-compose-advanced-state-side-effects

  - https://developer.android.com/codelabs/advanced-kotlin-coroutines

From threads to coroutines



Coroutine

computation that can be suspended

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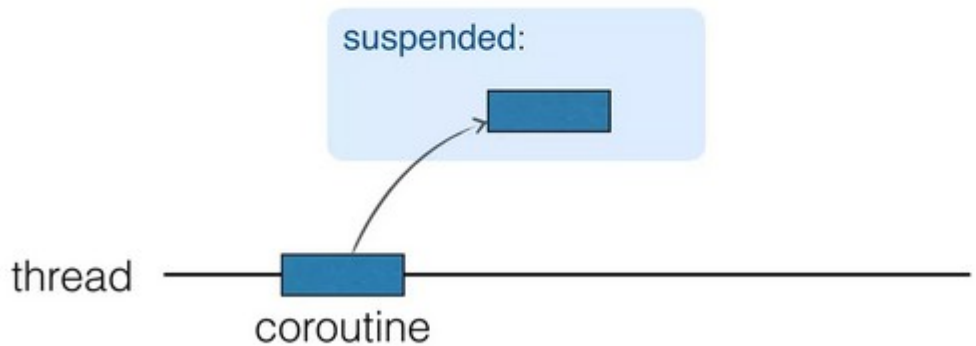
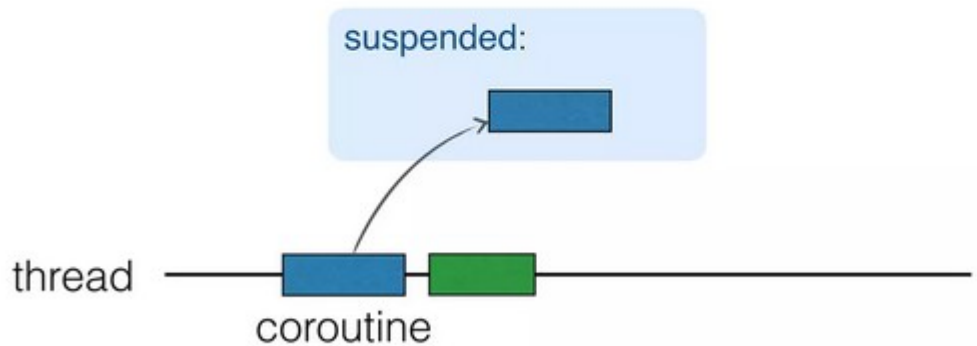


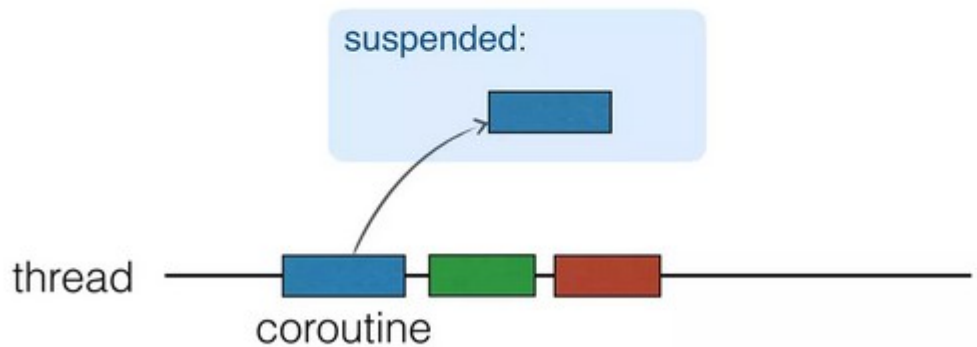
Coroutine

computation that can be suspended



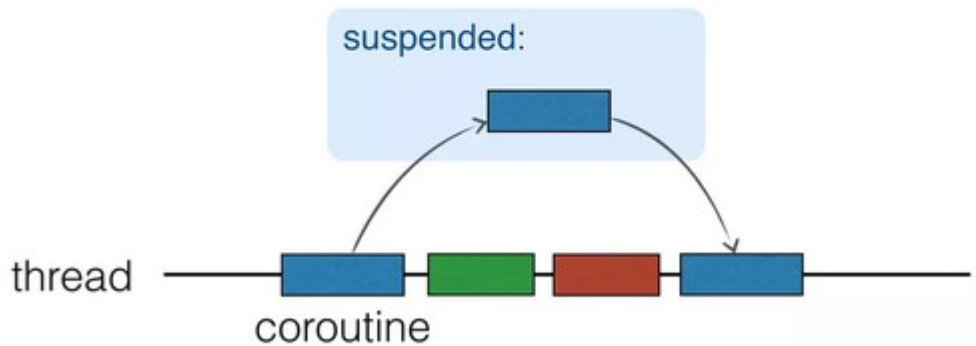
Coroutine

computation that can be suspended



Coroutine

computation that can be suspended



Thread is not blocked!

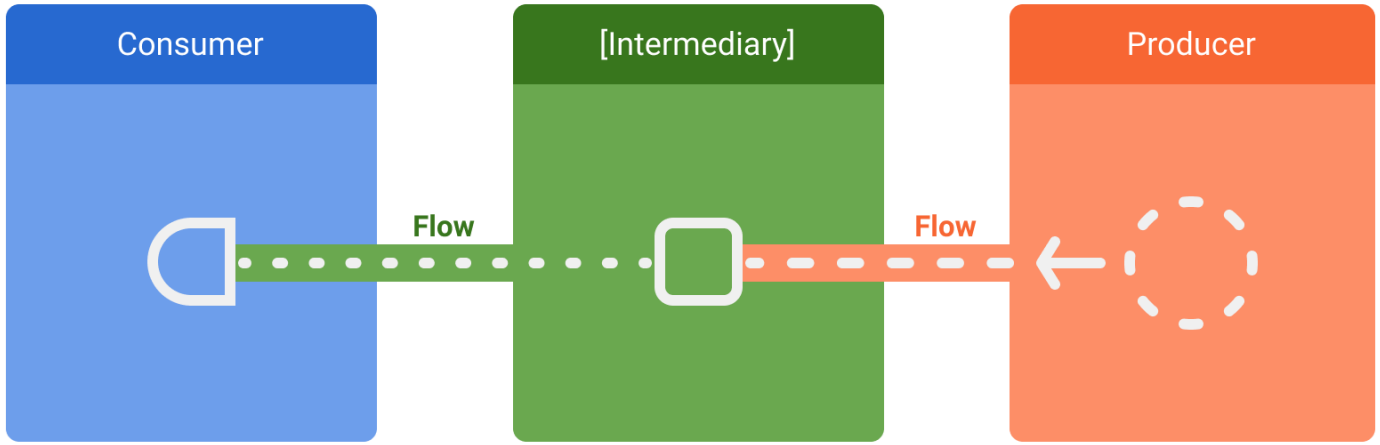
StateFlow

- StateFlow is a data holder observable flow that emits the current and new state updates.
  - Its value property reflects the current state value.
  - To update state and send it to the flow, assign a new value to the value property of the MutableStateFlow class
- In Android, StateFlow works well with classes that must maintain an observable immutable state.

Kotlin Flows

- A suspending function asynchronously returns a single value, but how can we return multiple asynchronously computed values? This is where Kotlin Flows come in.
- Using the List<Int> result type, means we can only return all the values at once.
  - To represent the stream of values that are being computed asynchronously, we can use a Flow<Int> type just like we would use a Sequence<Int> type for synchronously computed values:
- Let's review this page together:
  - https://kotlinlang.org/docs/flow.html
- Flows are cold streams similar to sequences — the code inside a flow builder does not run until the flow is collected.
- Terminal operators on flows are suspending functions that start a collection of the flow. The collect operator is the most basic one, but there are others such as toList(), toSet(), first(), reduce()
  - Calling toList() on a Flow collects all of the objects emitted by the Flow and returns them to you in a List.
- https://bladecoder.medium.com/kotlins-flow-in-viewmodels-it-s-complicated-556b472e281a
- https://developer.android.com/kotlin/flow
- https://developer.android.com/kotlin/flow/stateflow-and-sharedflow
- https://blog.canopas.com/7-useful-ways-to-create-flow-in-kotlin-577992b73315

Flow



Misc Flows

- collectAsState is an extension on StateFlow.
- Collects values from this StateFlow and represents its latest value via State.
- You need to handle the collection as per appropriate Lifecyle.

- You may see documentation online regarding LiveData. Kotlin does something different with its Flows
  - https://medium.com/androiddevelopers/migrating-from-livedata-to-kotlins-flow-379292f419fb

Flow: List vs non-List

- From ChatGPT (even more typing saved!)
- The difference between Flow<List<Frog>> and Flow<Frog> lies in the nature of the emitted values and the structure of the resulting flow.
- Flow<List<Frog>>:
  - This represents a flow that emits lists of Frog objects.
  - Each emission of the flow contains a list of Frog objects.
  - It is useful when you expect multiple Frog objects to be emitted together as a batch or collection.
  - For example, if you want to fetch a list of all frogs from a database and receive the entire list at once.
- Flow<Frog>:
  - This represents a flow that emits individual Frog objects.
  - Each emission of the flow contains a single Frog object.
  - It is useful when you want to process Frog objects one at a time or react to individual Frog objects as they are emitted.
  - For example, if you want to observe a stream of real-time updates for individual frogs in a dynamic manner.
- In summary, Flow<List<Frog>> emits lists of Frog objects, while Flow<Frog> emits individual Frog objects. The choice between the two depends on the specific use case and whether you need to work with batches of frogs or process them individually.

DataStore

- Simple walkthrough: https://medium.com/jetpack-composers/android-jetpack-datastore-5dfdfea4a3ea
- Room: https://developer.android.com/courses/pathways/android-basics-compose-unit-6-pathway-2
- https://developer.android.com/courses/pathways/android-basics-compose-unit-6-pathway-3
- https://developer.android.com/codelabs/android-preferences-datastore#7
- https://medium.com/androiddevelopers/all-about-preferences-datastore-cc7995679334
- https://developer.android.com/topic/libraries/architecture/datastore?gclid=CjwKCAiA55mPBhBOEiwANmzoQtX8aFaxx5WFTDOpYVN429tF3U8X3BnZu8ZMfJhRqGtyme_PzaypHhoCQDsQAvD_BwE&gclsrc=aw.ds#datastore-typed

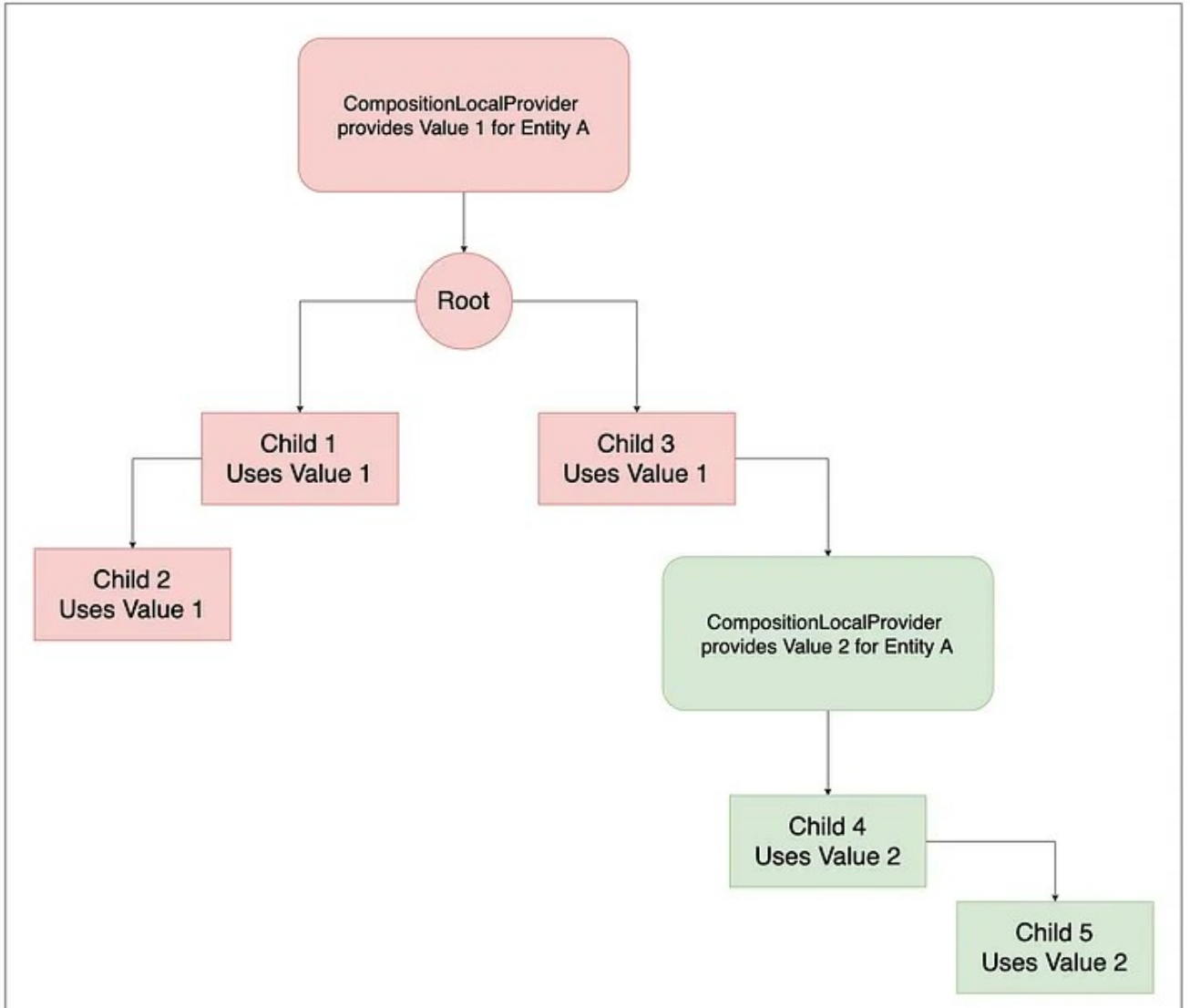
- https://android-developers.googleblog.com/2020/09/prefer-storing-data-with-jetpack.html
  - Nice walkthrough
- Firebase:
  - https://firebase.google.com/codelabs/build-android-app-with-firebase-compose#2

Error Handling

- https://levelup.gitconnected.com/error-handling-in-clean-architecture-using-flow-and-jetpack-compose-b39c729a68eb

Advanced: Provider Pattern: Interesting "Override" Behavior

- This may not be something we use in this course, but it is interesting
- In the example to the right, one CompositionLocalProvider is declared at the root level of the UI tree for A
  - Normally, the entire tree gets access to the provided instance of A.
- But, we can change this value, by wrapping a sub-tree under a new CompositionLocalProvider.
  - That way, the following sub-tree will use the latest value, and the earlier value will be overridden.
  - This only applies for the sub-tree which was wrapped – all the other nodes will keep on getting the value provided at the root level:



Misc

- FlowRow/FlowColumn: https://developer.android.com/jetpack/compose/layouts/flow
- Adaptive layouts: https://developer.android.com/jetpack/compose/layouts/adaptive