

# CMPS 312



## Model-View-ViewModel (MVVM) Architecture

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# 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.

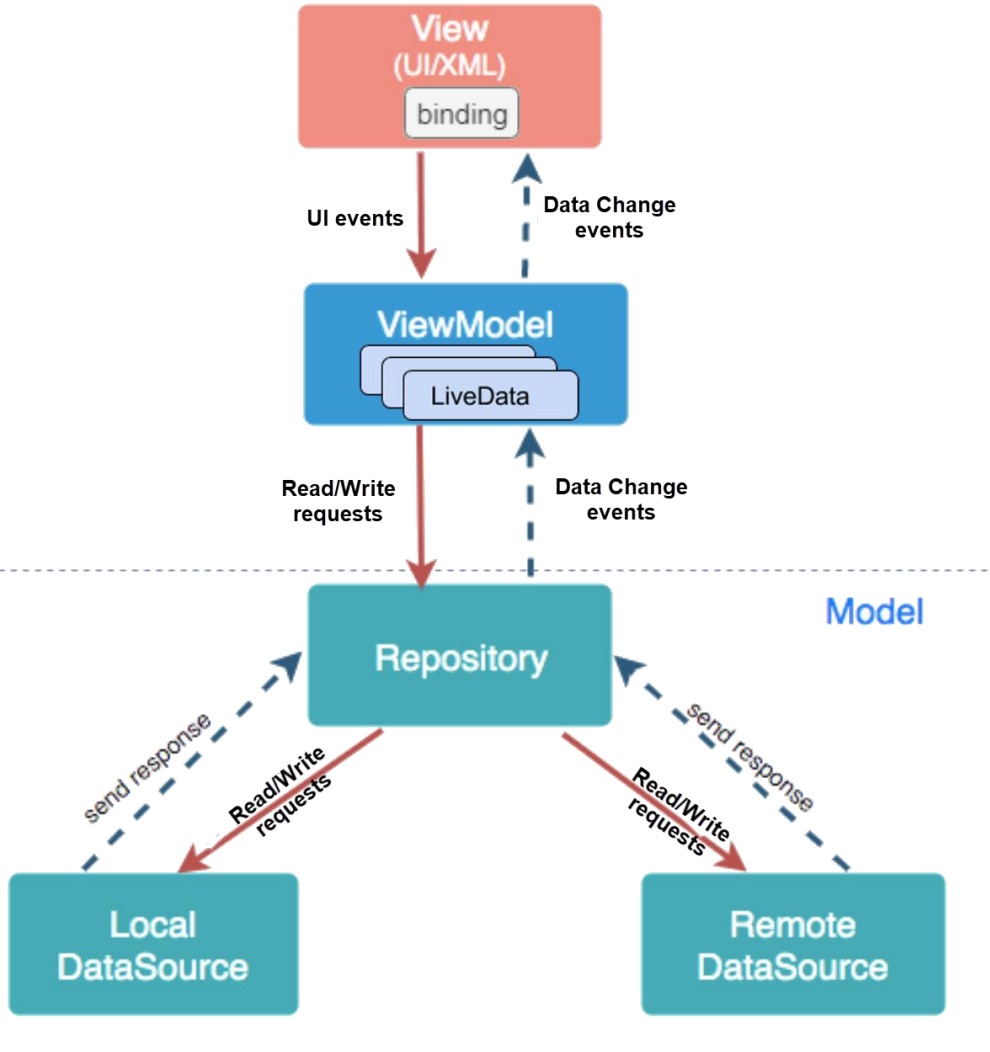
It observes data changes from the ViewModel to update the UI accordingly

## 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



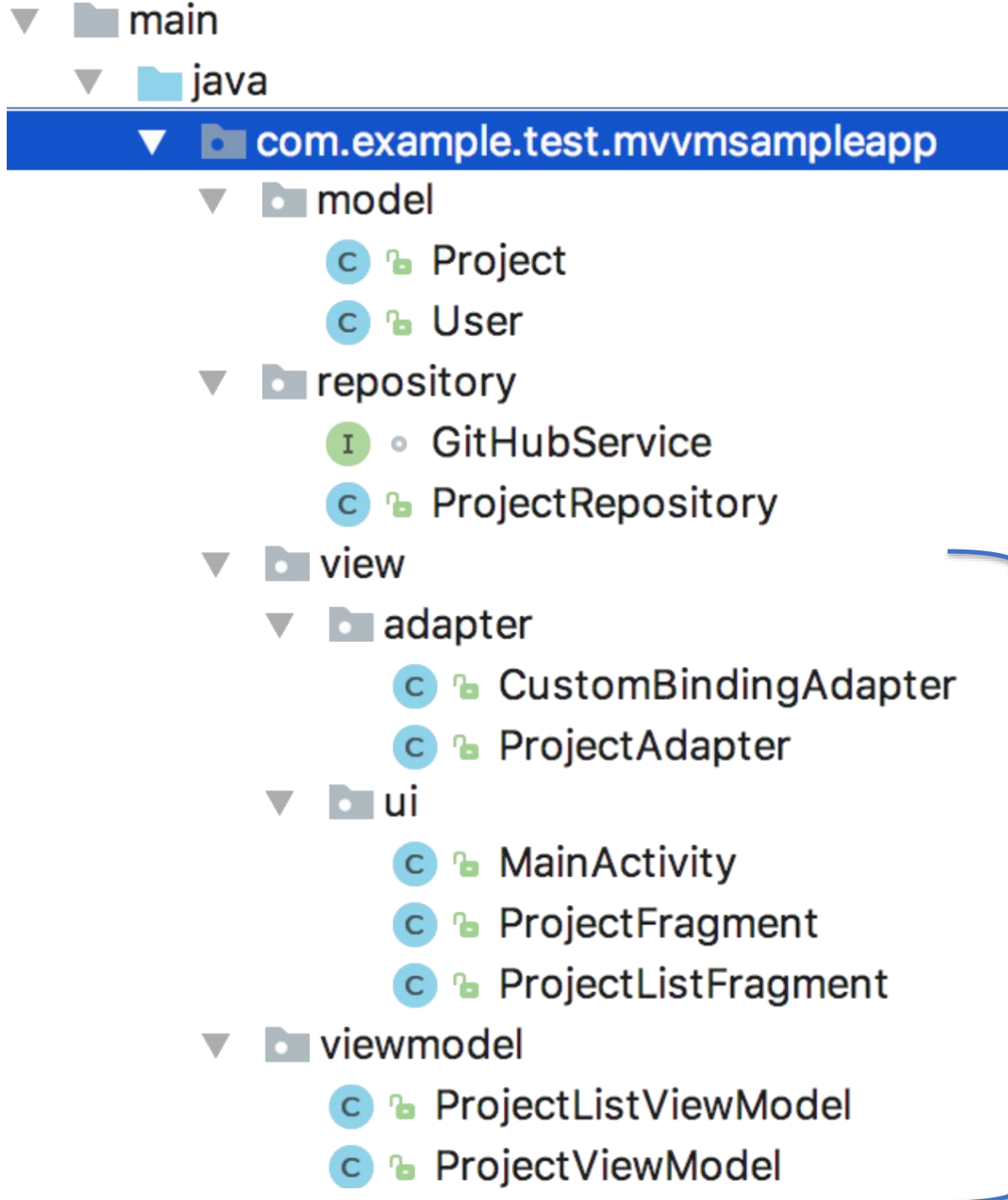
- ***Separation of concerns*** = separate ui from app logic
  - App logic is not intermixed with the UI. Consequently, code is cleaner, flexible and easier to understand and change
  - Allow changing a component without significantly disturbing the others (e.g., View can be completely changed without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

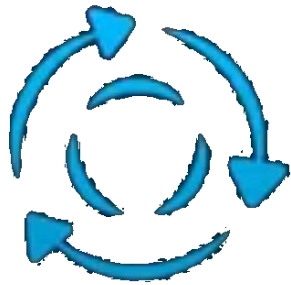
# Recommended Project Structure



You may  
organize the  
view by feature



# ViewModel



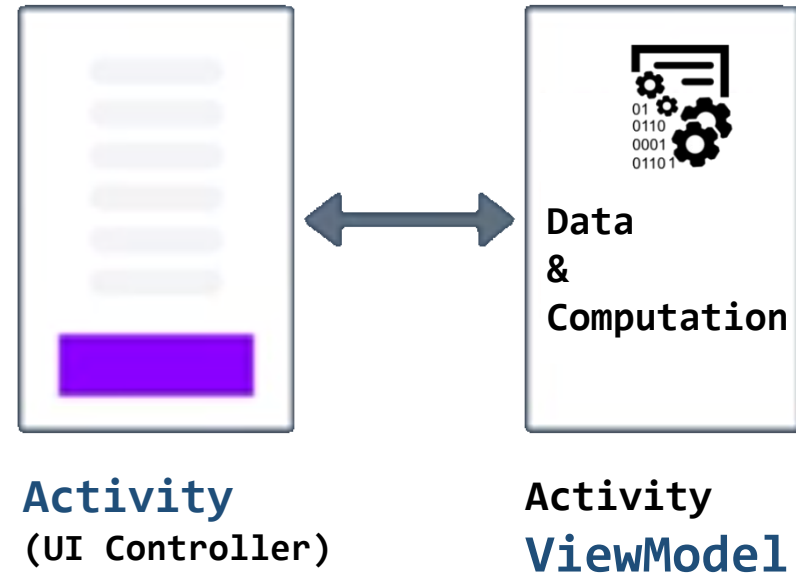
**Lifecycle Aware**



**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 re-creates a UI Controller (e.g., when the screen rotates), any transient UI-related data you store in it is lost



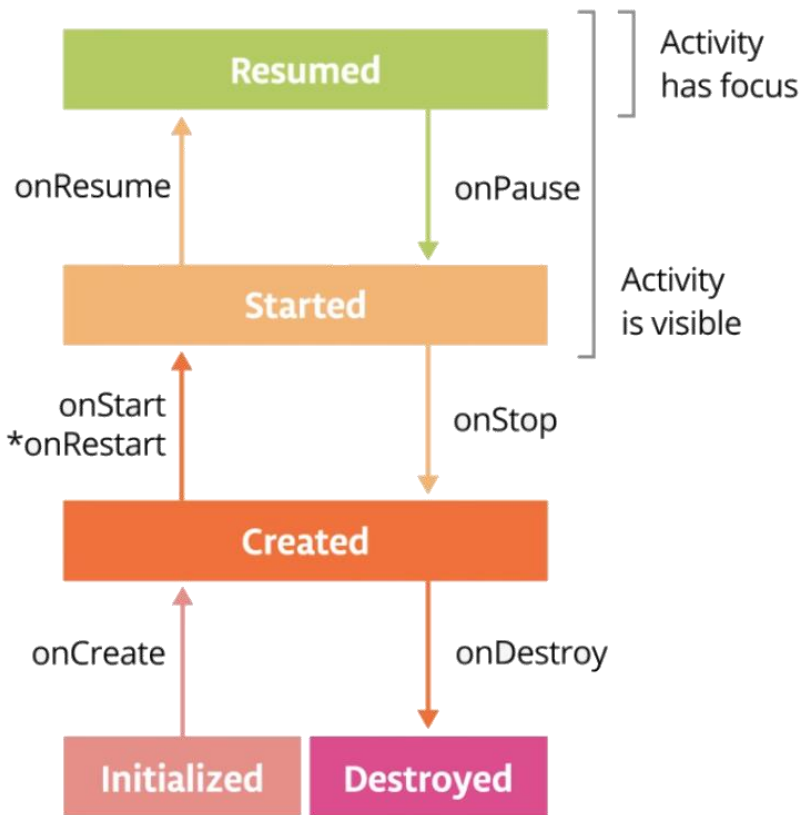
## User **ViewModel**:

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

# Activity Lifecycle

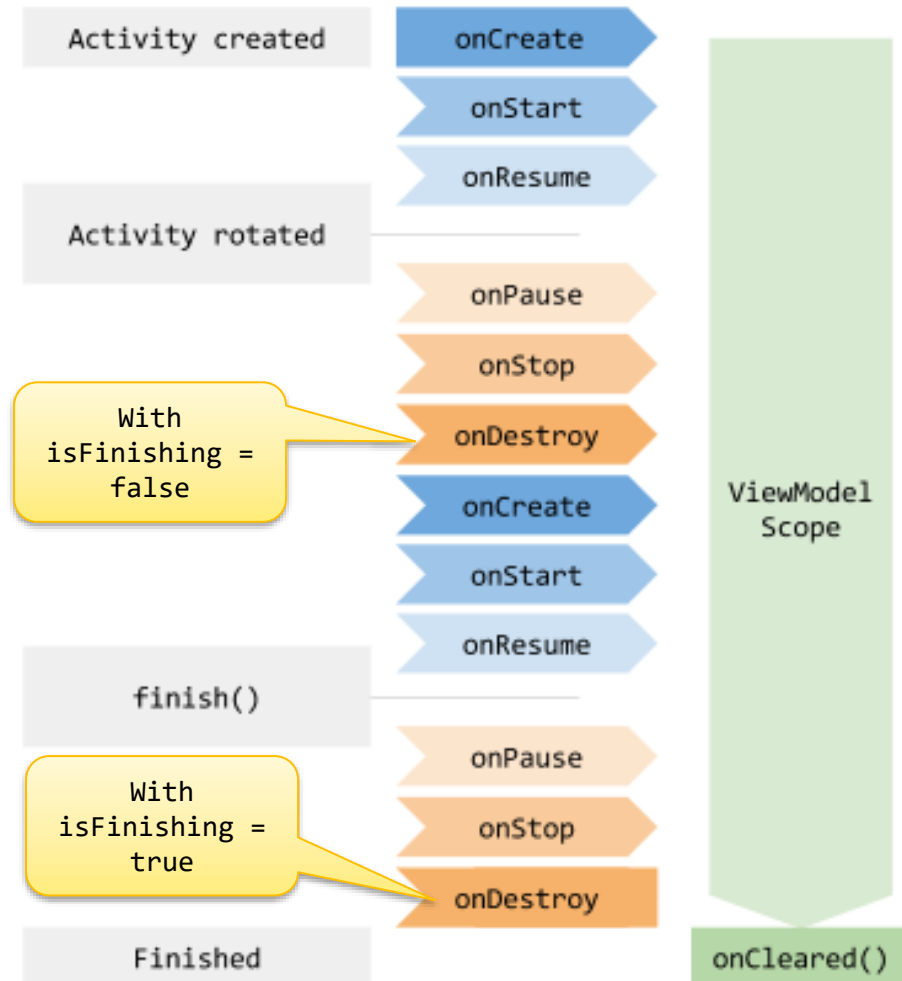
An activity has essentially **four** states:

- **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>()  
        //Or ViewModelProvider(<this activity>).get(<Your ViewModel>.class)  
        //val viewModel = ViewModelProvider(this).get(MainActivityViewModel::class.java)  
        team1ScoreTv.text = viewModel.team1Score.toString()  
    }  
}
```

# Associate the Activity and ViewModel

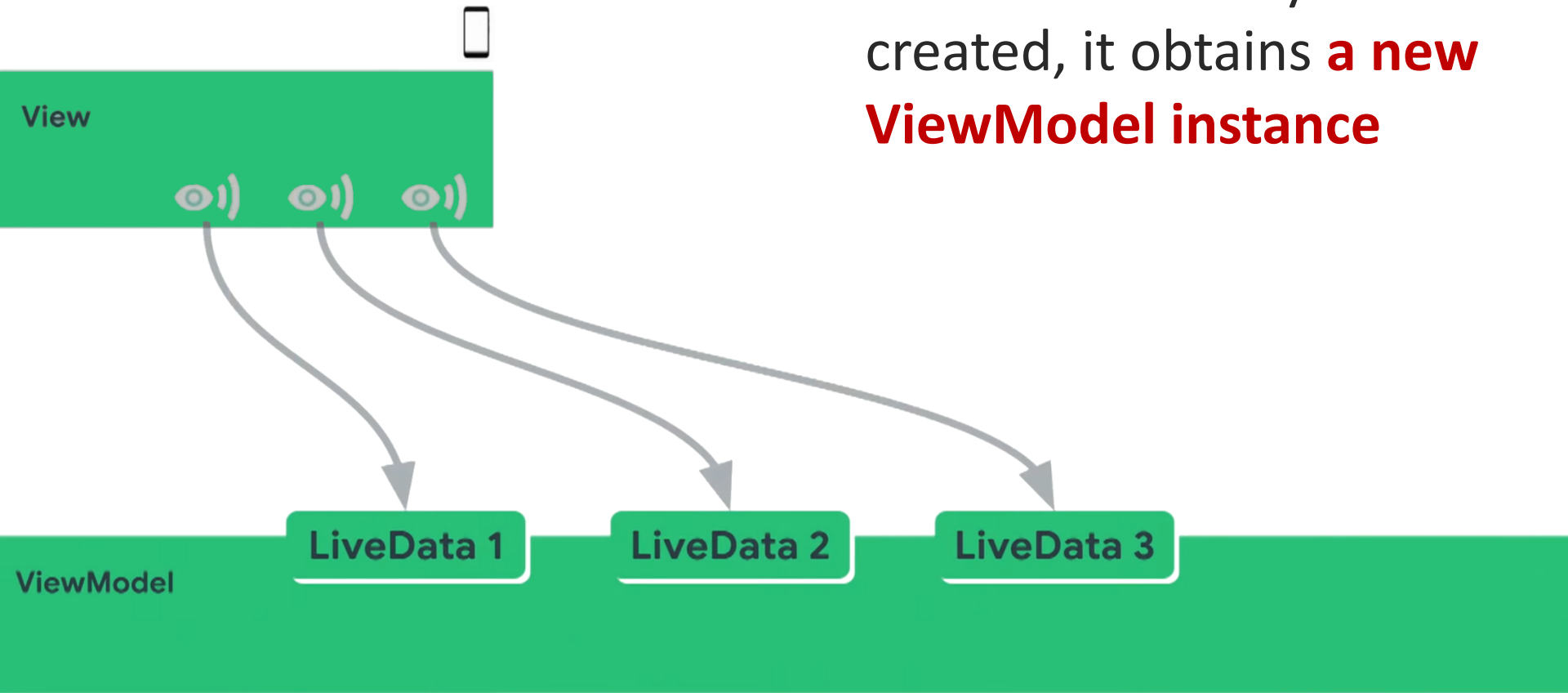
- The activity obtains an instance of the ViewModel using

```
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

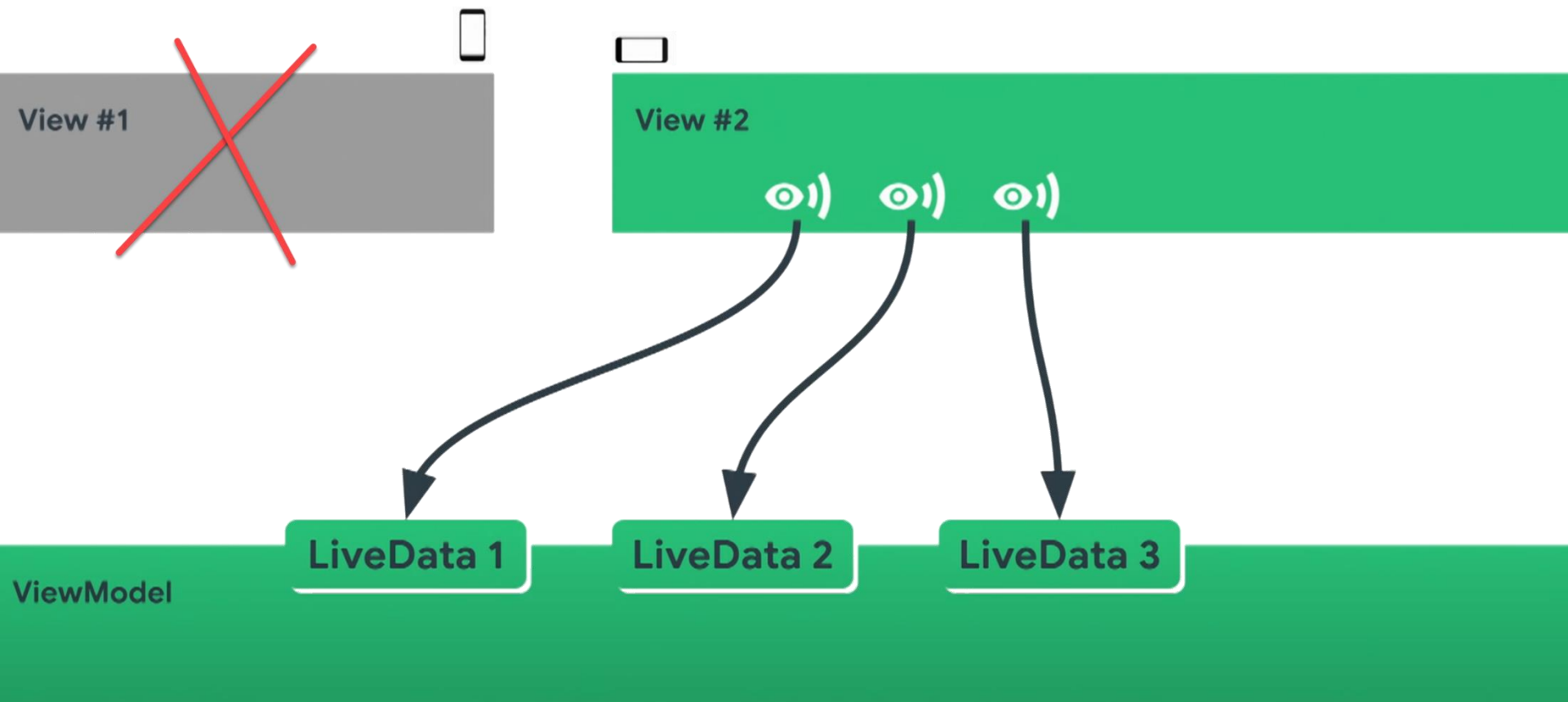
# When the Activity is first Created

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

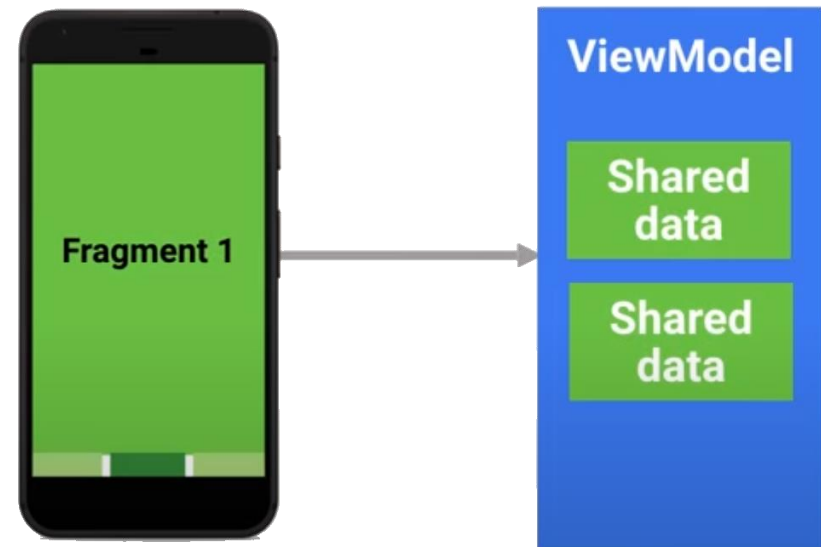


- ViewModel should not hold a reference to Activities, Fragments, or Views
- Should not have any Android framework related code
- As this defeats the purpose of separating the UI from the data
- Can lead to **memory leaks** and **crashes** (due to null pointer exceptions) as the ViewModel outlives the 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  
  
    private val model: SharedViewModel by activityViewModels()  
}
```

# 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" }
```

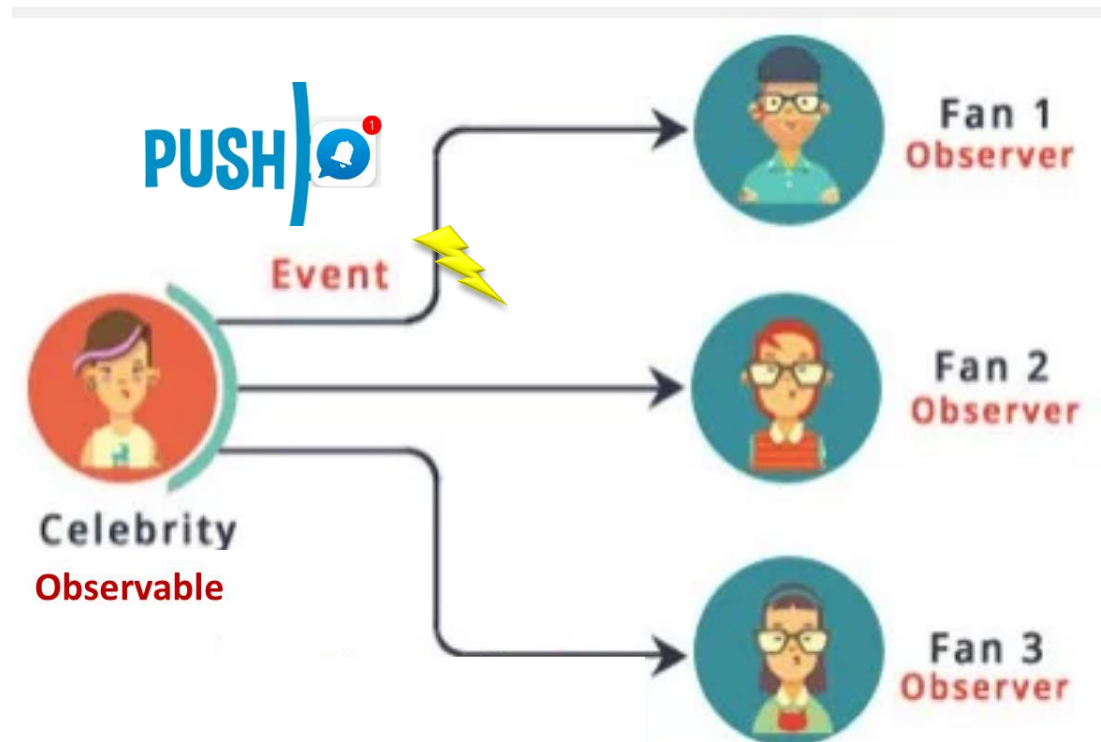
# LiveData

# 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

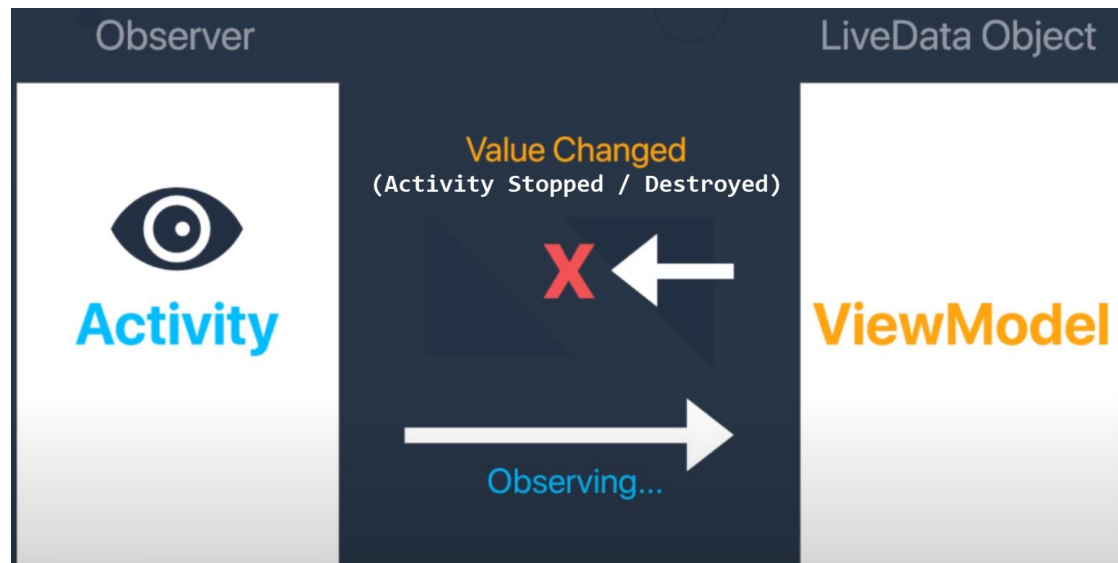
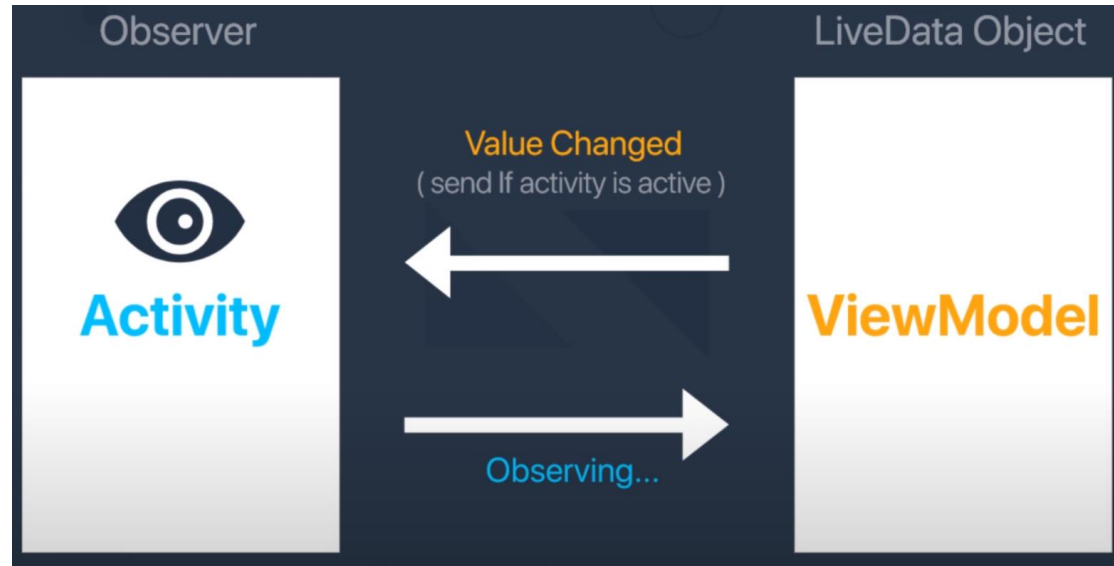
- A celebrity who has many fans on Instagram. Fans want to get all the latest updates (photos, videos, posts etc.). Here fans are **Observers** and celebrity is an **Observable** (called **LiveData** on Android)



# 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() {  
        _team1Score.value = _team1Score.value?.inc()  
    }  
}
```

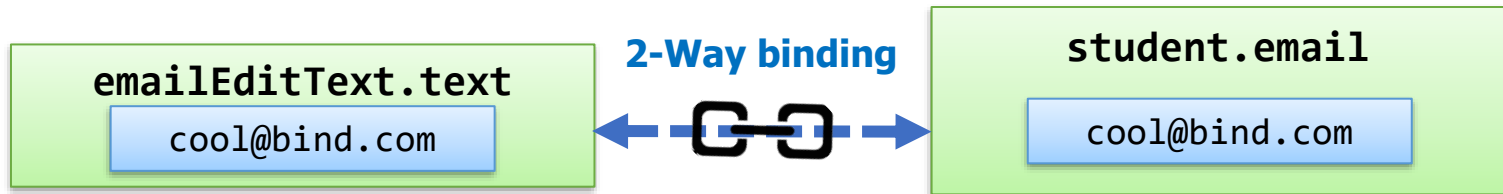
- View **observes** LiveData changes

```
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.

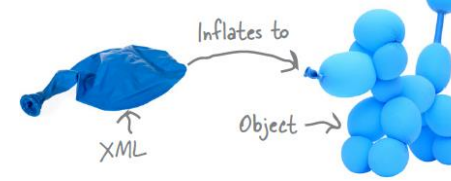
# Transforming a Standard XML Layout Into a Data Binding Layout

```
<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="viewModel"
            type="qa.edu.cmps312.mvvm.MainActivityViewModel" />
    </data>
    <androidx.constraintlayout.widget.ConstraintLayout
        android:layout_width="match_parent"
        android:layout_height="match_parent"
        tools:context=".MainActivity">

        <TextView
            android:id="@+id/team1ScoreTv"
            ...
            android:text="@{viewModel.team1Score}"
        />

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

# Inflating Layout with Bindings



- onCreate use **DataBindingUtil** to inflate the view layout and obtain an instance of the binding class **ActivityMainBinding**
- Specify the current activity as the binding lifecycle owner
- Associate the Activity with the ViewModel
- Bind the layout with ViewModel

```
// onCreate
```

```
...
```

```
val binding: ActivityMainBinding = DataBindingUtil.setContentView(this,  
    R.layout.activity_main  
)
```

```
// Specify the current activity as the lifecycle owner of the binding instance
```

```
binding.lifecycleOwner = this
```

```
// Associate the Activity with the ViewModel
```

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

```
// Bind layout with ViewModel
```

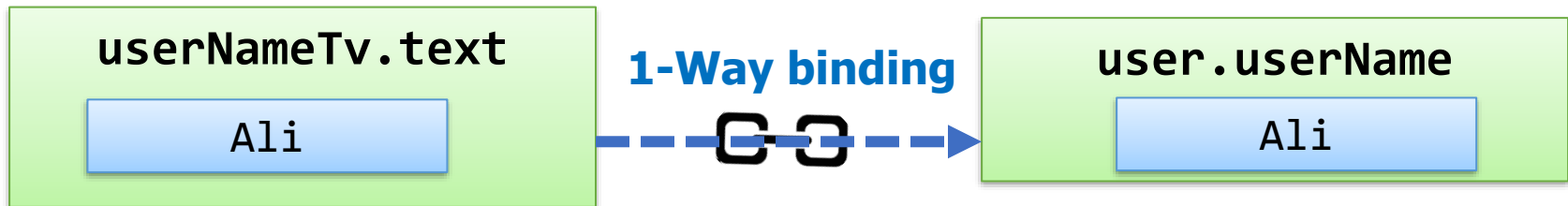
```
binding.viewModel = viewModel
```

```
}
```

# 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., 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 Adapter

- Hide UI component is 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}"/>
```



# Bidirectional Binding

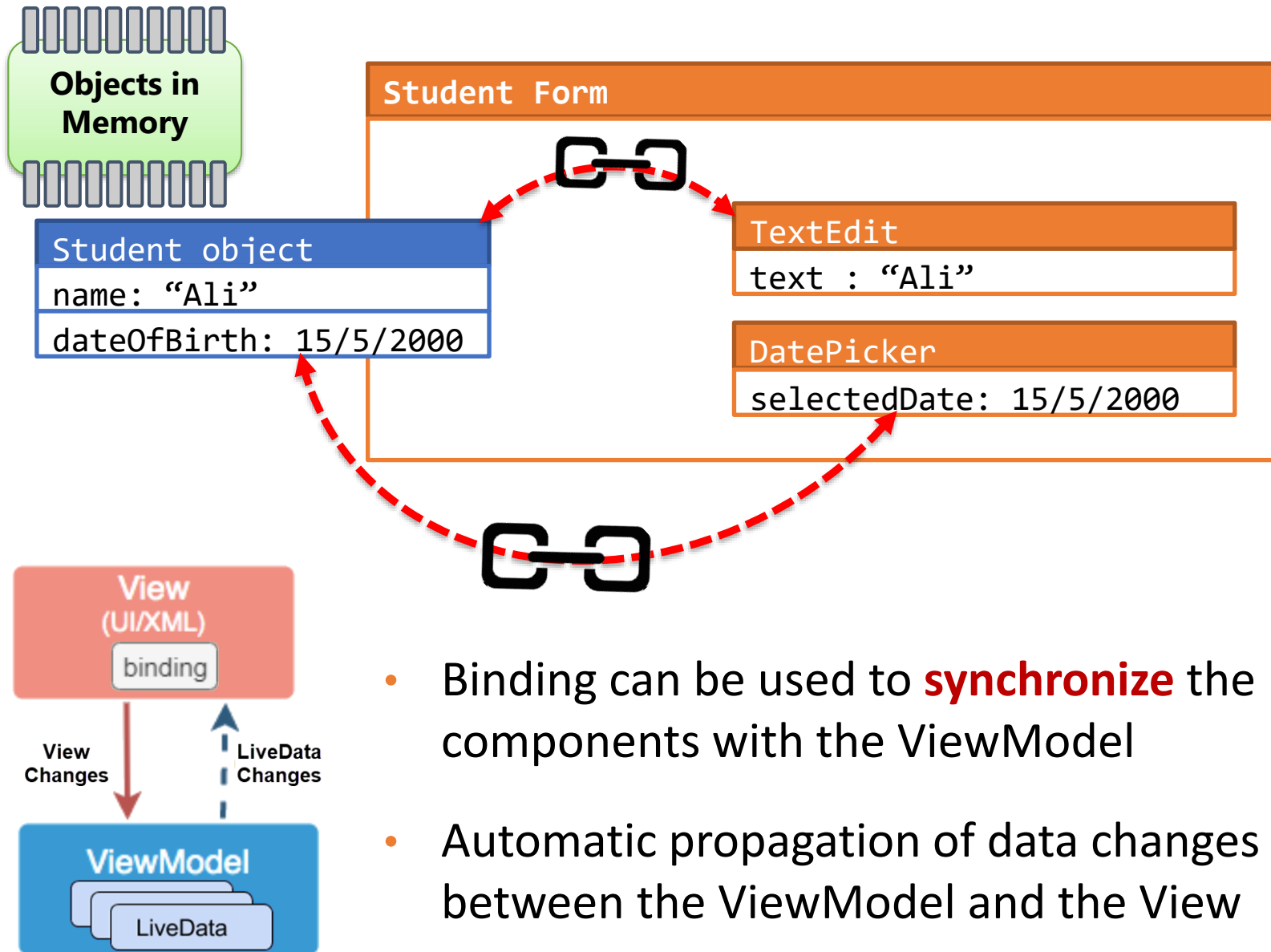
- Bidirectional (2-Way) Binding

```
<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)
        }

    @get:Bindable
    var lastName
        get() = _lastName
        set(value) {
            _lastName = value
            notifyPropertyChanged(BR.lastName)
        }
}
```

# 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>