Lecture #4
Local Persistence & Architecture Components

Mobile Applications 2019-2020

Local Persistence Options

- Internal storage
  - Internal cache files
- External storage
- Shared preferences
- **Databases**

https://developer.android.com/guide/topics/data/

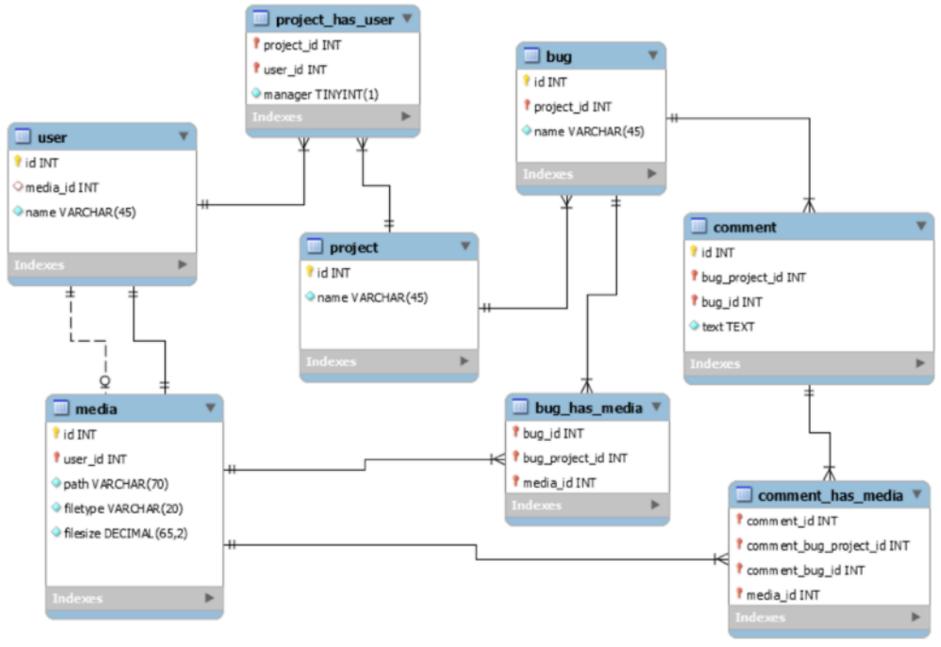
Options

- **SQLite**
- **Realm**
- **Room**

SQLite

Define a schema and a contract

```
object FeedReaderContract {
  // Table contents are grouped
  // together in an anonymous object.
  object FeedEntry : BaseColumns {
    const val TABLE_NAME = "entry"
    const val COLUMN_NAME_TITLE =
      "title"
    const val COLUMN_NAME_SUBTITLE =
      "subtitle"
  }
}
```



https://developer.android.com/training/data-storage/sqlite

SQLite Helper

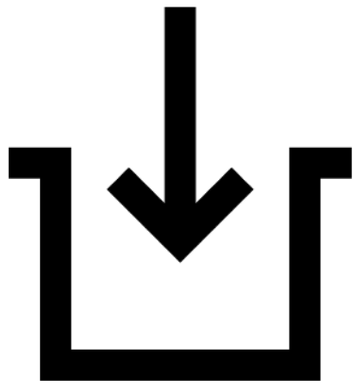
Create a database using an SQL helper

```
private const val SQL_CREATE_ENTRIES = """
 CREATE TABLE ${FeedEntry.TABLE_NAME} (
  ${BaseColumns._ID} INTEGER PRIMARY KEY,
  ${FeedEntry.COLUMN_NAME_TITLE} TEXT,
  ${FeedEntry.COLUMN_NAME_SUBTITLE} TEXT)
"""

private const val SQL_DELETE_ENTRIES =
 "DROP TABLE IF EXISTS ${FeedEntry.TABLE_NAME}"
```

SQLite

```
class FeedReaderDbHelper(context: Context) :
    SQLiteOpenHelper(context, DATABASE_NAME, null, DATABASE_VERSION) {
  override fun onCreate(db: SQLiteDatabase) {
    db.execSQL(SQL_CREATE_ENTRIES)
  }
  override fun onUpgrade(db: SQLiteDatabase, oldVersion: Int, newVersion: Int) {
    // This database is only a cache for online data, so its upgrade policy is
    // to simply to discard the data and start over
    db.execSQL(SQL_DELETE_ENTRIES)
    onCreate(db)
  }
  override fun onDowngrade(db: SQLiteDatabase, oldVersion: Int, newVersion: Int) {
    onUpgrade(db, oldVersion, newVersion)
  }
  companion object {
    // If you change the database schema, you must increment the database version.
    const val DATABASE_VERSION = 1
    const val DATABASE_NAME = "FeedReader.db"
  }
}
```

SQLite - Insert



```
// Gets the data repository in write mode
val db = dbHelper.writableDatabase

// Create a new map of values, where column names are the keys
val values = ContentValues().apply {
    put(FeedEntry.COLUMN_NAME_TITLE, title)
    put(FeedEntry.COLUMN_NAME_SUBTITLE, subtitle)
}
// Insert the new row, returning the primary key value of the new row
val newRowId = db?.insert(FeedEntry.TABLE_NAME, null, values)
```

```
val dbHelper = FeedReaderDbHelper(context)
```

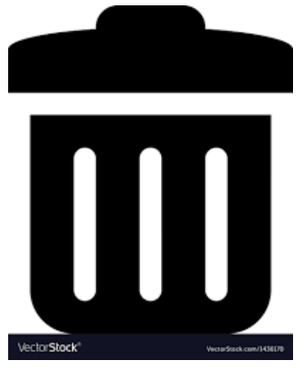
SQLite - Query

```
val dbHelper = FeedReaderDbHelper(context)
val db = dbHelper.readableDatabase
// Define a projection that specifies which columns from the database
// you will actually use after this query.
val projection = arrayOf(
  BaseColumns._ID,
  FeedEntry.COLUMN_NAME_TITLE,
  FeedEntry.COLUMN_NAME_SUBTITLE)
// Filter results WHERE "title" = 'My Title'
val selection = "${FeedEntry.COLUMN_NAME_TITLE} = ?"
val selectionArgs = arrayOf("My Title")
// How you want the results sorted in the resulting Cursor
val sortOrder = "${FeedEntry.COLUMN_NAME_SUBTITLE} DESC"
val cursor = db.query(
        FeedEntry.TABLE_NAME,   // The table to query
        projection,             // The array of columns
                                // to return (pass null to get all)
        selection,              // The columns for the WHERE clause
        selectionArgs,          // The values for the WHERE clause
        null,                   // don't group the rows
        null,                   // don't filter by row groups
        sortOrder               // The sort order
)
```

SQLite - Query

```
val dbHelper = FeedReaderDbHelper(context)

val db = dbHelper.readableDatabase
val projection = arrayOf(...)
val selection = "${FeedEntry.COLUMN_NAME_TITLE} = ?"
val selectionArgs = arrayOf("My Title")
val sortOrder = "${FeedEntry.COLUMN_NAME_SUBTITLE} DESC"
val cursor = db.query(...)

val itemIds = mutableListOf<Long>()
with(cursor) {
    while (moveToNext()) {
        val itemId = getLong(getColumnIndexOrThrow(BaseColumns._ID))
        itemIds.add(itemId)
    }
}
```

SQLite - Delete




```
val dbHelper = FeedReaderDbHelper(context)
val db = dbHelper.writableDatabase
// Define 'where' part of query.
val selection = "${FeedEntry.COLUMN_NAME_TITLE} LIKE ?"
// Specify arguments in placeholder order.
val selectionArgs = arrayOf("MyTitle")
// Issue SQL statement.
val deletedRows = db.delete(FeedEntry.TABLE_NAME, selection, selectionArgs)
```

SQLite - Update

```
val dbHelper = FeedReaderDbHelper(context)
val db = dbHelper.writableDatabase

// New value for one column
val title = "MyNewTitle"
val values = ContentValues().apply {
    put(FeedEntry.COLUMN_NAME_TITLE, title)
}

// Which row to update, based on the title
val selection = "${FeedEntry.COLUMN_NAME_TITLE} LIKE ?"
val selectionArgs = arrayOf("MyOldTitle")
val count = db.update(
        FeedEntry.TABLE_NAME,
        values,
        selection,
        selectionArgs)
```

SQLite - Management

```
val dbHelper = FeedReaderDbHelper(context)
```

```
val db = dbHelper.writableDatabase
```

```
val db = dbHelper.readableDatabase
```

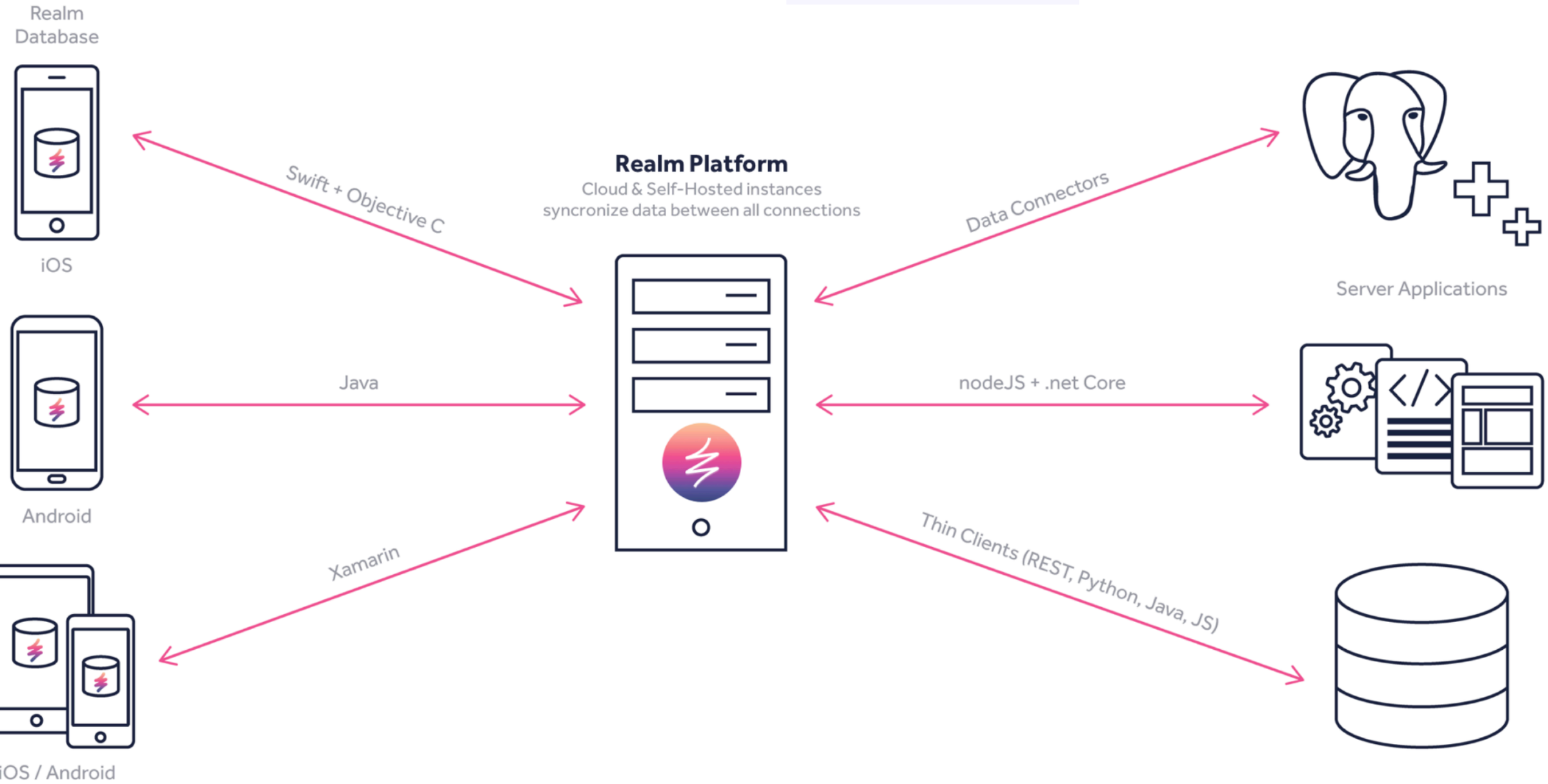
```
override fun onDestroy() {
    dbHelper.close()
    super.onDestroy()
}
```

DEMO

SQLite - Caution

- There is no compile-time verification of raw SQL queries. As your data graph changes, you need to update the affected SQL queries manually. This process can be time consuming and error prone.
- You need to use lots of boilerplate code to convert between SQL queries and data objects.

Realm



https://realm.io

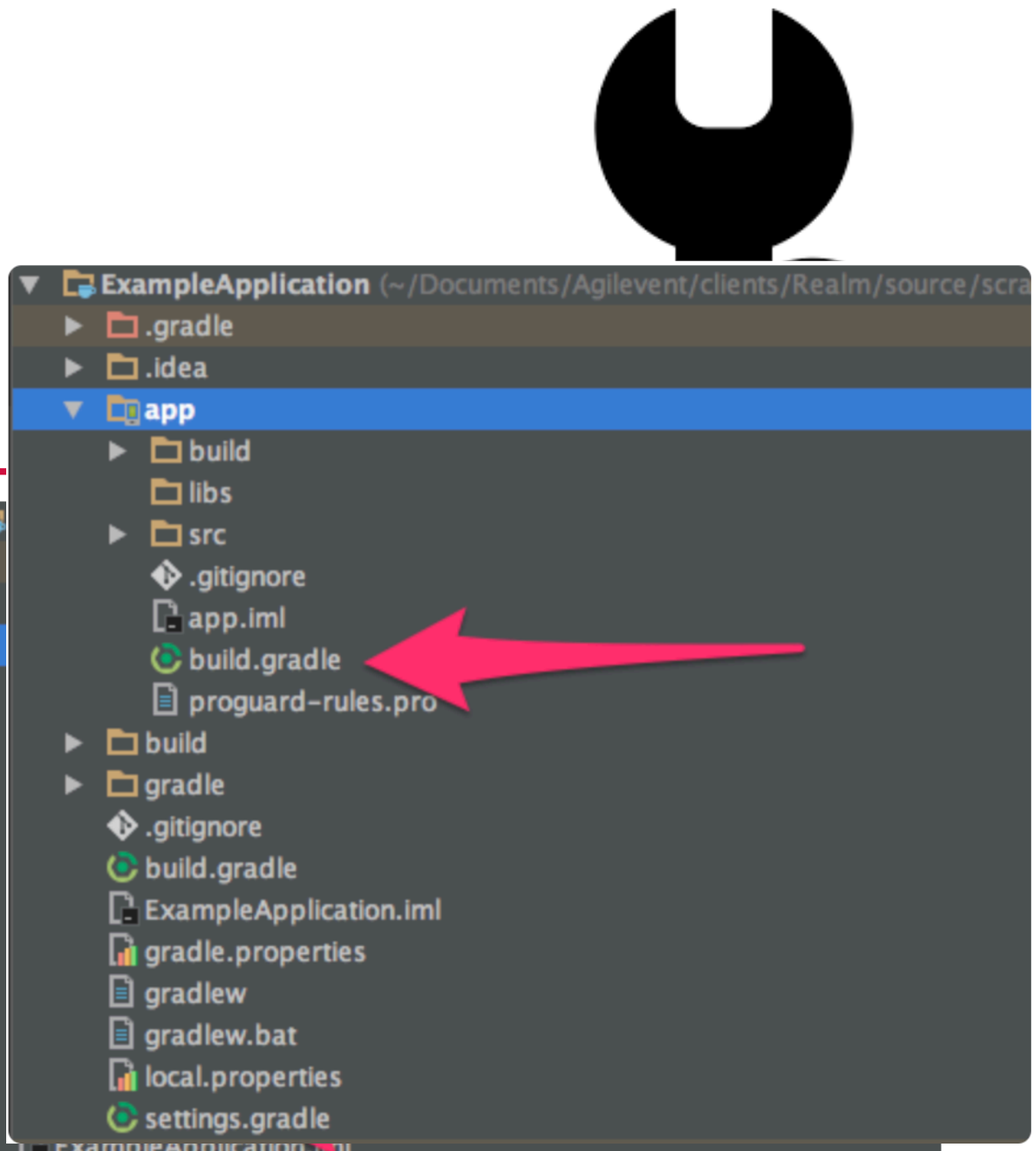
Realm - Installation

In project level `build.gradle:`

```
buildscript {
    repositories {
        jcenter()
    }
    dependencies {
        classpath "io.realm:realm-gradle-
    }
}
```

In module level `build.gradle:`

```
apply plugin: 'realm-android'
```



Realm - Domain

```
open class Dog : RealmObject() {
 var name: String? = null
 @LinkingObjects("dog")
 val owners: RealmResults<Person>? = null
}
```

```
open class Person(
 @PrimaryKey var id: Long = 0,
 var name: String = "",
 var age: Int = 0,
 // Other objects in a one-to-one
 // relation must also subclass RealmObject
 var dog: Dog? = null
) : RealmObject()
```

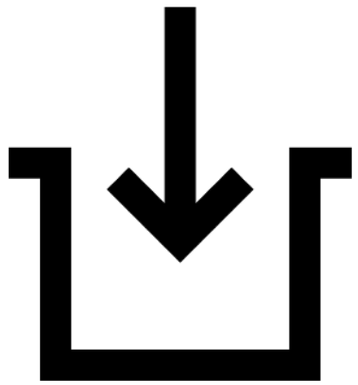
Realm - Usage

Initialization

```java
// Use them like regular java objects
Dog dog = new Dog();
dog.setName("Rex");
dog.setAge(1);

// Initialize Realm (just once per application)
Realm.init(context);

// Get a Realm instance for this thread
Realm realm = Realm.getDefaultInstance();

// Query Realm for all dogs younger than 2 years old
final RealmResults<Dog> puppies = realm.where(Dog.class).
  lessThan("age", 2).findAll();
puppies.size();
```

Usage

Realm - Insert

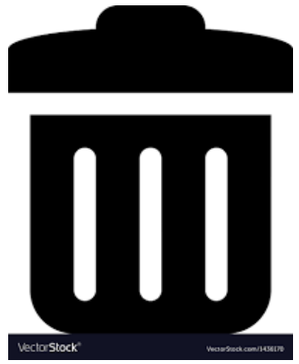


```
open class Person(
 @PrimaryKey var id: Long = 0,
 var name: String = "",
 var age: Int = 0,
 // Other objects in a one-to-one
 // relation must also subclass RealmObject
 var dog: Dog? = null
  ) : RealmObject()


realm.executeTransaction { realm →
     // Add a person
     val person = realm.createObject<Person>(0)
     person.name = "Young Person"
     person.age = 14
}
```

Realm - Query

```
open class Person(
 @PrimaryKey var id: Long = 0,
 var name: String = "",
 var age: Int = 0,
 // Other objects in a one-to-one
 // relation must also subclass RealmObject
 var dog: Dog? = null
) : RealmObject()


val age = 22
val persons = realm.where<Person>().
    equalTo("age", age).findAll()!!
```

Realm - Delete




```
open class Person(
 @PrimaryKey var id: Long = 0,
 var name: String = "",
 var age: Int = 0,
 // Other objects in a one-to-one
 // relation must also subclass RealmObject
 var dog: Dog? = null
) : RealmObject()


val age = 22
val persons = realm.where<Person>().
    equalTo("age", age).findAll()!!

persons.deleteAllFromRealm()
```

Realm - Update


```
open class Person(
 @PrimaryKey var id: Long = 0,
 var name: String = "",
 var age: Int = 0,
 // Other objects in a one-to-one
 // relation must also subclass RealmObject
 var dog: Dog? = null
) : RealmObject()

// Find the first person (no query conditions)
// and read a field
val person = realm.where<Person>().findFirst()!!

// Update person in a transaction
realm.executeTransaction { _ →
    person.name = "Updated Person"
    person.age = 99
}
```

Android Jetpack

Accelerate Development

Eliminate boilerplate code

Build high quality, robust apps

https://developer.android.com/jetpack/

Android Jetpack Components

Foundation

AppCompat

Android KTX

Multidex

Test

Architecture

Data Binding

Lifecycles

LiveData

Navigation

Paging

Room

ViewModel

WorkManager

Behavior

Download Manager

Media & playback

Notifications

Permissions

Sharing

Slices

UI

Animations & Transitions

Auto

Emoji

Fragment

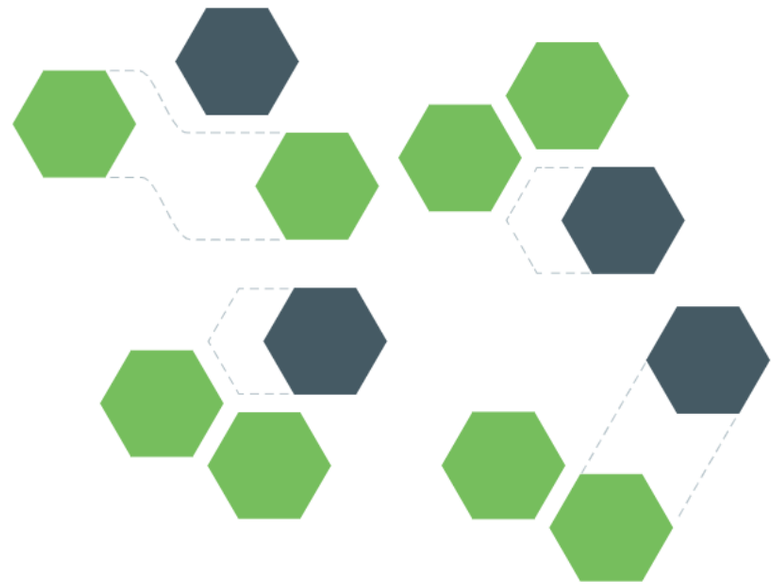
Layout

Palette

TV

Wear OS

Adding Components



In project level `build.gradle:`

```
allprojects {
    repositories {
        google()
        jcenter()
    }
}
```

In module level `build.gradle:`

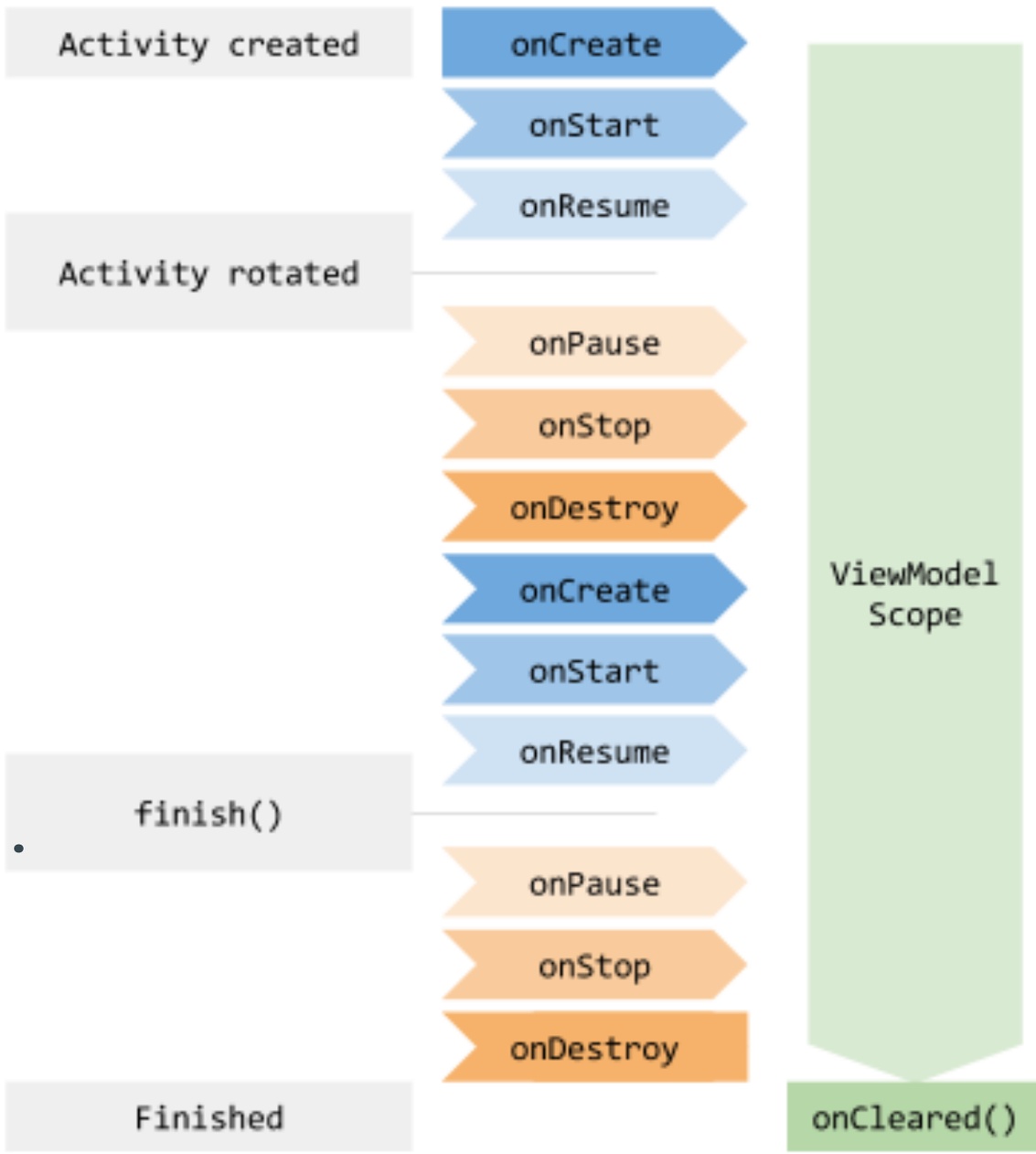
```
dependencies {
 def lifecycle_version = “2.1.0"
 // ViewModel and LiveData
 implementation "androidx.lifecycle:lifecycle-extensions-ktx:$lifecycle_version"
 // alternatively - just ViewModel
 implementation "androidx.lifecycle:lifecycle-viewmodel-ktx:$lifecycle_version"
 // alternatively - just LiveData
 implementation "androidx.lifecycle:lifecycle-livedata-ktx:$lifecycle_version"
}
```

https://developer.android.com/topic/libraries/architecture/adding-components

ViewModel

```
class MyViewModel : ViewModel() {
  private val users:
    MutableLiveData<List<User>> by lazy {
      loadUsers()
    }
  fun getUsers(): LiveData<List<User>> {
    return users
  }
  private fun loadUsers() {
    // Do an asynchronous
    //operation to fetch users.
  }
}
```

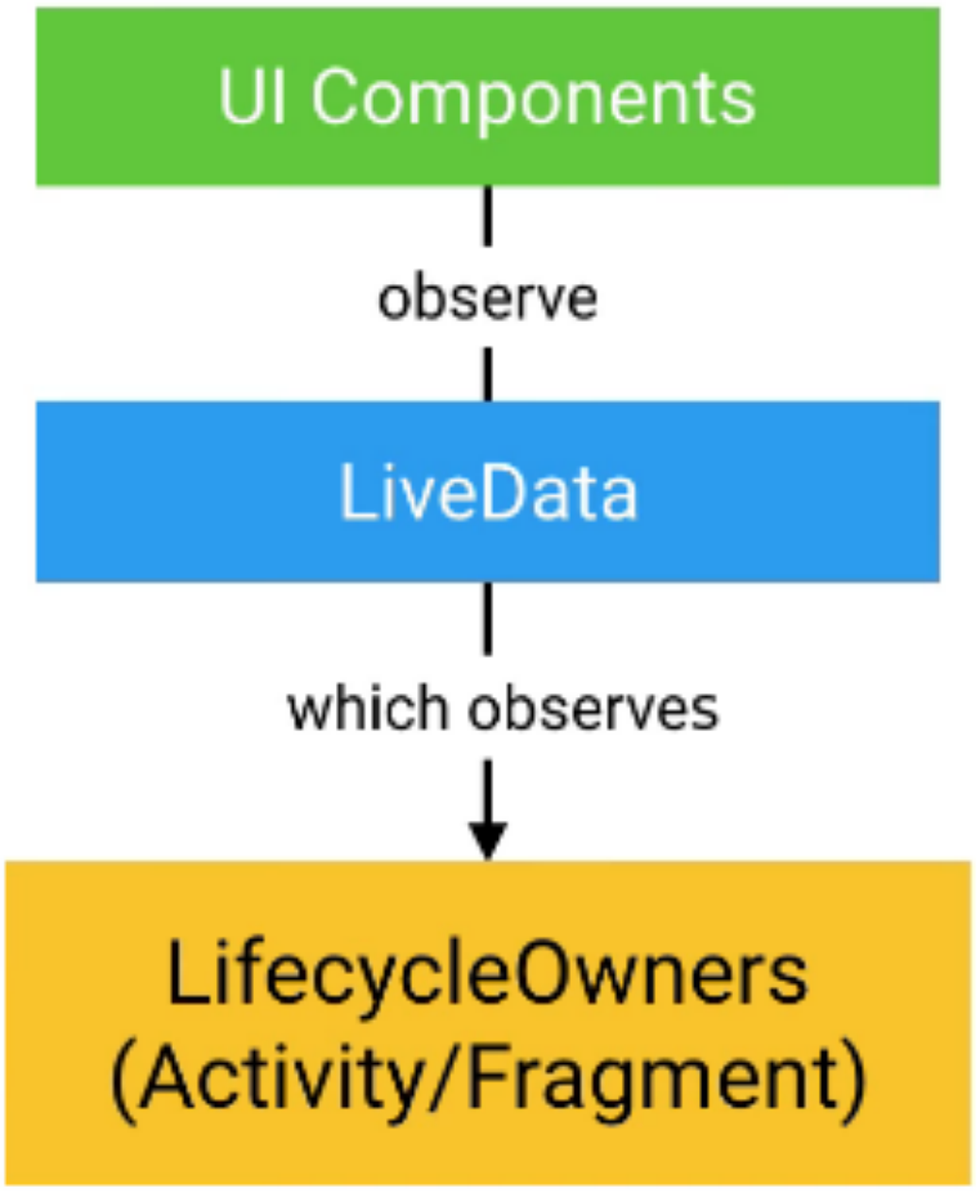
```
class MyActivity : AppCompatActivity() {
  override fun onCreate(
      savedInstanceState: Bundle?) {
    val model = ViewModelProviders.of(this).
      get(MyViewModel::class.java)
    model.getUsers().
      observe(this, Observer<List<User>>{
        users -> // update UI
      })
  }
}
```



https://developer.android.com/topic/libraries/architecture/viewmodel

LiveData

- Ensures your UI matches your data state (Follows the observer pattern).
- No memory leaks (Observers are bound to Lifecycle).
- No crashes due to stopped activities (Inactive when the activity is in back stack).
- No more manual lifecycle handling (Observers are bound to Lifecycle).
- Always up to date data (Receives the latest data upon becoming active).
- Proper configuration changes (Immediately receives the latest available data).
- Sharing resources (Can be shared in your app).



https://developer.android.com/topic/libraries/architecture/livedata

LiveData

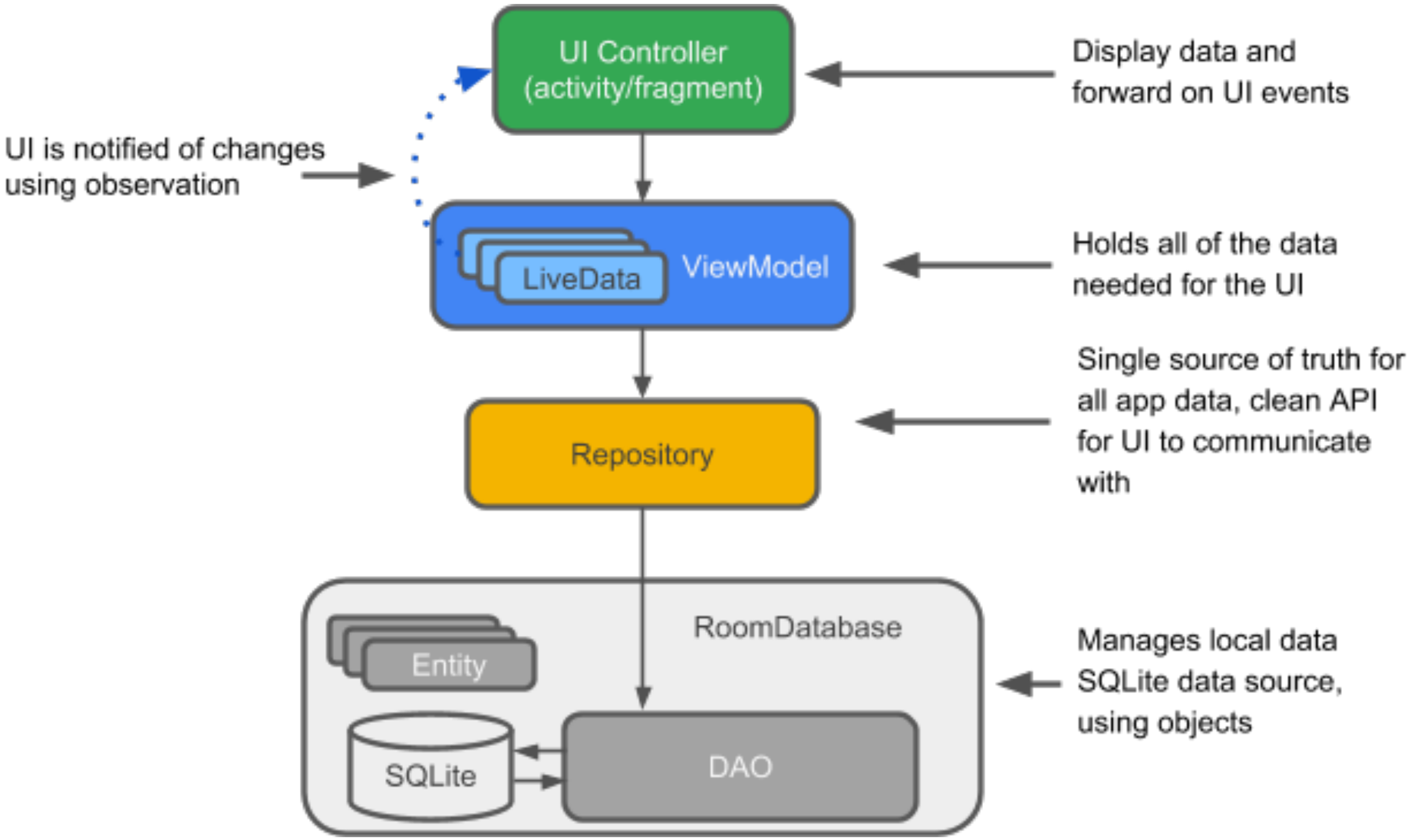
```
class StockLiveData(symbol: String) : LiveData<BigDecimal>() {
    private val mStockManager = StockManager(symbol)
    private val mListener = { price: BigDecimal ->
        value = price
    }
    override fun onActive() {
        mStockManager.requestPriceUpdates(mListener)
    }
    override fun onInactive() {
        mStockManager.removeUpdates(mListener)
    }
}
```

```
override fun onActivityCreated(savedInstanceState: Bundle?) {
    super.onActivityCreated(savedInstanceState)
    val myPriceListener: LiveData<BigDecimal> = StockLiveData(symbol)
    myPriceListener.observe(this, Observer<BigDecimal> {
       price: BigDecimal? ->
        // Update the UI.
    })
}
```

Share Data Between Fragments

```
class SharedViewModel : ViewModel() {
    val selected = MutableLiveData<Item>()

    fun select(item: Item) {
        selected.value = item
    }
}

class MasterFragment : Fragment() {
    private lateinit var itemSelector: Selector

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        model = activity?.run {
            ViewModelProviders.of(this)[SharedViewModel::class.java]
        } ?: throw Exception("Invalid Activity")
        itemSelector.setOnClickListener { item ->
            // Update the UI
        }
    }
}

class DetailFragment : Fragment() {
    private lateinit var model: SharedViewModel

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        model = activity?.run {
            ViewModelProviders.of(this)[SharedViewModel::class.java]
        } ?: throw Exception("Invalid Activity")
        model.selected.observe(this, Observer<Item> { item ->
            // Update the UI
        })
    }
}
```

Room



https://developer.android.com/topic/libraries/architecture/room

Installation

In module level `build.gradle:`

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

```
ext {
    roomVersion = '2.2.0'
    archLifecycleVersion = '2.2.0-beta01'
    androidxArchVersion = '2.1.0'
}

// Room components
implementation "androidx.room:room-runtime:$roomVersion"
implementation "androidx.room:room-ktx:$roomVersion"
kapt "androidx.room:room-compiler:$roomVersion"
androidTestImplementation "androidx.room:room-testing:$roomVersion"

// Lifecycle components
implementation "androidx.lifecycle:lifecycle-extensions:$archLifecycleVersion"
kapt "androidx.lifecycle:lifecycle-compiler:$archLifecycleVersion"
androidTestImplementation "androidx.arch.core:core-testing:$androidxArchVersion"
```

Room - Create the entity

```
@Dao
interface WordDao {
    @Entity(tableName = "word_table")
    class Word(@PrimaryKey
               @ColumnInfo(name = "word")
               val word: String)

    @Insert
    fun insert(word: Word)

    @Query("DELETE FROM word_table")
    fun deleteAll()
}
```

```
    @get:Query("SELECT * from word_table ORDER BY word ASC")
    val alphabetizedWords: LiveData<List<Word>>
```

Room - Database

```
@Database(entities = [Word::class], version = 1)
abstract class WordRoomDatabase : RoomDatabase() {
 abstract fun wordDao(): WordDao
 companion object {
  private var INSTANCE: WordRoomDatabase? = null
  fun getInstance(context: Context): WordRoomDatabase? {
   if (INSTANCE == null) {
    synchronized(WordRoomDatabase::class.java) {
     INSTANCE = Room.databaseBuilder(context.applicationContext,
      WordRoomDatabase::class.java, "word_database")
       .fallbackToDestructiveMigration()
       .addCallback(sRoomDatabaseCallback)
       .build()
     }
    }
    return INSTANCE
  }
}
```

Repository


```
// Declares the DAO as a private property in the constructor. Pass in the DAO
// instead of the whole database, because we only need access to the DAO
class WordRepository(private val wordDao: WordDao) {

  // Room executes all queries on a separate thread.
  // Observed LiveData will notify the observer when the data has changed.
  val allWords: LiveData<List<Word>> = wordDao.getAllWords()

  suspend fun insert(word: Word) {
    wordDao.insert(word)
  }
}
```

Use in ViewModel

```
class WordViewModel(application: Application) : AndroidViewModel(application) {

 private val repository: WordRepository
 val allWords: LiveData<List<Word>>

 init {
   val wordsDao = WordRoomDatabase.getDatabase(application).wordDao()
    repository = WordRepository(wordsDao)
    allWords = repository.allWords
  }

 fun insert(word: Word) = viewModelScope.launch {
    repository.insert(word)
  }
}
```

Lecture outcomes

- Understand the old SQLite workflow
- Implement the CRUD operations
- When changing multiple entities, use transactions
- Migrate the local db from one version to another
- Use Room, ViewModel and LiveData