

CMPS 312



Model-View-ViewModel (MVVM) Architecture

Dr. Abdelkarim Erradi
CSE@QU

Outline

1. Model-View-ViewModel (MVVM)
2. ViewModel
3. LiveData
4. Data Binding

MVVM Architecture

Model-View-ViewModel (MVVM) Architecture

IMPORTANT

View = UI to get input from the user.

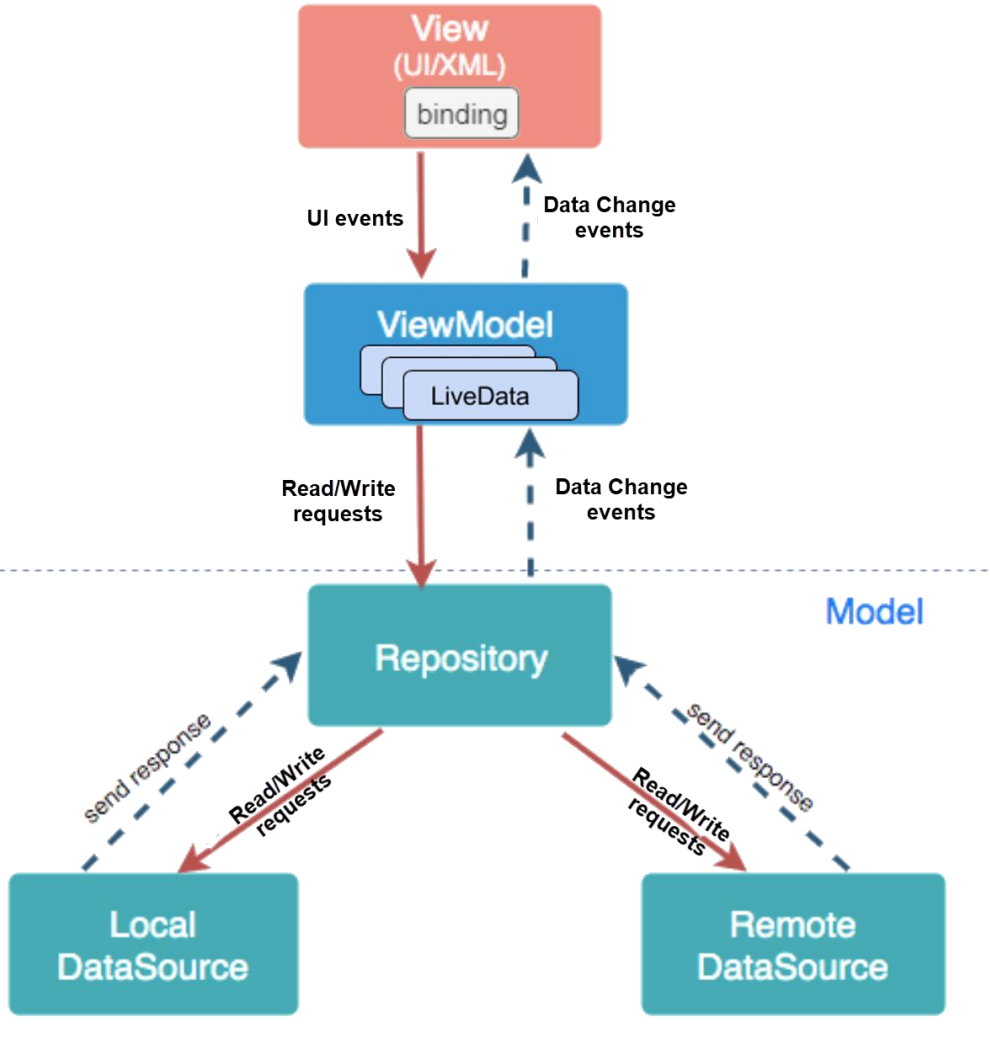
It observes data changes from the ViewModel to update the UI accordingly

ViewModel

- Holds data needed for the UI
 - Interacts with the Model to read/write data based on user input
 - Notifies the view of data changes
- Implements logic / computation

Model - handles data operations

- Model has **entities** that represent app data
- Repositories read/write data from either a Local Database (using [Room](#) library) or a Remote Web API (using [Retrofit](#) library)
- Implements data-related logic / computation



MVVM Key Principles

- Separation of concerns:
 - View, ViewModel, and Model are **separate components** with distinct roles
- Loose coupling:
 - ViewModel has no direct reference to the View
 - View never accesses the model directly
 - Model unaware of the view
- Observer pattern:
 - View observes the ViewModel
 - ViewModel observes the Model
- Inversion of Control: not be covered in this course
 - Uses Dependency Injection instead of direct instantiation of objects


Advantages of MVVM



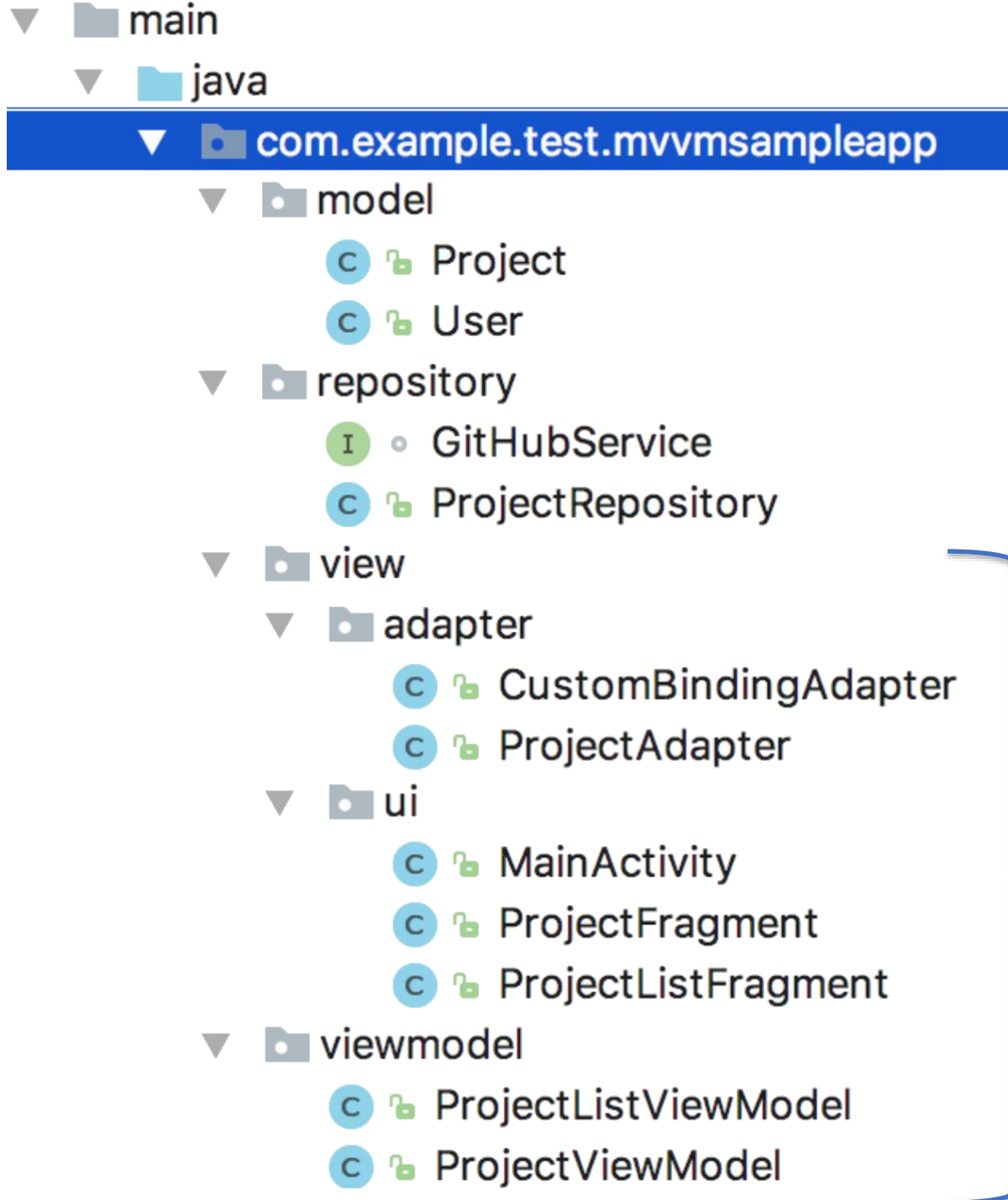
- ***Separation of concerns*** = separate ui from app logic
 - App logic is not intermixed with the UI. Consequently, code is cleaner, flexible and easier to understand and change
 - Allow changing a component without significantly disturbing the others (e.g., View can be completely changed without touching the model)
 - Easier **testing** of the App components

MVVM => Easily **maintainable** and **testable** app

Android Architecture Components

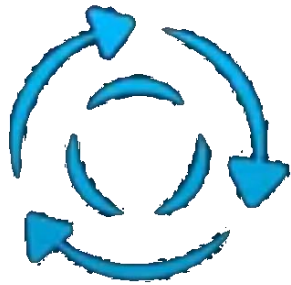
- Android architecture components are a collection of libraries to ease developing MVVM-based Apps
- Part of [Android Jetpack](#)  They include:
 - [ViewModel](#) stores UI-related data that isn't destroyed on screen rotation
 - [LiveData](#) data holder that notifies the View when the underlying data changes
 - [Data Binding](#) of objects to UI components to trigger UI updates when the data changes
 - [Room](#) to read / write data to local SQLite database

Recommended Project Structure



You may
organize the
view by feature

ViewModel



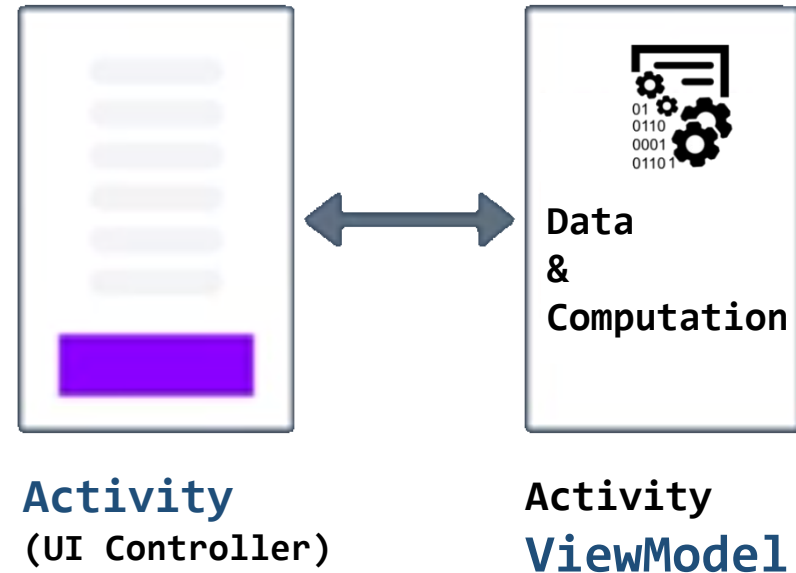
Lifecycle Aware



Survives Config Changes

ViewModel

- ViewModel is used to **store and manage UI-related data**
 - in a lifecycle conscious way
 - allows data to survive device configuration changes such as *screen rotations* or *changing the device's language*
- If the system destroys or recreates a UI Controller (e.g., when the screen rotates), any transient UI-related data you store in it is lost

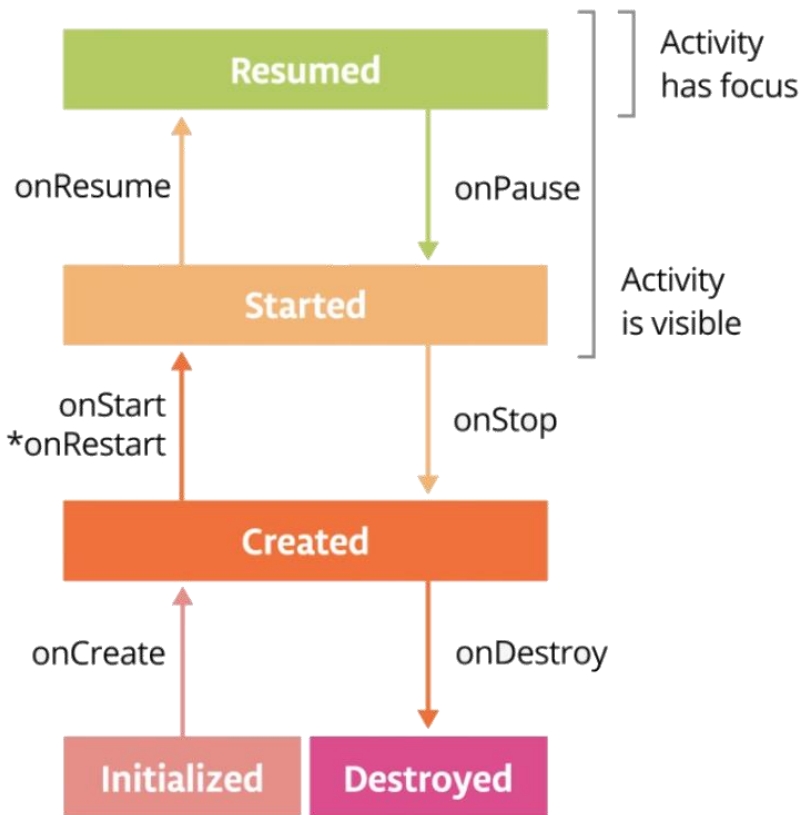


User **ViewModel**:

- Store UI data
- Read/write data from a Repository

Activity Lifecycle

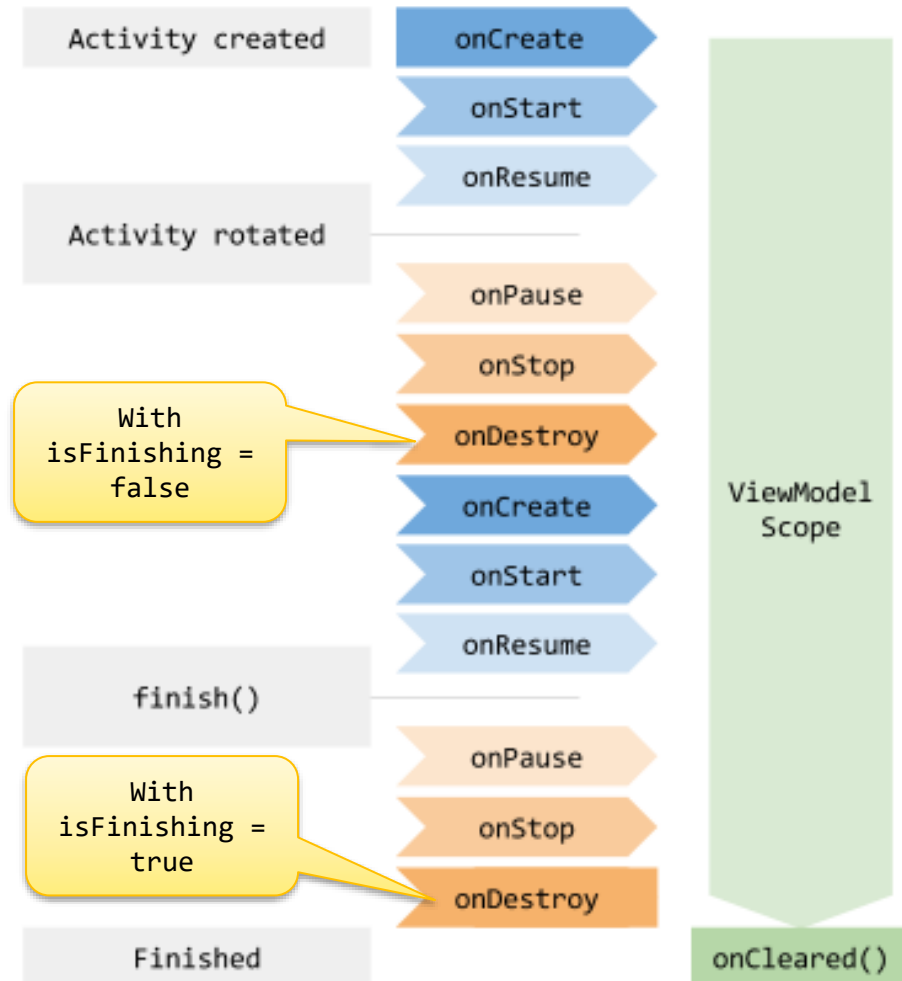
An activity has essentially **four** states:



- **Resumed** if the activity is in the foreground of the screen (has focus)
- **Started** if the activity has lost focus but is still visible (e.g., beneath a dialog box).
 - When the user returns to the activity, it is **resumed**
- **Created** if the activity is completely obscured by another activity.
 - When the user navigates to the activity, it must be **restarted** and restored to its previous state.
- **Destroyed** when the user closes the app or if the activity is killed (when memory is needed or due to `finish()` being called on the activity)

ViewModel Lifecycle

- ViewModel object is scoped to the activity in which it is created
- However, it has a **longer lifespan** compared to the associated Activity which may undergo a rotation and get recreated
- It remains in memory until the activity is completely destroyed
 - When the activity is recreated (after a screen rotation) the associated ViewModel remains alive



ViewModel Example

```
class MainActivityViewModel : ViewModel() {  
    var team1Score = 0  
    fun incrementTeam1Score() = team1Score++  
}
```

```
class MainActivity : AppCompatActivity() {  
    override fun onCreate(savedInstanceState: Bundle?) {  
        ...  
        // Associate the Activity with the ViewModel  
        val viewModel by viewModels<MainActivityViewModel>()  
        team1ScoreTv.text = viewModel.team1Score.toString()  
    }  
}
```

Associate the Activity and ViewModel

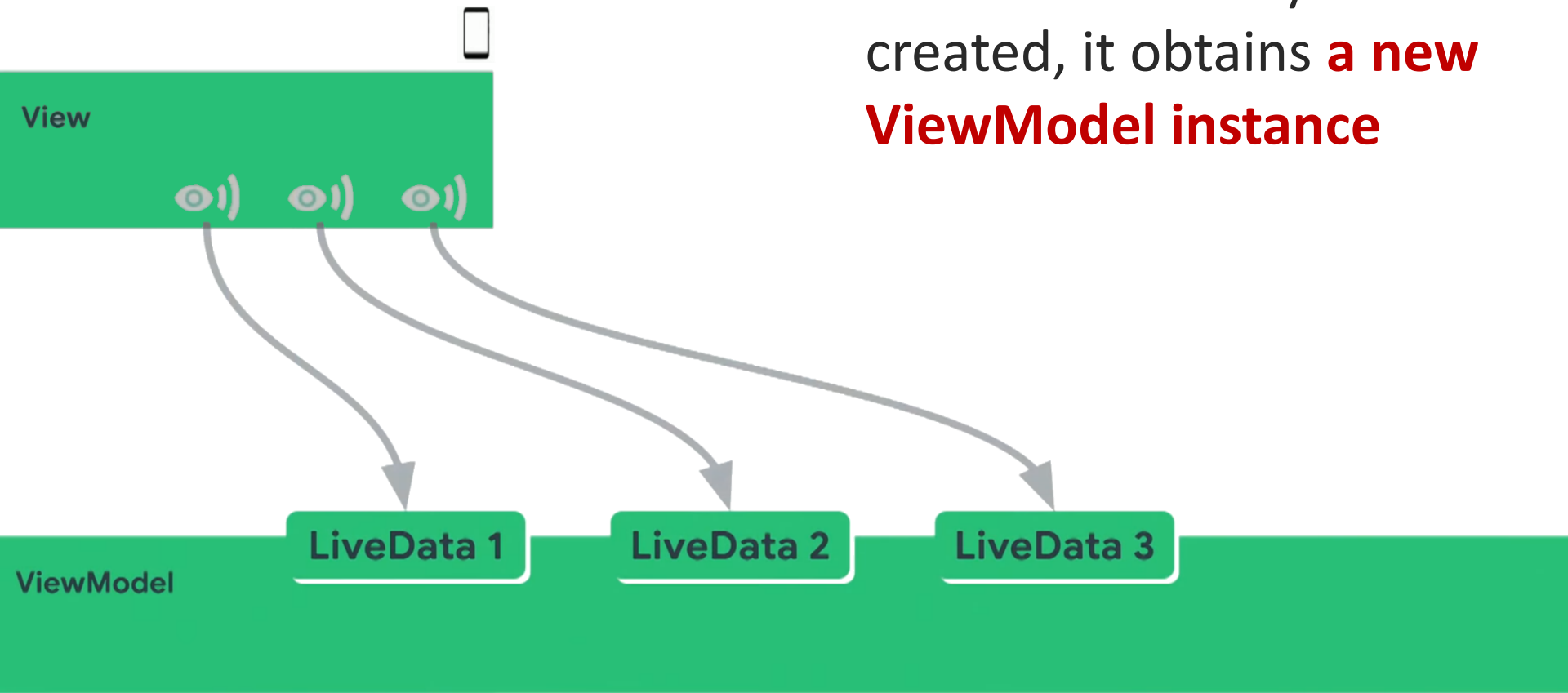
- The activity obtains an instance of the ViewModel using

```
val viewModel by viewModels<MainActivityViewModel>()
```

- For the first call, this creates and returns a new ViewModel instance
- For subsequent calls, which happens whenever onCreate is called, it will return the pre-existing ViewModel associated with the Activity (e.g., MainActivity)
 - This is what preserves the data and maintains the connection with the **same** ViewModel

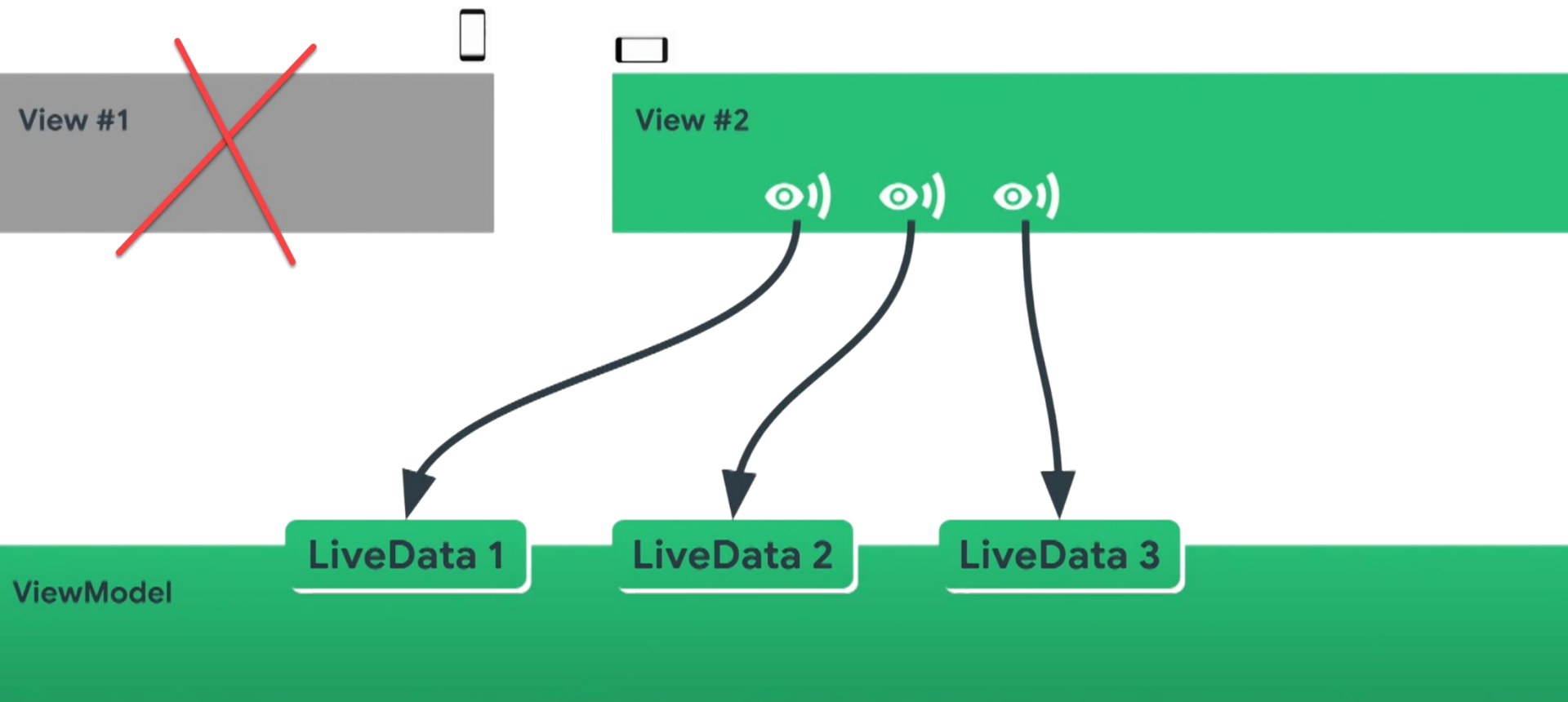
When the Activity is first Created

When the Activity is first created, it obtains **a new ViewModel instance**



OnConfig change (e.g., Screen Rotates)

OnConfig change, the Activity is destroyed, and a new instance of the Activity is created then it obtains **the same ViewModel instance used previously**



“no contexts in ViewModels” rule

- ViewModel should **not be aware of the View** who is interacting with
=> It should be **decoupled** from the View

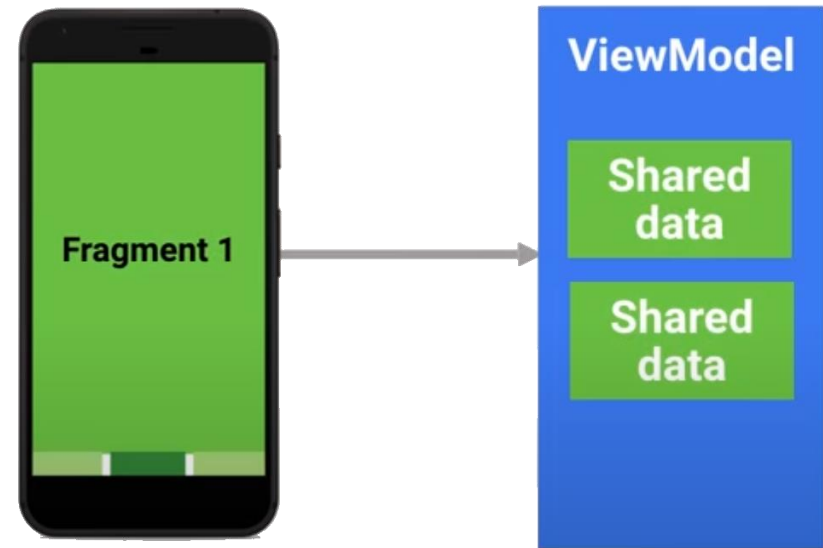


- ViewModel should not hold a reference to Activities, Fragments, or Views
- Should not have any Android framework related code
- As this defeats the purpose of separating the UI from the data
- Can lead to **memory leaks** and **crashes** (due to null pointer exceptions) as the ViewModel outlives the View
 - if you rotate an Activity 3 times, 3 three different Activity instances will be created, but you only have one ViewModel instance

Share data between fragments



- Fragments can **share** a **ViewModel** associated with the **activity**



```
class DetailFragment : Fragment() {  
    // Use the 'by activityViewModels()' to get a reference to the ViewModel  
    // associated with the activity  
  
    val viewModel = by activityViewModels<SharedViewModel>()  
}
```

Dependencies

// Add to - Module:app build.gradle

```
def lifecycle_version = "2.2.0"
// ViewModel
implementation "androidx.lifecycle:lifecycle-viewmodel-ktx:$lifecycle_version"
// LiveData
implementation "androidx.lifecycle:lifecycle-livedata-ktx:$lifecycle_version"

// Kotlin extensions - activity-ktx & fragment-ktx
def activity_version = "1.1.0"
implementation "androidx.activity:activity-ktx:$activity_version"
def fragment_version = "1.2.5"
implementation "androidx.fragment:fragment-ktx:$fragment_version"

// Configure using Java 8 - add Module:app/build.gradle under android { ...
compileOptions {
    sourceCompatibility JavaVersion.VERSION_1_8
    targetCompatibility JavaVersion.VERSION_1_8
}
kotlinOptions { jvmTarget = "1.8" }
```

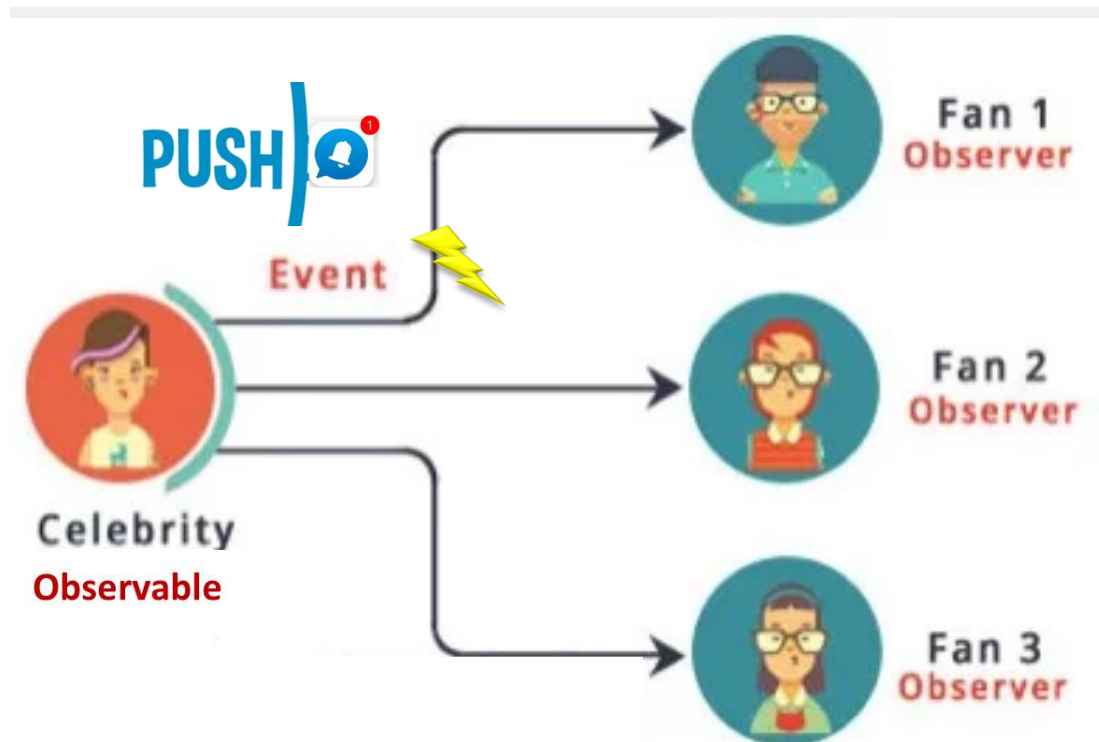
LiveData

LiveData

- LiveData is an **observable data holder**: **active** observers (i.e., the View) get notified when data change
- Activity/Fragment can observe LiveData objects for changes without creating **explicit and rigid dependency** between them
 - This decouples completely the LiveData object producer from the LiveData object consumer
 - ViewModel exposes its data using **LiveData** that the View can observe and update the UI accordingly

Observable - Real-Life Example

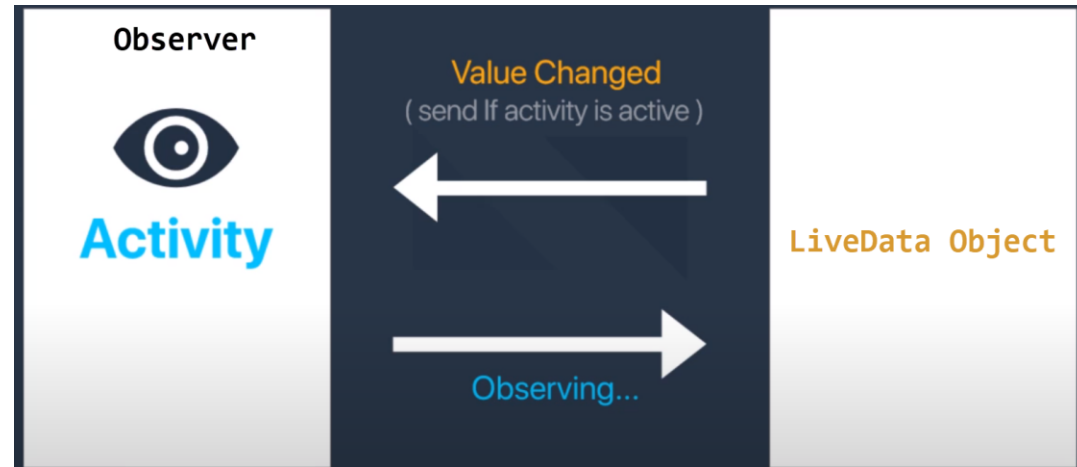
- A celebrity who has many fans on Instagram. Fans want to get all the latest updates (photos, videos, posts etc.). Here fans are **Observers** and celebrity is an **Observable** (called **LiveData** on Android)



LiveData is lifecycle-aware

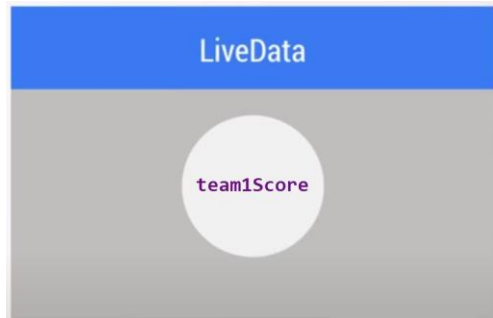
LiveData is aware of the Lifecycle of its Observer

- Notifies data changes to only **active** observers (Stopped/Destroyed activity/fragment will NOT receive updates)
- It automatically removes the subscription when the observer is destroyed so it will not get any updates



LiveData in Code

LiveData **warps around** an object and allows the view the **observe** it



↑
Observes



- ViewModel expose LiveData objects that the View can observe

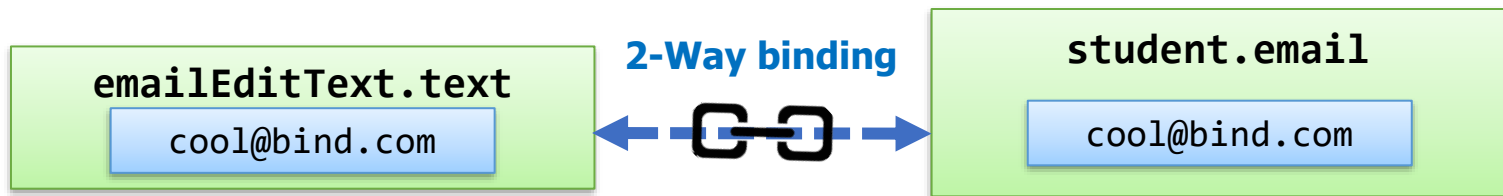
```
class MainActivityViewModel : ViewModel() {  
    private val _team1Score = MutableLiveData<Int>(0)  
  
    // Expose read only LiveData that the View can observe or bind to  
    val team1Score: LiveData<Int> get() = _team1Score  
  
    fun incrementTeam1Score() {  
        // call postValue to notify Observers  
        _team1Score.postValue((_team1Score.value ?: 0) + 1)  
    }  
}
```

- View **observes** LiveData changes

```
class MainActivity : AppCompatActivity() {  
    // onCreate  
    // Associate the Activity with the ViewModel  
    val viewModel by viewModels<MainActivityViewModel>()  
  
    viewModel.team1Score.observe(this) {  
        team1ScoreTv.text = it.toString()  
    }  
}
```



Data Binding



Data Binding

- Data Binding allows **declarative binding** UI components -in the activity/fragment layouts- to a data source (typically a LiveData object in the ViewModel)
 - rather than programmatically assigning values to the UI components
- Declaratively **binding** the text property of the TextView with the userName property of the user object

```
<TextView android:id="@+id/userName"  
          android:text="@{user.userName}" />
```

- Rather than programmatically assigning the values to UI components

```
userNameTv.text = user.userName
```

Enable Data Binding

- To enable data binding add to app / build.gradle

```
apply plugin: 'kotlin-kapt'
```

```
android {    ...
```

```
    buildTypes {    ...    }
```

```
        android.buildFeatures.databinding true
```

```
}
```

- To use data binding in a layout file, wrap the entire XML layout in a **<layout>** tag. Then add layout variables.

Transforming a Standard XML Layout Into a Data Binding Layout

```
<layout 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">
  <data>
    <variable
      name="profile"
      type="qa.edu.cmps312.mvvm.model.Profile" />
  </data>
  <androidx.constraintlayout.widget.ConstraintLayout
    android:layout_width="match_parent"
    android:layout_height="match_parent">

    <TextView
      android:id="@+id/firstName"
      ...
      android:text="@{profile.firstName}"
    />

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

Connecting the View with the ViewModel

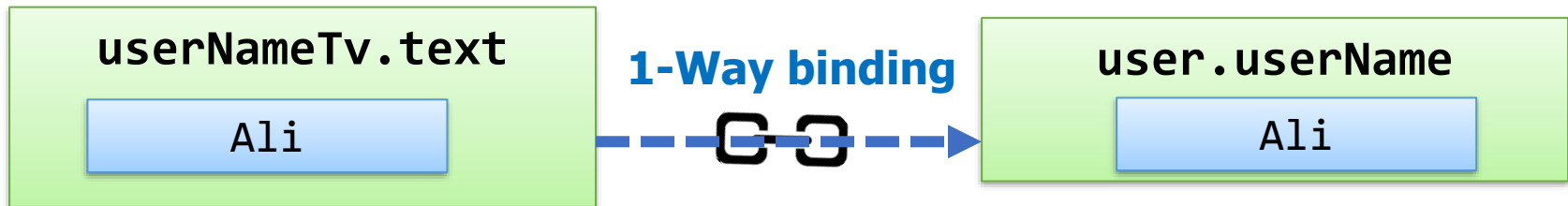
- onViewCreated obtain an instance of the **view Binding Class** (this class is auto-generated)
- Set the current fragment as the lifecycle owner of the obtained viewBinding
- Obtain a ViewModel instance using **activityViewModels** for shared viewModel scoped to the activity or using **viewModels** to get viewModel scoped to the fragment (if it is only used by the fragment)
- Bind the View with the viewModel

```
// onViewCreated(view: View, savedInstanceState: Bundle?)...  
// Obtain an instance of the view binding class  
val viewBinding = FragmentProfileBinding.bind(view)  
// Specify the current fragment as the lifecycle owner  
viewBinding.lifecycleOwner = this  
// Obtain a ViewModel instance scoped to activity  
val viewModel = by activityViewModels<ProfileViewModel>()  
// Bind the View with the viewModel.profile  
viewBinding.profile = viewModel.profile.value
```

Unidirectional Data Binding

- Data binding enables **synchronizing** UI with data source
 - The **target** listens for changes in the **source** and updates itself when the source changes
 - 1-Way binding syntax:

```
<TextView android:id="@+id/userName"  
    android:text="@{user.userName}" />
```

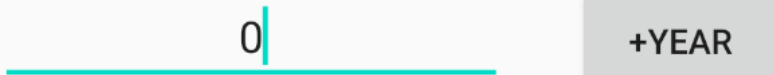


Binding Adapter

- Provide custom binding logic for an attribute
 - E.g., Hide UI component if the value associated with it is 0

```
@BindingAdapter("app:hideIfZero")
```

```
fun View.hideIfZero(value: Int) {  
    this.visibility = if (value == 0) View.GONE else View.VISIBLE  
}
```



Seniority icon is hidden
if the number of
yearsExperience = 0

```
<ImageView
```

```
    android:id="@+id/seniorityIv"
```

```
    ...
```

```
    app:hideIfZero="@{profile.yearsExperience}"/>
```


Binding Adapter [↗](#)

- Set icon and its color based on seniority

```
@BindingAdapter("app:seniorityIcon")
```

```
fun ImageView.popularityIcon(seniority: Seniority) {  
    val color = getSeniorityColor(seniority, this.context)  
    ImageViewCompat.setImageTintList(this, ColorStateList.valueOf(color))  
    this.setImageDrawable(getSeniorityIcon(seniority, this.context))  
}
```



```
<ImageView  
    android:id="@+id/seniorityIv"  
    ...  
    app:seniorityIcon="@{profile.seniority}" />
```

Binding expressions

- You may also use [Binding Expressions](#), but Binding Adapters are recommended to keep to view simpler. Also they are more reusable.

```
<TextView
    android:id="@+id/totalScoreTv"
    ...
    android:text="@{String.valueOf(viewModel.team1Score.intValue() + viewModel.team2Score.intValue())}"
    android:visibility="@{viewModel.team1Score.intValue() + viewModel.team2Score.intValue() > 0 ? View.VISIBLE : View.GONE}"
/>
```

Bidirectional Binding

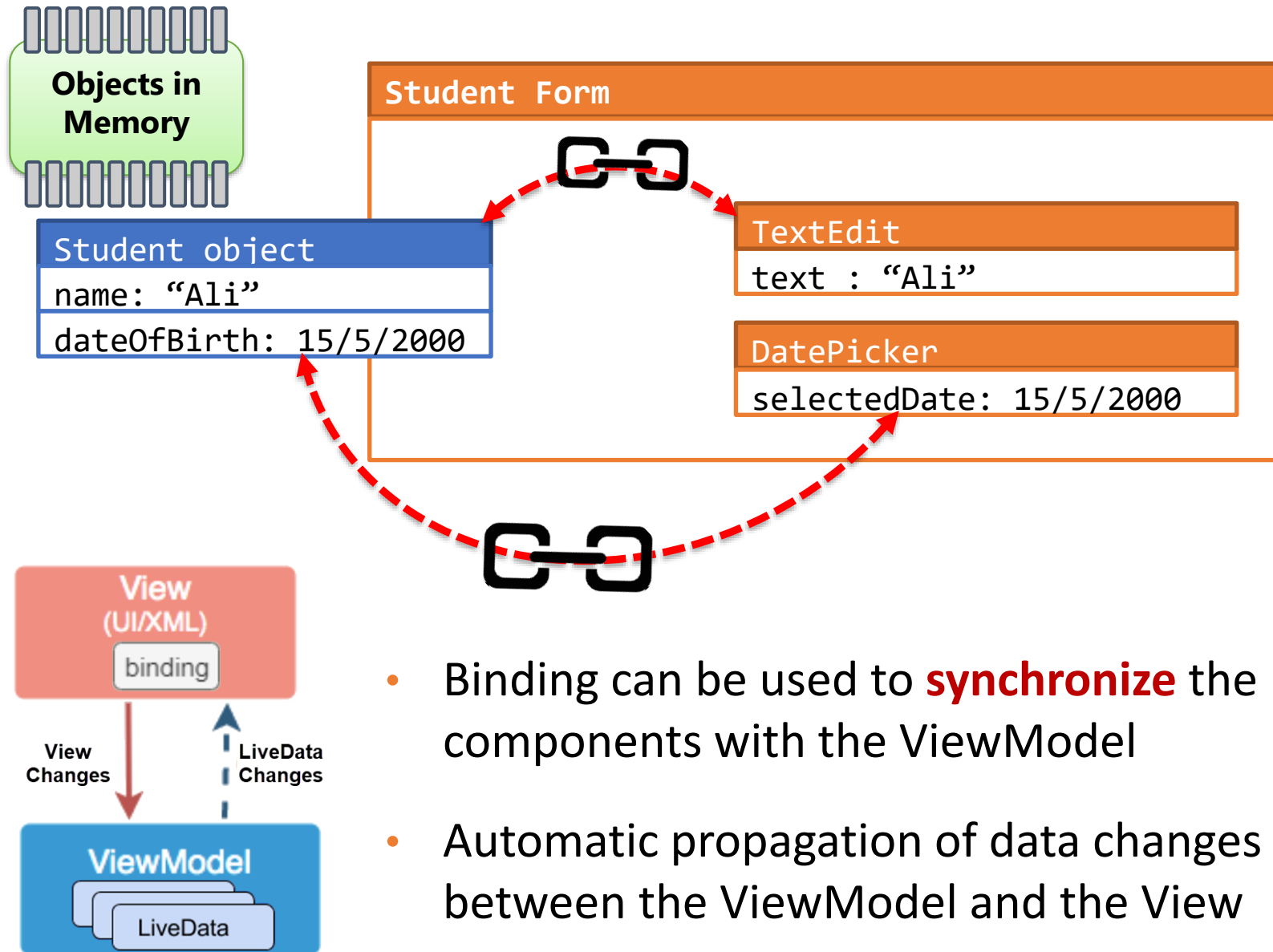
- Bidirectional (2-Way) Binding

```
<TextEdit android:id="@+id/userName"  
    android:text="@={user.userName}" />
```

- Any changes of **userNameTextEdit** text or the **user.userName** property will be synchronized



Two-way Binding UI Components Properties with Object Properties



- Binding can be used to **synchronize** the UI components with the ViewModel
- Automatic propagation of data changes between the ViewModel and the View

2-Way Binding requires the model to implement **BaseObservable**

- The model class must implement **BaseObservable** to notify the observers when property values change

```
data class Profile(private var _firstName: String,  
                  private var _lastName: String) : BaseObservable() {  
  
    @get:Bindable  
    var firstName  
        get() = _firstName  
        set(value) {  
            _firstName = value  
            notifyPropertyChanged(BR.firstName)  
        }  
  
    ... }
```

Resources

- MVVM
 - <https://developer.android.com/jetpack/guide>
 - <https://medium.com/androiddevelopers/viewmodels-a-simple-example-ed5ac416317e>
- Data Binding
 - <https://developer.android.com/topic/libraries/data-binding>
- Data Binding codelab
 - <https://codelabs.developers.google.com/codelabs/android-databinding>