Lab on apps development for tablets, smartphones and smartwatches

Week 7: Coroutines, Room and Maps

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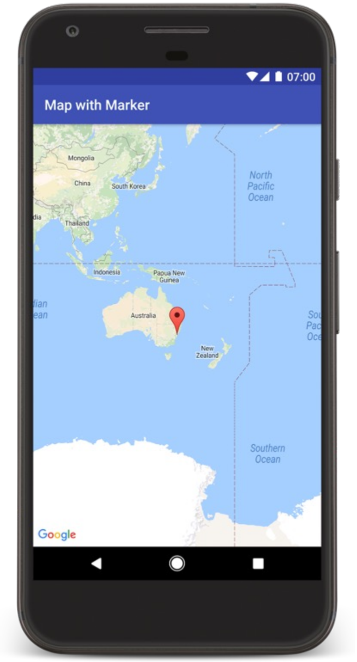
Class outline

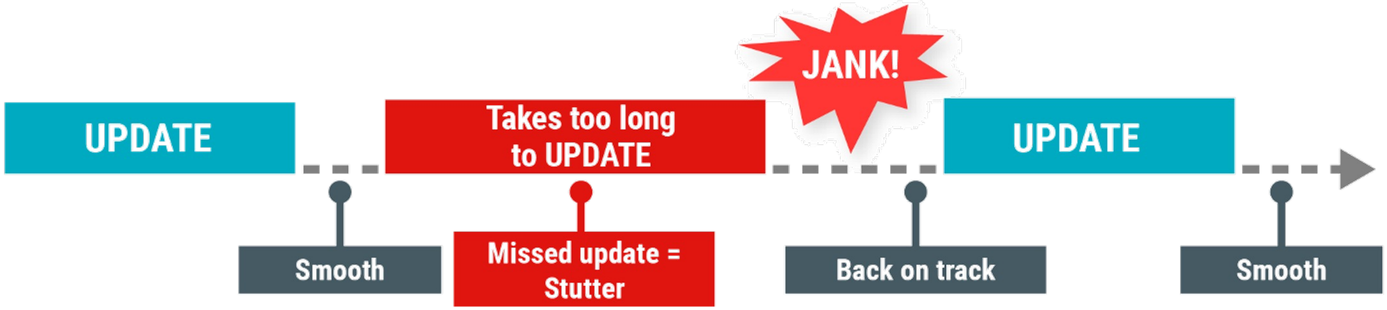
- **Coroutines and Room**

- Geolocation
  - GoogleMaps API
  - Location system service

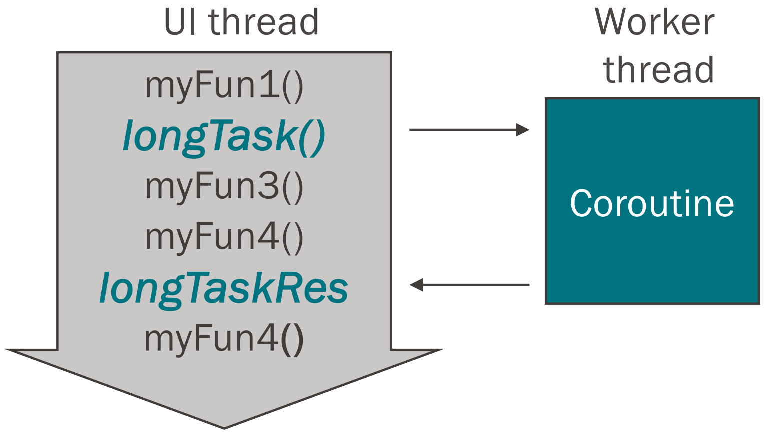


Coroutines

- The UI must be always fast:
  - Screen is updated every 16ms → UI thread has 16ms to do all the work



- Coroutines are (long-running) tasks on a background thread
  - non-blocking
  - asynchronous



Coroutines in Kotlin

- Functions that can be invoked as coroutines are marked with the suspend keyword → `suspend fun longrunningWork() {...}`

- Every coroutines has associated
  - a Job: a handle to the coroutines
  - a Dispatcher: mechanism to send coroutines to different threads
    - Dispatcher.IO → I/O tasks
    - Dispatcher.Default → CPU-intensive tasks
    - Dispatcher.Main → Main thread
  - a Scope: context in which the coroutine runs
    - ViewModelScope → coroutines are destroyed if ViewModel is cleared
    - LifecycleScope → coroutines are destroyed if Lifecycle owner (Activity) is cleared

Coroutines in Kotlin

- Functions that can be invoked as coroutines are marked with the suspend keyword → `suspend fun longrunningWork() {...}`

  - a Job
  - a Dispatcher
  - a Scope: context in which the coroutine runs

    In composables, rememberCoroutineScope() returns the composable scope

```
@Composable
fun myComposable(){
  val coroutineScope =  rememberCoroutineScope()

  Button(
    onClick = {
        coroutineScope.launch {
   }) {…}
}
```

From previous Lecture!

Launching a coroutine

- A coroutine is launched in a scope, specifies a dispatcher

```
fun someWorkNeedsToBeDone() {
    val job : Job = viewModelScope.launch {
        suspendFunction()
    }
}

suspend fun suspendFunction() {
    withContext(Dispatchers.IO) {
        longrunningWork()
    }
}
```

scope

Coroutine

Dispatcher

- Suspended functions do not block execution while waiting for results
  - other useful work can be done

    → e.g. update GUI, listen for user actions...

Room library

- Most apps needs data to be saved
  - persistent even when user closes the app
- Room provides that functionality via Room, an abstraction layer over SQLite
  - simplifies setting up and interacting over SQL databases
  - provides a query syntax based on SQL
- Apps interact with the database using normal function calls

SQLite and Room

- SQLite data in tables of rows and columns (spreadsheet…)
  - Field := intersection of a row and column
  - Rows are identified by unique IDs
  - Column names are unique per table

- Room links the Kotlin and the SQL syntaxes

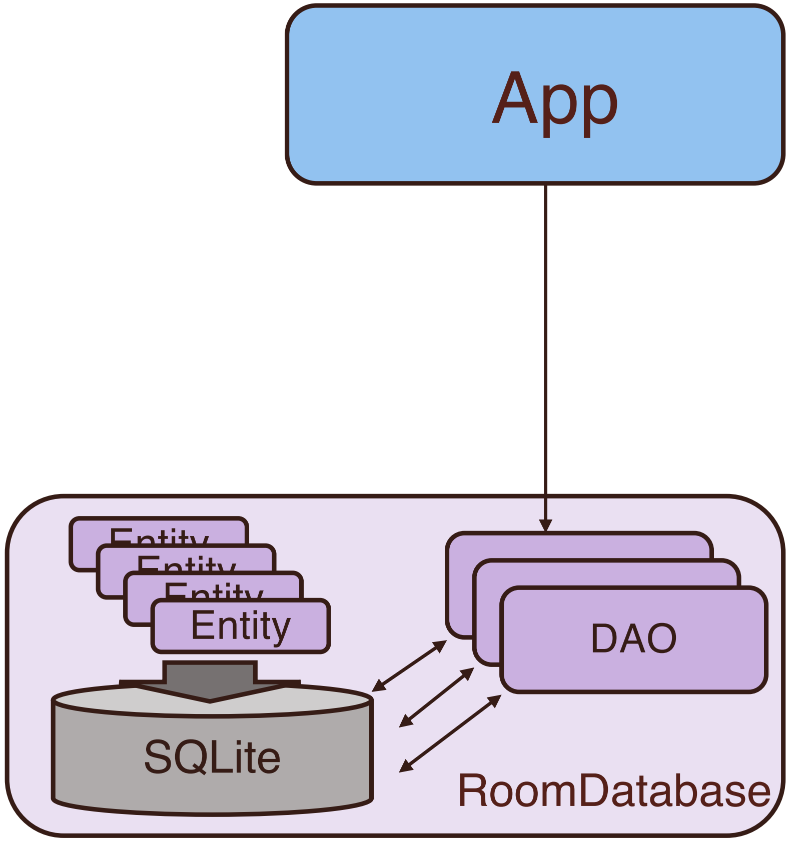
SQL

```
@Query("SELECT * from my_table WHERE myId = :key")
suspend fun get(key: Long): myTableRow?
```

Kotlin

Room library

- Three major components
  - Database
    main access point to DB
  - Entity
    class: describes a table within the database
    object: one table row
  - Data Access Objects (DAO)
    Functions for accessing the database



Room Entity

- Kotlin data class with @Entity annotation
  - optional tableName annotation
  - unique @PrimaryKey field
    - can be auto-generated
  - other fields
    - optional @ColumnInfo annotation

```
@Entity(tableName = "my_table")
data class MyEntity(
        @PrimaryKey(autoGenerate = true)
        var myId: Long = 0L,

        @ColumnInfo(name = "a_string")
        val aString: String = "",

        @ColumnInfo(name = "a_Int")
        var aInt: Int = −1

     ...
)
```

- Annotations are used to construct queries in the DAO (next slide)

```
@Query("SELECT ∗ from my_table WHERE a_int = :intParam")
suspend fun get(intParam: Int): List<myTableRow?>
```

Room Data Access Object (DAO)

- Room databases are accessed by the app (e.g. ViewModels) using methods defined in DAOs

- DAOs provide mapping between Kotlin methods and SQL queries
  - DAOs are interfaces → the implementation of methods is generated by Room based on SQL code

```
@Dao
interface MyDatabaseDao {

    @Insert
    fun insert(myTableRow: MyEntity)

    @Query("SELECT * from my_table WHERE myId = :key")
    fun get(key: Long): MyEntity?
}
```

@Insert, @Update, @Delete
→ convenience methods,
do not require any extra code

Arbitrary queries
are defined with @Query

Room Database

- Class annotated with @Database
- Only one instance needed for the app → Singleton
- getInstance() to either grab a handler of existing database, or create one

```
@Database(entities = [MyEntity::class], ...)
abstract class MyDatabase : RoomDatabase() {

    abstract val myDatabaseDaoInstance: MyDatabaseDao

    companion object {
        fun getInstance(context: Context): MyDatabase {

            ...

        }
    }
}
```

Entities used by the database

DAOs used by the database

getInstance() method in companion object

Performing Room queries

- Ultimately, databases should be accessed
  - get an handler to the DB instance

```
val dataSource = MyDatabase.getInstance(application).myDatabaseDaoInstance
```

- We can now access the DAO methods

```
class MyViewModel(
        val databaseDao: MyDatabaseDao,
        application: Application) : AndroidViewModel(application) {


    ...

    private fun fun1(key: Long): MyEntity? {
        return databaseDao.get(key)
    }
```

DAO

DAO method (query)

Room and coroutines

- Accessing database can be slow → delegate it to coroutines!

1. mark DAO methods as *suspend*

```kotlin
@Dao
interface MyDatabaseDao {
    @Query("SELECT * from my_table WHERE myId = :key")
    suspend fun get(key: Long): MyEntity?
}
```

2. launch coroutine with the appropriate scope

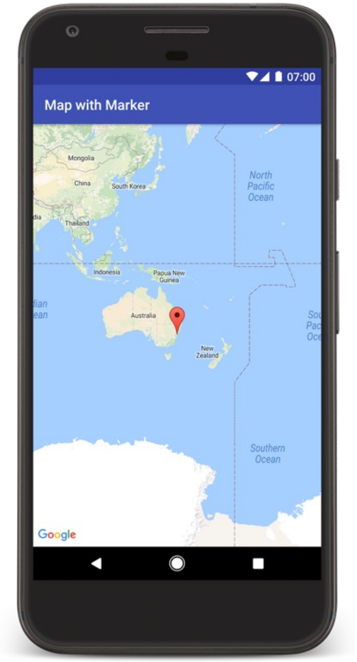
```kotlin
private fun longDbWork(key: Long) {
    viewModelScope.launch {
        myDBelement = getFunction(key)
    }
}
```

3. Call the DAO method
   - Room automatically uses the I/O dispatcher

```kotlin
private suspend fun getFunction(key : Long): MyEntity?
{
    var myDBelement = databaseDao.get(key)
    return myDBelement
}
```

Outline of the class

- Coroutines and Room
- **Geolocation**
  - GoogleMaps API
  - Location system service

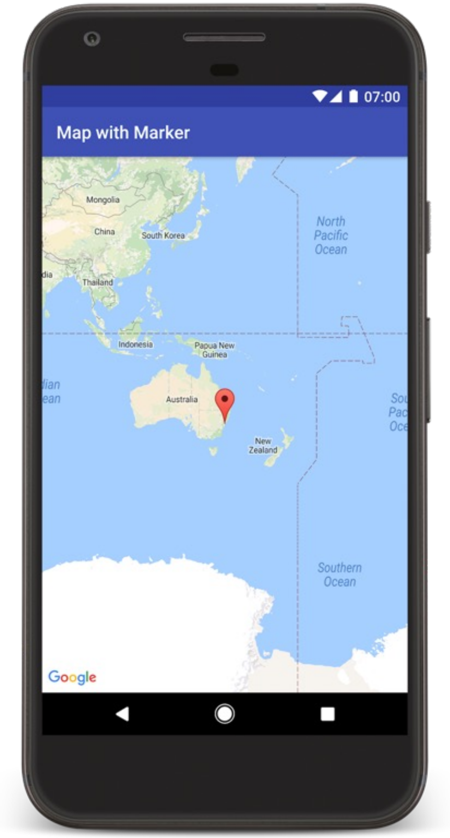


The GoogleMaps API

- The API allows you to add maps to your app based on Google Maps data.

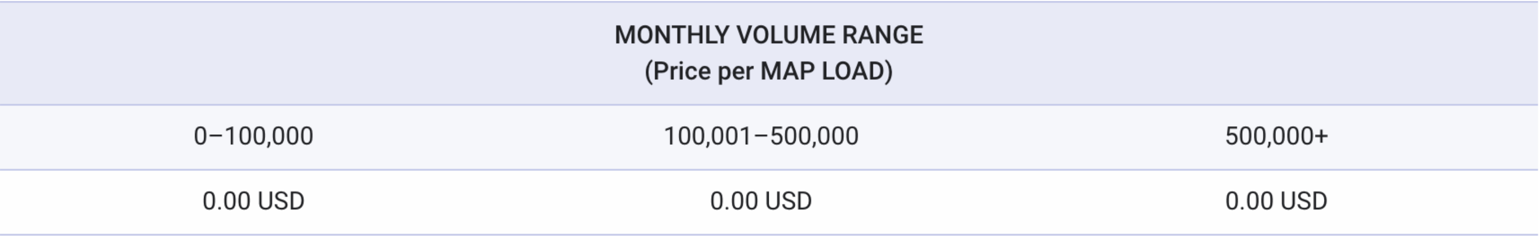
- Takes care of:
  - Access Google maps servers
  - Data downloading
  - Map display
  - Touch gestures on the map.

- De-facto monopoly
  - Alternatives: OpenStreetMap (Data), Mapbox (API)

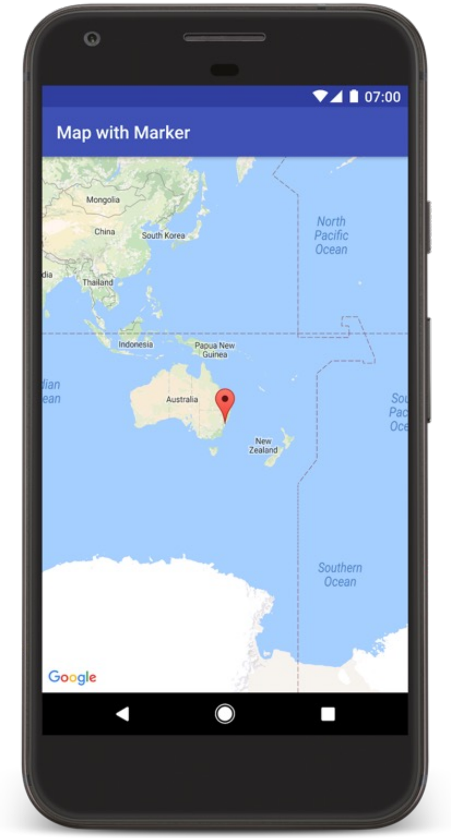


Setting up GoogleMaps in Cloud Store

- GoogleMaps requires an API key
  - obtained from Google Cloud Console: console.cloud.google.com/
  - requires a billing method, even if GoogleMap API is free for use in GoogleMap composable https://developers.google.com/maps/documentation/android-sdk/usage-and-billing#mobile-dynamic



MONTHLY VOLUME RANGE (Price per MAP LOAD)		
0–100,000	100,001–500,000	500,000+
0.00 USD	0.00 USD	0.00 USD



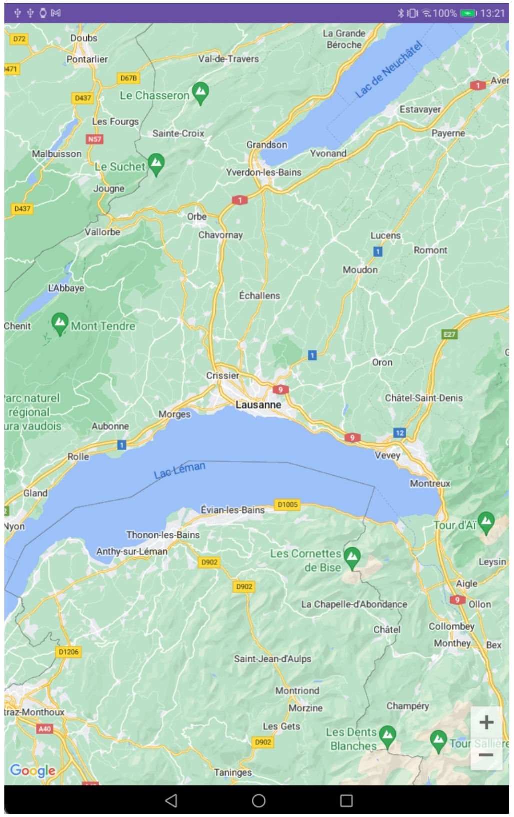
Displaying a map

1. Add a Google map key to the app manifest XML (obtained from GoogleCloud)

```
<meta-data
 android:name="com.google.android.geo.API_KEY"
    android:value="YOUR_KEY_HERE" />
```

2. Add a GoogleMap to the layout of the composable in which you want to host the map
   - Adding initial camera position

```
GoogleMap(
   modifier = Modifier.fillMaxSize(),
   cameraPositionState = cameraPositionState
)

val lausanne = LatLng(46.5197, 6.6323)
val cameraPositionState = rememberCameraPositionState {
   position = CameraPosition.fromLatLngZoom(lausanne, 10f)
}
```



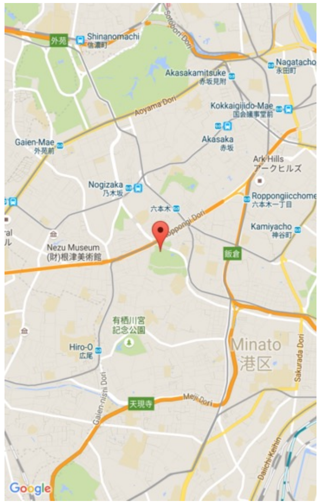
Customizing the map: Zoom

```
position = CameraPosition.fromLatLngZoom(lausanne, 10f)
```

- Zoom levels
  - 1 → World
  - 5 → Continent
  - 10 → City
  - 15 → Streets
  - 20 → Buildings

Akita
秋田
Sendai
仙台
Niigata
新潟
Kanazawa
金沢
Japan
Yokohama
横浜
Nagoya
名古屋
Google

Zoom level 5



Zoom level 15

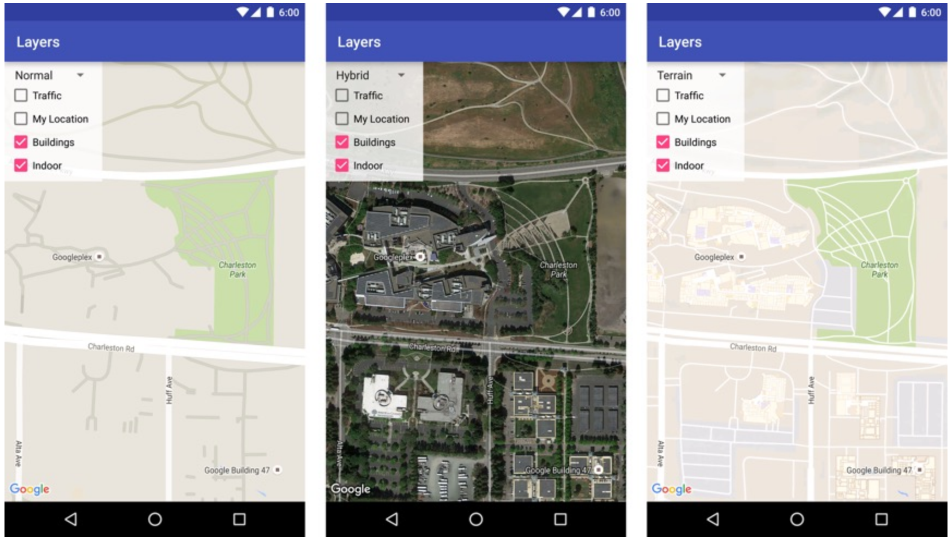
Roppongi Dori
SuperDeluxe
pandora
GATTO NERO
Aladdin
Kosher Japan
Chokoji
Google

Zoom level 20

Customizing the map: Type

- Define the Map type, governing the overall representation of the map
  - Normal → Typical road map
  - Hybrid → Satellite data + roads
  - Satellite → Satellite data only
  - Terrain → Topographic data
  - None → no tiles, empty grid

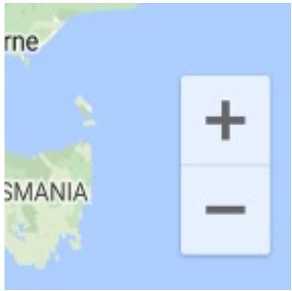
```
GoogleMap(
   …
   properties = MapProperties(mapType = MapType.NORMAL)
)
```



Customizing the map: Map controls

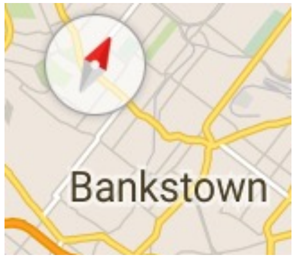
- Add zoom buttons

```
GoogleMap(
   …
   uiSettings = MapUiSettings(zoomControlsEnabled = true)
)
```



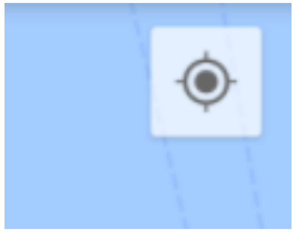
- Add compass
  - appears when you rotate the map, or the map is not aligned to the North

```
   uiSettings = MapUiSettings(compassEnabled = true)
```



- Add myLocation button
  - requires location information!

```
  uiSettings = MapUiSettings(myLocationButtonEnabled = true)
```



Location data

- Apps must advertise the use of location data

```
<manifest xmlns:android= ... >
    <uses-permission android:name="android.permission.ACCESS_FINE_LOCATION" />
    <application>           ...
    </application>
</manifest>
```

- ...ask the user permission to use it...

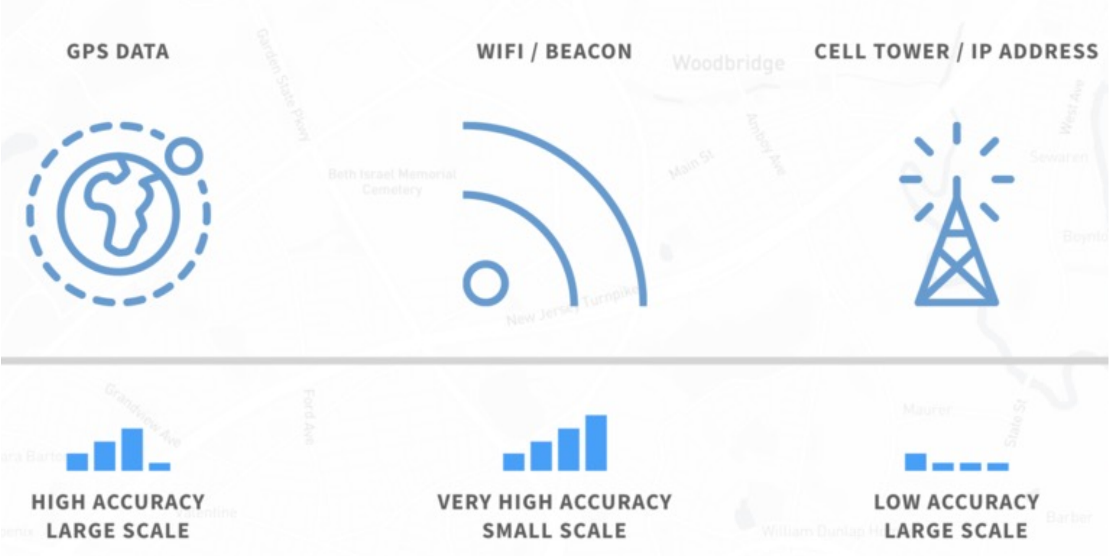
```
val cameraPermissionState = rememberPermissionState(
   android.Manifest.permission.ACCESS_FINE_LOCATION
)
if (!cameraPermissionState.hasPermission) {
   cameraPermissionState.launchPermissionRequest()
} else {
   //update UI accordingly
}
```

- ...and provide gradle dependencies...

```
implementation("com.google.accompanist:accompanist-permissions:0.23.1")
```

Location Provider(s)

- Location data can be obtained via several sources:
  - GPS, WiFi, Cell tower…



- Google provides a FusedLocationProvider system service
  - Provides best position estimate, without having to explicitly manage different sources

```
fusedLocationProviderClient = LocationServices
                              .getFusedLocationProviderClient(context)
```

Retrieve location data

- Location data is retrieved by asking the location provider for the last known location

```
private fun getDeviceLocation() {
    try {
        fusedLocationProviderClient.lastLocation
           .addOnCompleteListener(this) { task ->
                if (task.isSuccessful) {

                    lastKnownLocation = task.result
                    if (lastKnownLocation != null) {
                        ... //Do something with the location
                    }
                }
         }
    } catch (e: SecurityException) {
        Log.e("Exception: %s", e.message, e)
    }
}
```

“Location provider, get me the last known location”

Listening for the Location provider replay

“Here it is!”

No permission to use location data

Request location updates

- Get location information at regular intervals

1. Create a Location Request

```
val locationRequest = LocationRequest.create()
locationRequest.interval = 10000
locationRequest.fastestInterval = 5000
locationRequest.priority = LocationRequest.PRIORITY_HIGH_ACCURACY
```

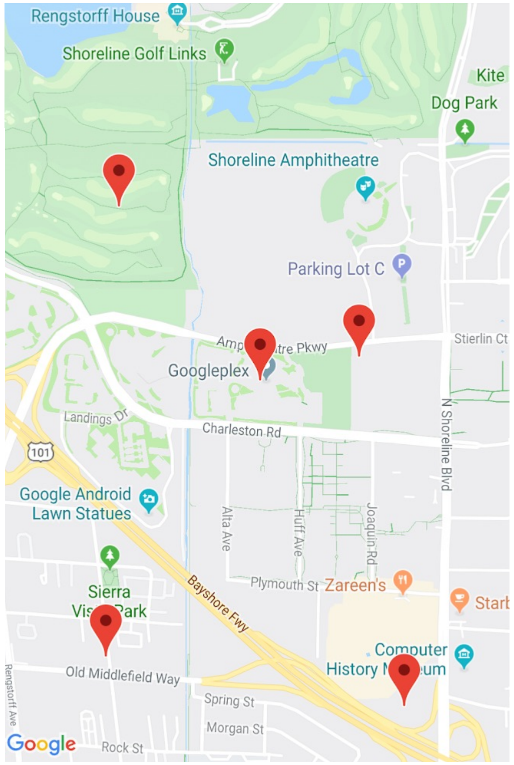
2. Request location updates to the fusedLocationProvider

```
fusedLocationProviderClient
        .requestLocationUpdates(
            locationRequest, locationCallback, Looper.getMainLooper())
```

Request location updates

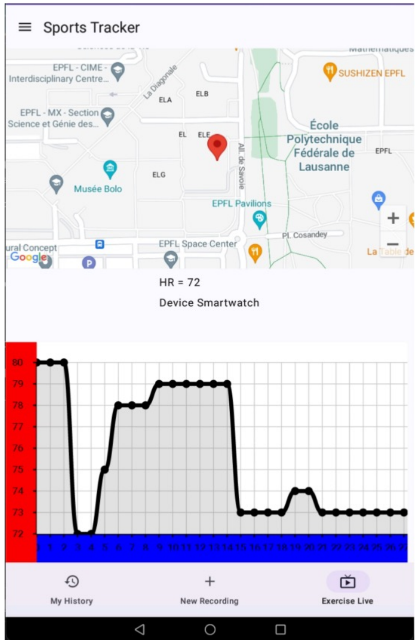
3. Implement the callback
   → what to do when data is received

```
private lateinit var locationCallback: LocationCallback

override fun onCreate(...) {
   ...

   locationCallback = object : LocationCallback() {
       override fun onLocationResult(locationResult: LocationResult?) {
           locationResult ?: return
           for (location in locationResult.locations){
               // Update UI with location data
               // ...
           }
       }
   }
}
```



Today’s Lab

- Add a map to ExcerciseLiveScreen
  - Showing the user’s current location
- Implement a Room database on the watch
  - storing and retrieving Heart Rate data



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Device Smartwatch

Questions?