UA/DETI • 45424 - Introdução à Computação Móvel (ICM)
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Android labs – 2020/21

Learning resources

- Android documentation: tutorials, API documentation, tools, best practices,…
- Android training, including courses by Google
- Android Courses at Udacity (by Google staff members)
- R. Meirs' "Professional Android" Book
- CodePath Android Cliffnotes: very good collection of topics on Android development.

Lab #1- Introduction to the development workflow and tools

Readings & learning resources

— Required: concepts for Lesson 1 and Lesson 2 in Android Developer Fundamentals course

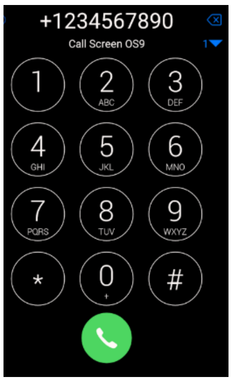
— Optional: slides for lesson 1.* and lesson 2.*
— Optional: Meiers' PA4: Chap. 2, 3 & 5.

Lab

Pre-requirements: install Android Studio.
In this lab, we will complete:

a) "Build your first app" – introductory tutorial, from Android documentation.
b) Code labs for "Lesson 2.x" (from Android Developer Fundamentals course materials)

HW/checkpoint assignment



CA1: build an app that acts as a dialer, with a "keypad" to enter the calling number. Start with the simplest approach possible.
When you press the dial button, a call should be started (just hand-over to the "real" built-in dialer).
You should add a set of 3 "speed dial" buttons (memories); when the users does a long press on one of these "speed dials"/memories, a secondary activity is offered to allow the user to update the speed dial details (define a label and associate a phone number).

Explore

- CodePath Android Cliffnotes: very good collection of topics on Android development.

#2- Flexible user interfaces and fragments

Readings & learning resources

— Concepts for Lesson 4 and Lesson 5 in ADF course
— Concepts for Lesson 1: Fragments in Android Developer Advanced
— Optional: slides for lesson 4.* and 5.* in ADF
— Optional: slides for Lesson 1: Fragments in ADAdv
— The Android Studio visual Layout Editor
— Optional: Meiers' PA4: Chap. 2, 3 & 5.

Lab

Proposed lab activities: (mostly from the Android Developer Fundamentals course materials):

a) Code lab 4.1 (Clickable images), from ADF course
b) Code lab 4.5 (RecyclerView), from ADF course. Make sure the RecyclerView AndroidX library.
Suggested adaptation to the codelab, taking into consideration the new the wizard creates the elements:

- @Step 3: in task 1.1, when you select the Basic Activity template, the wizard will include two fragments. You can remove the fragments (fragment_first, fragment_second) and the layouts created for those fragments. Then, adapt the content_main to define the layout of the main activity.
- @Step 3: in task 1.3, instead of creating a new image resource, you can just pick an icon from the drop down list (for attribute srcCompat).
- @Step 4: in task 2.1, be sure to add the androidx.recyclerview.widget.RecyclerView (and

not the support library v7). You can easily do it by using the designer (instead of editing the xml).

c) Code lab for Lesson 1: Fragments (01.1 + 01.2) from Android Developer Advanced
d) Code lab 4.4 (user navigation), from ADF course
e) Code lab 5.3 (adaptative layouts), from ADF course. The main objective here is to learn how android makes use of alternative resources.

f) Code lab 4.3 (menu and pickers), from ADF course

Note 1: some code labs use the old support library (e.g: android.**support**.v7.widget.RecyclerView). You should prefer, instead, the new packages under AndroidX (e.g.: **androidx.**recyclerview.widget.RecyclerView). If you need to use the old packages, when creating the project, select the option to use legacy libraries. More info on migrating to AndroidX.

Note 2: be sure to complete the code labs b) and c). Fragments and the ReciclerView will appear very often.

From CODEPATH:
"Within a fragment-heavy app, we need to remember to organize our code according to architectural best practices.
Activities are navigation controllers primarily responsible for:

- Navigation to other activities through intents.
- Presenting navigational components such as the navigation drawer or the viewpager.
- Hiding and showing relevant fragments using the fragment manager.
- Receiving data from intents and passing data between fragments.

Fragments are content controllers and contain most views, layouts, and event logic including:

- Layouts and views displaying relevant app content.
- Event handling logic associated with relevant views.
- View state management logic such as visibility or error handling.
- Triggering of network request through a client object.
- Retrieval and storage of data from persistence through model objects.

To reiterate, in a fragment-based architecture, the **activities are for navigation** and the **fragments are for views and logic**."

Explore

- Material design guidelines for User Experience (UX) and look-and-feel.
- Another guide to RecyclerView.
- Example of Master-Detail navigation, with Fragments.
- The (new) Android JetPack selection of components includes support for a new Navigation Component, which makes it easier to handle the navigation between fragments and activities. There is also a related codelab available.

#3- Background tasks & reacting to the user context

Readings & preparation

— Concepts for Lesson 7.1, 7.3 in the Background Tasks chapter of ADF. [Slides]
— Concepts for Lesson 7.1 (Location) in the ADA.

Lab@Home

Be sure to complete the following labs:

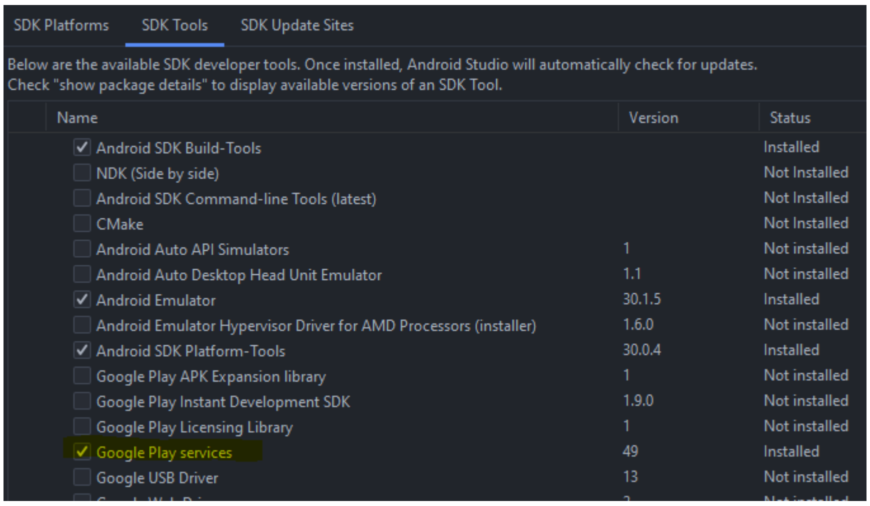
A) Code lab 7.1 (Fundamentals): AsyncTask
B) Code lab 7.1 (Advanced): Get device location and track location updates (this example shows several interesting points, besides the location. Should be completed carefully.)
C) Code lab 7.3 (Fundamentals): Broadcast receivers

Notes on the code labs:

A) In some cases, there is a starter project, or you may want to run the solution code. Note that the projects refer to somewhat old configurations. You may want to:
   - Update ***compileSdkVersion*** and ***targetSdkVersion*** in build.gradle to a recent version.
   - Use the new AndroidX instead og the old Support Libraries. There is a wizard for this refactoring: Menu Refactoring > Migrate to AndroidX

B) Android has two rules concerning the use of threads: do not block the UI thread (→any “heavier” work should be done in a separate thread); do UI work only on the UI thread (→access the UI only from the default thread, also called the UI thread). The **AsyncTask** is a helper class that combine, in the same object, methods that run in a separate thread (can run lengthier tasks), and methods that run in the main thread (can update the UI). Check the key points about AsyncTask usage.
C) To get the device **location** and track the location updates, Google offers an optimized API outside the basic Android SDK. The Fused Location API is included in the Google Play services and it offer a shared, energy-aware location access. Note that to use Play services you need both to add the dependency to you project and have the Google Play API in the device.

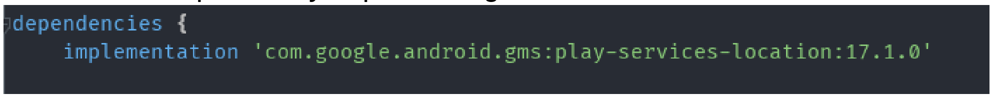
   In the SDK Tools, check the availability of “Google Play Services”:


SDK Platforms | SDK Tools | SDK Update Sites

Below are the available SDK developer tools. Once installed, Android Studio will automatically check for updates.
Check "show package details" to display available versions of an SDK Tool.

Name	Version	Status
✓ Android SDK Build-Tools		Installed
NDK (Side by side)		Not Installed
Android SDK Command-line Tools (latest)		Not Installed
CMake		Not Installed
Android Auto API Simulators	1	Not installed
Android Auto Desktop Head Unit Emulator	1.1	Not installed
✓ Android Emulator	30.1.5	Installed
Android Emulator Hypervisor Driver for AMD Processors (installer)	1.6.0	Not installed
✓ Android SDK Platform-Tools	30.0.4	Installed
Google Play APK Expansion library	1	Not installed
Google Play Instant Development SDK	1.9.0	Not installed
Google Play Licensing Library	1	Not installed
✓ Google Play services	49	Installed
Google USB Driver	13	Not installed

Confirm the dependency import, using a recent version.


```
dependencies {
    implementation 'com.google.android.gms:play-services-location:17.1.0'
```

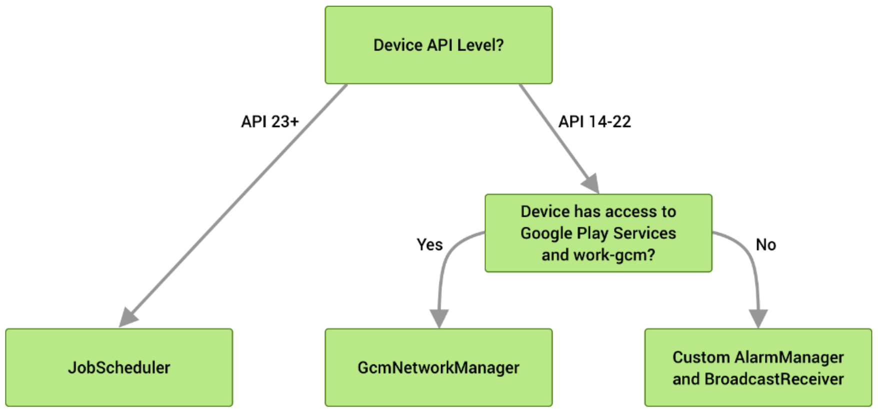
In the Location exercise:

- You will have to handle permissions. The code lab explains how to do it, but there is also a "receipt" in the last section of this document.
- Be sure that, if using an emulator, it supports Google APIs or Google Play.
- Run Google Maps app (inside the emulator) to (force the) update the location cache (otherwise, location changes may not be assumed in the emulator)

D) **Broadcast Receivers** provide a highly decoupled messaging system in Android, in which one component can subscribe for updates in a topic, while other component would post information to data channel (Publisher/Subscriber pattern). This is useful, for example, to get notifications on system events (just boot, lost connection to WiFi,..). Check the key points about Broadcast Receivers usage..

Explore

- Codelab: WorkManager (a more sophisticated job scheduler, with backward compatibility). A comprehensive description of the context and approach is available here. The **WorkManager** library is a good choice for tasks that are useful to complete, even if the user navigates away from a particular screen or your app. Some examples of tasks that are a good use of WorkManager:
  - Uploading logs
  - Applying filters to images and saving the image
  - Periodically syncing local data with the network


Device API Level?
API 23+
API 14-22
Device has access to Google Play Services and work-gcm?
Yes
No
JobScheduler
GcmNetworkManager
Custom AlarmManager and BroadcastReceiver

-
- WorkManager provides a convenient API on top of existing, but different, approaches.

#4- Connecting to remote services & mobile backend

Readings and resources

— Retrofit is a type-safe REST client for Android, Java and Kotlin developed by Square. The library provides a powerful framework for authenticating and interacting with remote APIs and sending network requests with OkHttp. This library makes downloading JSON or XML data from a web API straightforward. Once the data is downloaded it is then parsed into a Java Object.

— Firebase is the Google's mobile backend platform that plays very well with Android. It offers a convenient way to:

  — Gain insights on user behavior (with Analytics): how/where is the app being used?
  — Set up user authentication (with Authentication).

- Store structured data wire Firestore or blob data with Cloud Storage (central cloud "repository").
- Send notifications to users (with Cloud Messaging).
- Find out when and why your app may be crashing (with Crash Reporting).

Firestore is a redesigned cloud database, that works with Firebase, and offers better scalability. It keeps your data in sync across client apps through **realtime** listeners and offers **offline** support.

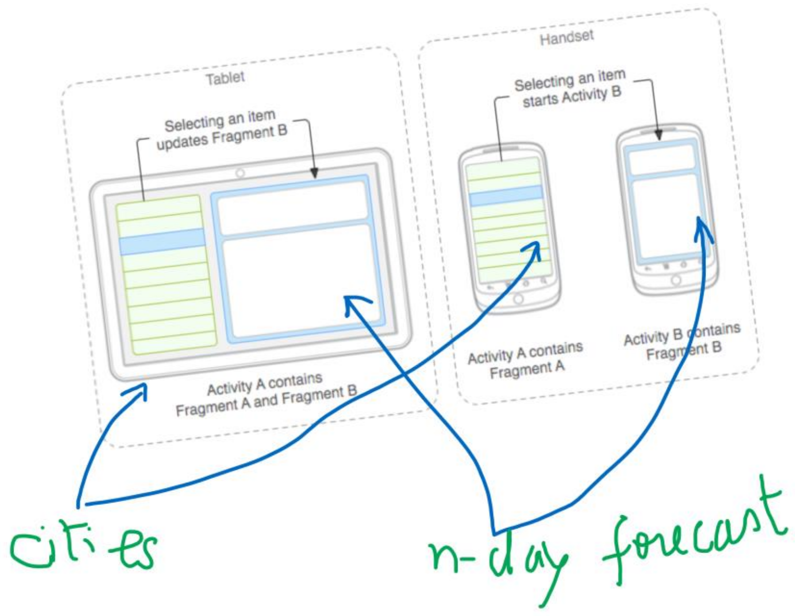
Lab

In this lab:

1) Study the example discussed here to access a REST API using Retrofit. [An updated version of the code is available in project RetrofitSample.]
2) Follow the Android Firebase Codelab to develop a simple chat client ("Friendly Chat") and get started with Firebase.
   Note1: the **keytool** utility is available in the *bin* directory of your Java installation. You may confirm the Java location: File Menu > Project Structure > SDK location > *JDK Location*.
   Note 2: if you get errors related to AndroidX not being enabled, in gradle.properties, set android.useAndroidX=**true**

Homework/Checkpoint Assignment

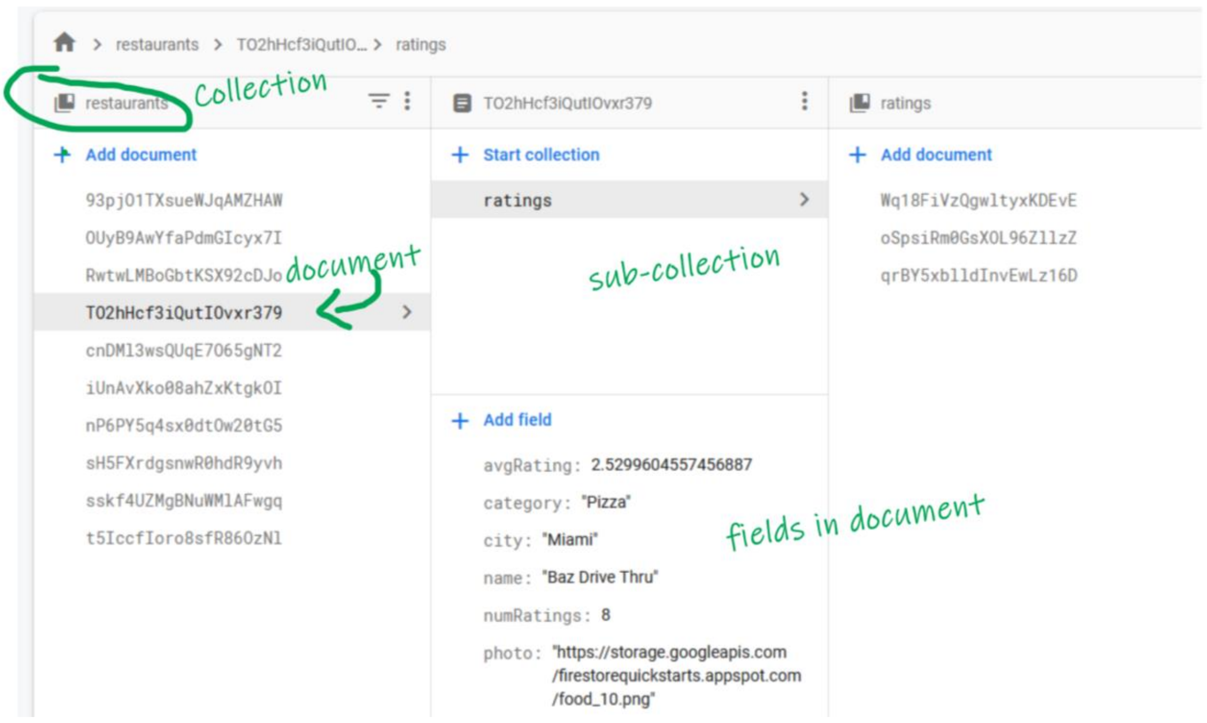
CA2: build an app that offers a weather forecast. The user should, first, select the city of interest (from a limited list of cities) and then get the forecast for the upcoming days (for the selected city). The app should make use of **fragments** (and **RecyclerView**) and offer two **alternative layouts** (("normal" screen, and "large landscape") .
The weather forecast content should be obtained by invoking an external API. A sample project NextWeather is available to demonstrate the use of the IPMA API (using the Retrofit library).


Tablet
Selecting an item updates Fragment B
Activity A contains Fragment A and Fragment B
Handset
Selecting an item starts Activity B
Activity A contains Fragment A
Activity B contains Fragment B
cities
n-day forecast

Explore

1) Read and Write data into cloud Firestore (you should, first, have used Firebase).
   Note: the project makes use of FirestoreAdapter, a RecyclerView adapter to get data drom Firestore.

Instead of Retrofit, you may use the Volley library, for HTTP requests.



```
restaurants               TO2hHcf3iQutIOvxr379                    ratings
93pj01TXsueWJqAMZHAW      ratings                                 Wq18FiVzQgwltyxKDEvE
OUyB9AwYfaPdmGIcyx7I                                              oSpsiRm0GsXOL96Z1lzZ
RwtwLMBoGbtKSX92cDJo                                              qrBY5xblldInvEwLz16D
TO2hHcf3iQutIOvxr379
cnDMl3wsQUqE7065gNT2
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sH5FXrdgsnwR0hdR9yvh
sskf4UZMgBNuWMlAFwgq
t5IccfIoro8sfR860zNl

avgRating: 2.5299604557456887
category: "Pizza"
city: "Miami"
name: "Baz Drive Thru"
numRatings: 8
photo: "https://storage.googleapis.com
       /firestorequickstarts.appspot.com
       /food_10.png"
```
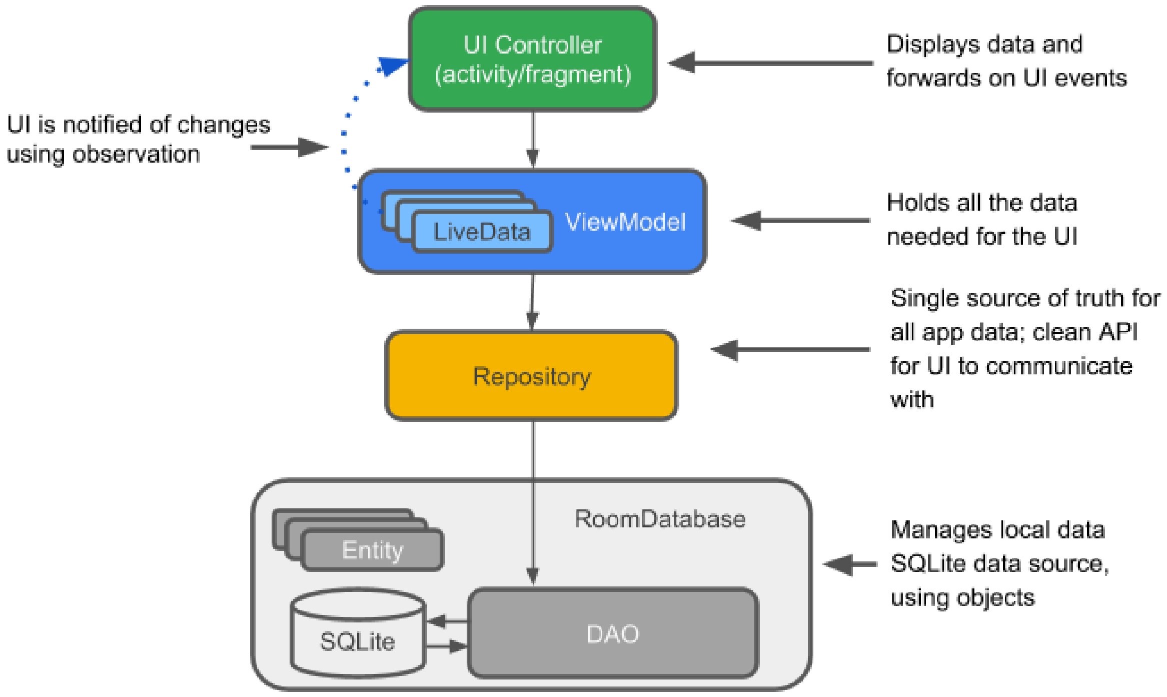
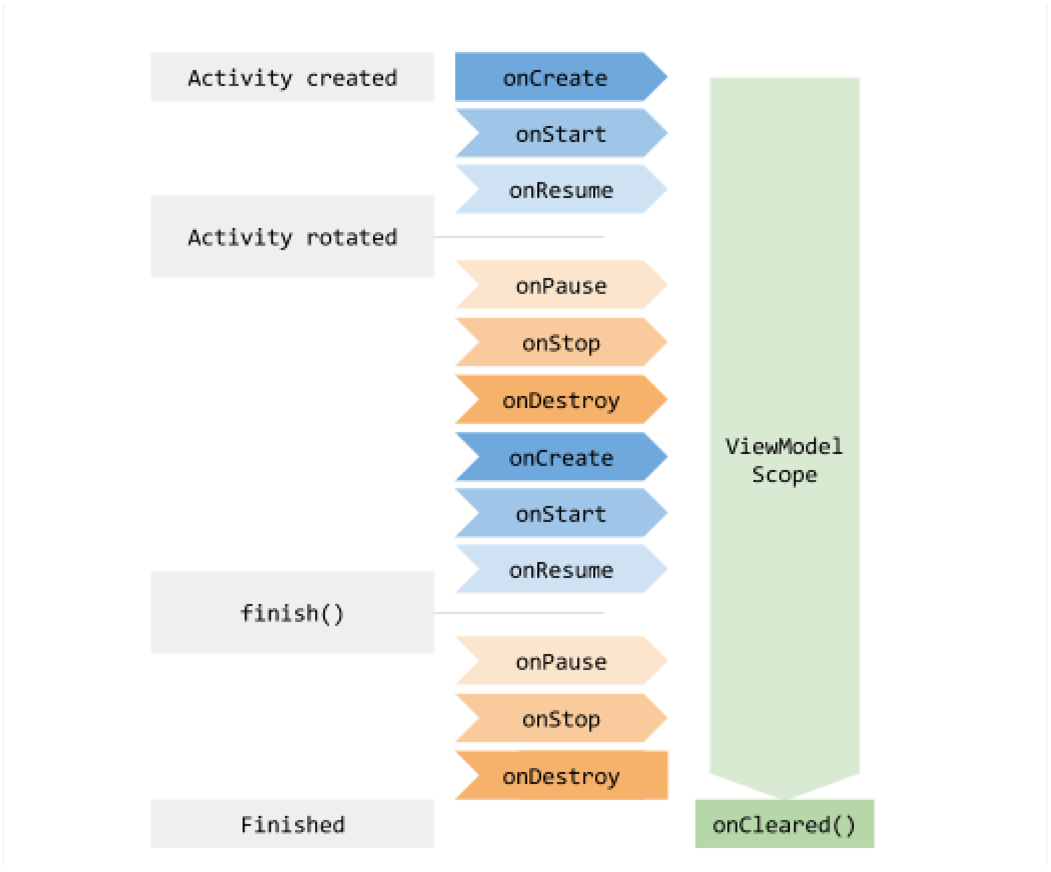

Lab #6: Architectural components (store data with Room)

References

- ADA Lesson 14: Architectural Components
- Android JetPack overview and short video introduction Architectural Components
- Lesson 9: Preferences and settings and Lesson 10: Storing data with Room
- See also the Documentation guide “Save data in a local database using Room”
- Slides: 10.1- Room databases.


UI Controller (activity/fragment)
Displays data and forwards on UI events
UI is notified of changes using observation
LiveData
ViewModel
Holds all the data needed for the UI
Repository
Single source of truth for all app data; clean API for UI to communicate with
RoomDatabase
Entity
SQLite
DAO
Manages local data SQLite data source, using objects



Using Room (annotations):

- Create entity(ies) to model the data. The @Entity will be mapped into a SQL table.
- Define an API to interact with the data in a @Dao object. Map methods into SQL statements (you may omit SQL for default @Insert, @Delete, @Update).
- If you wrap the results in a LiveData, the changes to the result set become observable (tracked), and data will be accessed in a separate threaded automatically.
- Create a @Database object, declaring the entities to be managed and exposing required DAOs; implement a method to return a database singleton.

Lab

1- Be sure to complete the exercise for Room with a View (uses all layers in the Architecture, from Database do ViewModels.)

2- Code Lab : lifecycle aware components (Using ViewModels, Lifecycles and LiveData). Note: Git for the starter code

Common programming cases & receipts

Permissions

- Dynamically verify and ask for App permissions (required from API 23+)

Data binding: https://medium.com/@sgkantamani/data-binding-in-android-4ff7bba93a2c