Data persistence in Android

with Room library

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World before Room

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- **Boilerplate code**

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- **Boilerplate code**

```
SQLiteDatabase db = mDbHelper.getReadableDatabase();

// Define a projection that specifies which columns from the database
// you will actually use after this query.
String[] projection = {
    FeedEntry._ID,
    FeedEntry.COLUMN_NAME_TITLE,
    FeedEntry.COLUMN_NAME_SUBTITLE
    };

// Filter results WHERE "title" = 'My Title'
String selection = FeedEntry.COLUMN_NAME_TITLE + " = ?";
String[] selectionArgs = { "My Title" };

// How you want the results sorted in the resulting Cursor
String sortOrder =
    FeedEntry.COLUMN_NAME_SUBTITLE + " DESC";

Cursor cursor = db.query(
    FeedEntry.TABLE_NAME,                     // The table to query
    projection,                               // The columns to return
    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
    );
```

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- **Difficult migrations**

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- **Difficult migrations**

```
erride
    public void onUpgrade(SQLiteDatabase db, int oldVersion, int newVersion) {
        if      (oldVersion == DATABASE_VERSION_1 && newVersion == DATABASE_VERSION_2) { upgradeSchema_DBv1_To_DBv2(db); }
        else if (oldVersion == DATABASE_VERSION_1 && newVersion == DATABASE_VERSION_3) { upgradeSchema_DBv1_to_DBv3(db); }
        else if (oldVersion == DATABASE_VERSION_1 && newVersion == DATABASE_VERSION_4) { upgradeSchema_DBv1_to_DBv4(db); }
        else if (oldVersion == DATABASE_VERSION_1 && newVersion == DATABASE_VERSION_5) { upgradeSchema_DBv1_To_DBv5(db); }
        else if (oldVersion == DATABASE_VERSION_2 && newVersion == DATABASE_VERSION_3) { upgradeSchema_DBv2_To_DBv3(db); }
        else if (oldVersion == DATABASE_VERSION_2 && newVersion == DATABASE_VERSION_4) { upgradeSchema_DBv2_To_DBv4(db); }
        else if (oldVersion == DATABASE_VERSION_2 && newVersion == DATABASE_VERSION_5) { upgradeSchema_DBv2_To_DBv5(db); }
        else if (oldVersion == DATABASE_VERSION_3 && newVersion == DATABASE_VERSION_4) { upgradeSchema_DBv3_To_DBv4(db); }
        else if (oldVersion == DATABASE_VERSION_3 && newVersion == DATABASE_VERSION_5) { upgradeSchema_DBv3_To_DBv5(db); }
        else if (oldVersion == DATABASE_VERSION_4 && newVersion == DATABASE_VERSION_5) { upgradeSchema_DBv4_To_DBv5(db); }
        fillData(db);
}
```

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World before Room

- **Hard to test**

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Solutions

3d-party ORM libraries over SQLite like:

- **DBFlow**
- **Requery**
- **GreenDAO**

- **And so on, many of them!**

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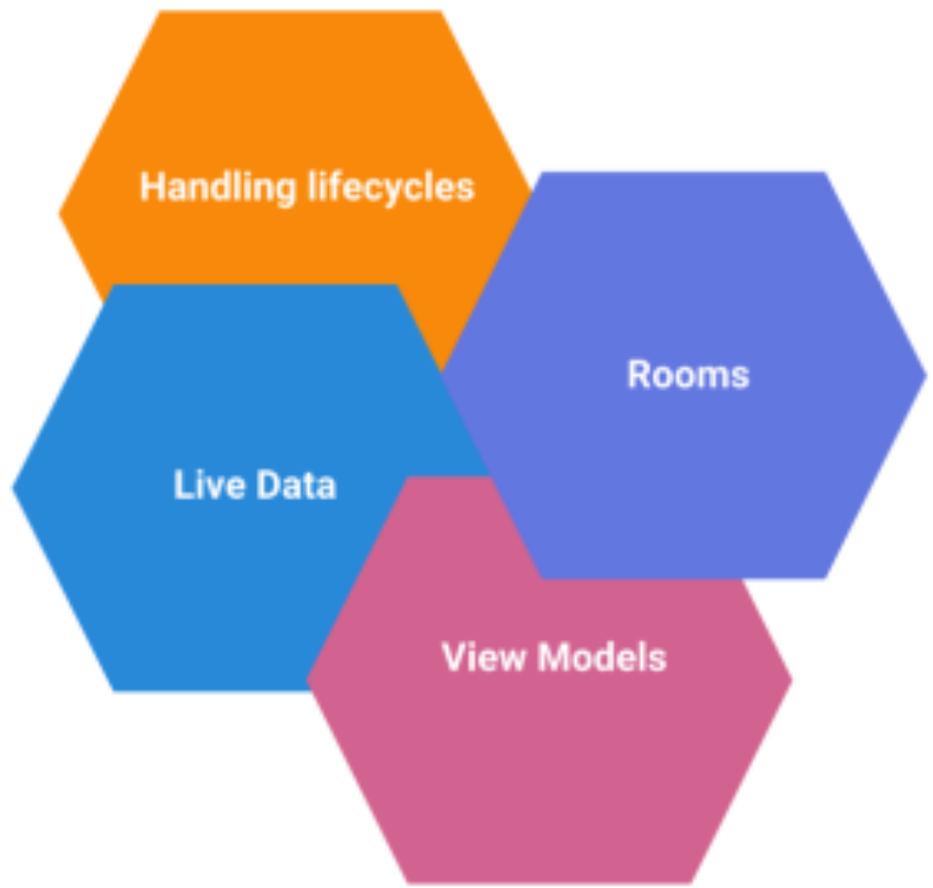
Solutions

…OR even replacement for SQLite like

Google I/O 2017

Android Architecture Components



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Adding to project

Release notes: 1.0.0 - November 6, 2017

- For Room, add:
  - `implementation "android.arch.persistence.room:runtime:1.0.0"`
  - `annotationProcessor "android.arch.persistence.room:compiler:1.0.0"`
  - For testing Room migrations, add:
    - `testImplementation "android.arch.persistence.room:testing:1.0.0"`
  - For Room RxJava support, add:
    - `implementation "android.arch.persistence.room:rxjava2:1.0.0"`

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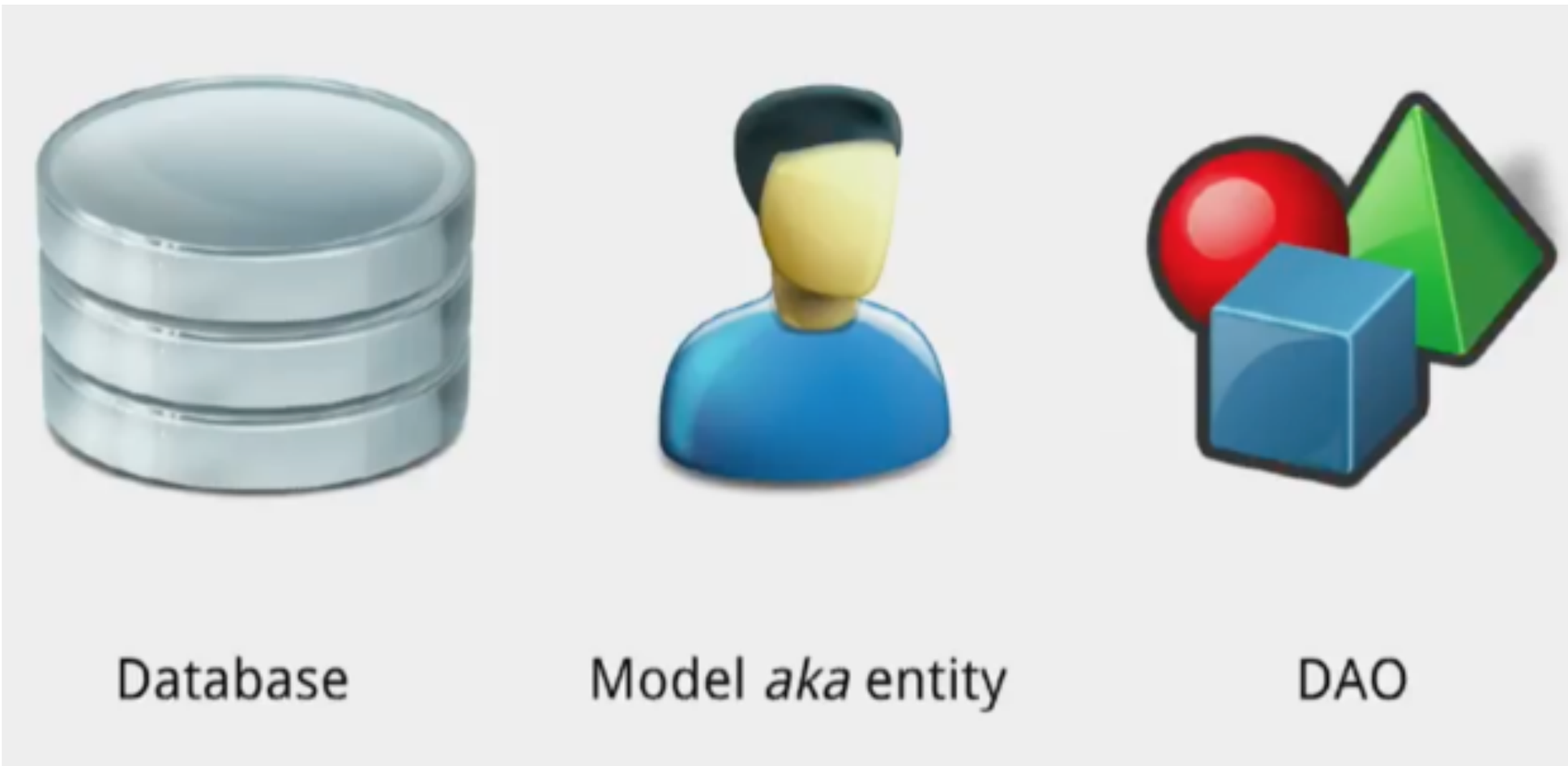
Room structure



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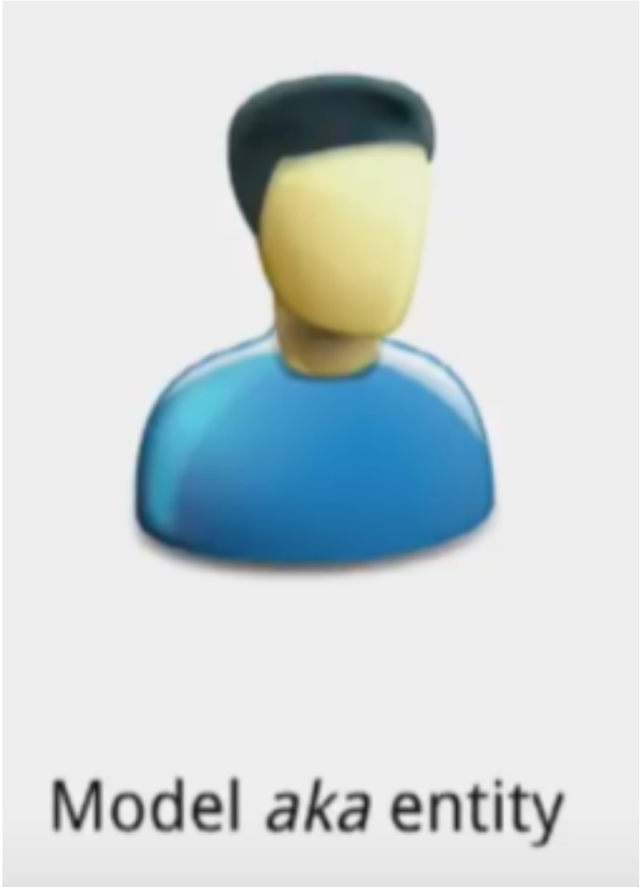
Entity

```
public class Employee {
    private String id;
    private String lastName;
}
```



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Entity

```
@Entity(tableName = "employees")
public class Employee {

    @NonNull
    @PrimaryKey
    private String id;

    @ColumnInfo(name = "last_name", index = true)
    private String lastName;

    @Ignore
    private int someNotPersistedField;

    private transient int anotherSomeNotPersistedField;
```

Note: need getters & setters, not support for Lombok, AutoValue

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Another Entity

```
@Entity(tableName = "departments")
public class Department {

    @NonNull
    @PrimaryKey
    private String id;

    @ColumnInfo(name = "name")
    private String name;

}
```

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Relation

Object references - not supported

```
@Entity(tableName = "departments")
public class Department {

    @NonNull
    @PrimaryKey
    private String id;

    @ColumnInfo(name = "name")
    private String name;

    @OneToMany
    List<Employee> employees;

}
```

From doc - **Key takeaway:** Room disallows object references between entity classes. Instead, you must explicitly request the data that your app needs.

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Relation

```
@Entity(tableName = "employees",
        foreignKeys = @ForeignKey(entity = Department.class,
                parentColumns = "id",
                childColumns = "department_id",onDelete = CASCADE))
public class Employee {

    @NonNull
    @PrimaryKey
    private String id;

    @ColumnInfo(name = "department_id")
    private String departmentId;
```

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Embedding

```
@Entity(tableName = "employees")
public class Employee {

    @NonNull
    @PrimaryKey
    private String id;

    @Embedded
    private EmployeeInfo employeeInfo;
```

```
public class EmployeeInfo {
    @ColumnInfo(name = "salary")
    private String salary;
```

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Data types

```
@Entity(tableName = "employees")
public class Employee {

    @ColumnInfo(name = "hire_date")
    private Date hireDate;
```

Date - unknown type, requires converting

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Data types

```
public class Converters {
    @TypeConverter
    public static Date fromTimestamp(Long value) {

        return value == null ? null : new Date(value);
    }

    @TypeConverter
    public static Long dateToTimestamp(Date date) {

        return date == null ? null : date.getTime();
    }
}
```

Should be added to database object

```
@TypeConverters({Converters.class})
public abstract class EmployeesDatabase extends RoomDatabase {
```

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Database object

```
@Database(entities = {Employee.class, Department.class},
        version = 1)
@TypeConverters({Converters.class})
public abstract class EmployeesDatabase extends RoomDatabase {
```

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Database object

```
@Database(entities = {Employee.class, Department.class},
        version = 1)
@TypeConverters({Converters.class})
public abstract class EmployeesDatabase extends RoomDatabase {

    public abstract EmployeesDao employeesDao();

    private static volatile EmployeesDatabase INSTANCE;

    public static EmployeesDatabase getInstance(Context context) {
        if (INSTANCE == null) {
            synchronized (EmployeesDatabase.class) {
                if (INSTANCE == null) {
                    INSTANCE = Room.databaseBuilder(
                            context.getApplicationContext(),
                            EmployeesDatabase.class,
                            name: "Employees.db")
                            .build();
                }
            }
        }
        return INSTANCE;
    }

}
```

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DAO

```
public abstract EmployeesDao employeesDao();
```

- QUERY
- INSERT
- UPDATE
- DELETE

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DAO

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM employes")
    List<Employee> getEmployees();

}
```

- Need to write SQL queries, not typical for ORMs

- Retrofit style

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DAO

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM employes")
    List<Employee> getEmployees();

}
```

error: There is a problem with the query: [SQLITE_ERROR] SQL error or missing database (no such table: employes)

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DAO - code generation

```
@Generated("android.arch.persistence.room.RoomProcessor")
public class EmployeesDao_Impl implements EmployeesDao {
  private final RoomDatabase __db;
```

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DAO - code generation

```
@Generated("android.arch.persistence.room.RoomProcessor")
public class EmployeesDao_Impl implements EmployeesDao {
  private final RoomDatabase __db;

  @Override
  public void insertEmployee(Employee employee) {
    __db.beginTransaction();
    try {
      __insertionAdapterOfEmployee.insert(employee);
      __db.setTransactionSuccessful();
    } finally {
      __db.endTransaction();
    }
  }
```

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DAO - Threading

- QUERY
- INSERT
- UPDATE
- DELETE

All Synchronous

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DAO - Threading

- QUERY
- INSERT
- UPDATE
- DELETE

All Synchronous

```
Caused by: java.lang.IllegalStateException:
   Cannot access database on the main thread since it may
   potentially lock the UI for a long periods of time.
```

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DAO - Threading

Quick, but not good fix

```
if (INSTANCE == null) {
    INSTANCE = Room.databaseBuilder(
            context.getApplicationContext(),
            EmployeesDatabase.class,
            name: "Employees.db")
            .allowMainThreadQueries()
            .build();
}
```

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DAO - LiveData

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM employees WHERE id = :id")
    LiveData<Employee> getEmployee(String id);
```

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DAO - RxJava

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM employees WHERE id = :id")
    Maybe<Employee> getEmployee(String id);
```

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DAO - RxJava

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM employees WHERE id = :id")
    Maybe<Employee> getEmployee(String id);


    @Query("SELECT * FROM employees WHERE id = :id")
    Single<Employee> getEmployee(String id);
```

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DAO - RxJava

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM employees WHERE id = :id")
    Maybe<Employee> getEmployee(String id);


    @Query("SELECT * FROM employees WHERE id = :id")
    Single<Employee> getEmployee(String id);


    @Query("SELECT * FROM employees WHERE id = :id")
    Flowable<Employee> getEmployee(String id);
```

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DAO - RxJava

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM employees WHERE id = :id")
    Maybe<Employee> getEmployee(String id);


    @Query("SELECT * FROM employees WHERE id = :id")
    Single<Employee> getEmployee(String id);


    @Query("SELECT * FROM employees WHERE id = :id")
    Flowable<Employee> getEmployee(String id);


    @Query("SELECT * FROM employees WHERE id = :id")
    Flowable<List<Employee>> getEmployee(String id);
```

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DAO - Query, Joins

From official documentation:

```
@Dao
public interface MyDao {
    @Query("SELECT * FROM book "
           + "INNER JOIN loan ON loan.book_id = book.id "
           + "INNER JOIN user ON user.id = loan.user_id "
           + "WHERE user.name LIKE :userName")
   public List<Book> findBooksBorrowedByNameSync(String userName);
}
```

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DAO - Query, Joins

Another way:

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM departments WHERE id = :id")
    Flowable<DepartmentAndEmployeesInfo> getDepartment(String id);
```

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DAO - Query, Joins

Another way:

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM departments WHERE id = :id")
    Flowable<DepartmentAndEmployeesInfo> getDepartment(String id);
```

```
public class DepartmentAndEmployeesInfo {

    @Embedded
    private Department department;

    @Relation(parentColumn = "id",entityColumn = "department_id")
    private List<Employee> employees;
```

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DAO - Query, Joins

Another way:

```
@Dao
public interface EmployeesDao {

    @Query("SELECT * FROM departments WHERE id = :id")
    Flowable<DepartmentAndEmployeesInfo> getDepartment(String id);
```

```
public class DepartmentAndEmployeesInfo {

    @Embedded
    private Department department;

    @Relation(parentColumn = "id",entityColumn = "department_id")
    private List<Employee> employees;
```

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Testing

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Testing

```java
@RunWith(AndroidJUnit4.class)
public class EmployeeDaoTest {

    private EmployeesDatabase database;

    private EmployeesDao employeesDao;
```

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Testing

```
@RunWith(AndroidJUnit4.class)
public class EmployeeDaoTest {

    private EmployeesDatabase database;

    private EmployeesDao employeesDao;
```

```
@Rule
public InstantTaskExecutorRule instantTaskExecutorRule = new InstantTaskExecutorRule();
```

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Testing

```java
@RunWith(AndroidJUnit4.class)
public class EmployeeDaoTest {

    private EmployeesDatabase database;

    private EmployeesDao employeesDao;

@Rule
public InstantTaskExecutorRule instantTaskExecutorRule = new InstantTaskExecutorRule();

@Before
public void initDb() throws Exception {
    database = Room.inMemoryDatabaseBuilder(InstrumentationRegistry.getContext(),
            EmployeesDatabase.class)
            .allowMainThreadQueries()
            .build();
    employeesDao = database.employeesDao();
}

@After
public void closeDb() throws Exception {
    database.close();
}
```

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Testing

RxJava's Flowable

```
private static final Employee EMPLOYEE
        = new Employee( id: "id",  lastName: "Dogar");
@Test
public void insertAndGetUser() {
    database.employeesDao().insertEmployee(EMPLOYEE);

    database.employeesDao()
            .getEmployees()
            .test()
            .assertValue(employee -> {
                return employee != null
                        && employee.getId().equals(EMPLOYEE.getId())
                        && employee.getLastName().equals(EMPLOYEE.getLastName());
            });
}
```

Similar with LiveData

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Testing

More real-life example UnitTest

```
public class LocalEmployeeRepository implements EmployeeRepository {
    private final EmployeesDao employeesDao;
    public LocalEmployeeRepository(EmployeesDao employeesDao) {
        this.employeesDao = employeesDao;
    }
```

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Testing

More real-life example UnitTest

```
public class EmployeeRepositoryTest {

    @Mock
    EmployeesDao mockedDao;

    private EmployeeRepository employeeRepository;

    @Before
    public void setUp() throws Exception {
        MockitoAnnotations.initMocks( testClass: this);

        employeeRepository = new LocalEmployeeRepository(mockedDao);
    }
```

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Migrations

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Migrations

```
@Entity(tableName = "employees")
public class Employee {

    @NonNull
    @PrimaryKey
    private String id;

    @ColumnInfo(name = "last_name", index = true)
    private String lastName;
```

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Migrations

```
@Entity(tableName = "employees")
public class Employee {

    @NonNull
    @PrimaryKey
    private String id;

    @ColumnInfo(name = "last_name", index = true)
    private String lastName;

---

    @ColumnInfo(name = "new_field")
    private Integer newField;
```

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Migrations

Update version

```
@Database(entities = {Employee.class, Department.class},
        version = 1)
@TypeConverters({Converters.class})
public abstract class EmployeesDatabase extends RoomDatabase {
```

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Migrations

Update version

```
@Database(entities = {Employee.class, Department.class},
        version = 1)
@TypeConverters({Converters.class})
public abstract class EmployeesDatabase extends RoomDatabase {
```

```
@Database(entities = {Employee.class, Department.class},
        version = 2)
@TypeConverters({Converters.class})
public abstract class EmployeesDatabase extends RoomDatabase {
```

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Migrations

Provide migration

```
private static final Migration MIGRATION_1_2 = new Migration(1, 2) {
    @Override
    public void migrate(@NonNull SupportSQLiteDatabase database) {
        database.execSQL("ALTER TABLE `employees`" +
                " ADD COLUMN `new_field` INTEGER");
    }
};
```

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Migrations

Provide migration

```
private static final Migration MIGRATION_1_2 = new Migration(1, 2) {
    @Override
    public void migrate(@NonNull SupportSQLiteDatabase database) {
        database.execSQL("ALTER TABLE `employees`" +
                " ADD COLUMN `new_field` INTEGER");
    }
};
```

Add it to db object

```
INSTANCE = Room.databaseBuilder(
        context.getApplicationContext(),
        EmployeesDatabase.class,
        name: "Employees.db")
        .addMigrations(MIGRATION_1_2)
        .build();
```

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Migrations

Migrations execution

```
INSTANCE = Room.databaseBuilder(
        context.getApplicationContext(),
        EmployeesDatabase.class,
        name: "Employees.db")
        .addMigrations(
                MIGRATION_1_2,
                MIGRATION_2_3,
                MIGRATION_3_4,
                MIGRATION_2_4)
        .build();
```

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Migrations

Migrations execution

```
INSTANCE = Room.databaseBuilder(
        context.getApplicationContext(),
        EmployeesDatabase.class,
        name: "Employees.db")
        .addMigrations(
                MIGRATION_1_2,
                MIGRATION_2_3,
                MIGRATION_3_4,
                MIGRATION_2_4)
        .build();
```

Shortest path

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Migrations Testing

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Migrations Testing

Setup

- Turn on schema export (as json file)

```
{
  "formatVersion": 1,
  "database": {
    "version": 2,
    "identityHash": "ed3c6326ed4ff343d28ae24912fc9316",
    "entities": [
      {
        "tableName": "employees",
        "createSql": "CREATE TABLE IF NOT EXISTS `${TAB
        "fields": [
          {
            "fieldPath": "id",
            "columnName": "id",
```

- In build.gradle: Set schema location to tests
- Export schema for annotation processor

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Migrations Testing

```
@RunWith(AndroidJUnit4.class)
public class MigrationTest {
    private static final String TEST_DB_NAME = “test_employee_db”;

    @Rule
    public MigrationTestHelper helper;

    public MigrationTest() {
        helper = new MigrationTestHelper(InstrumentationRegistry.getInstrumentation(),
                EmployeesDatabase.class.getCanonicalName(),
                new FrameworkSQLiteOpenHelperFactory());
    }
```

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Migrations Testing

```
@Test
  public void migrate1To2() throws IOException {
      SupportSQLiteDatabase db = helper.createDatabase(TEST_DB_NAME, 1);
      insertEmployee(db); // need to insert with ContentValues SQLIte API
      helper.runMigrationsAndValidate(TEST_DB_NAME, 2, true, MIGRATION_1_2);
```

And then build db object, get Data from DAO and write asserts

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Summary

- Removes ugly boilerplate low level APIs code
- Nice testing and RxJava2 support
- Google support
- Use it if you need it

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Links

Florina Muntenescu blogs

- https://medium.com/@florina.muntenescu

Aleksander Piotrowski, Talk at GDGDevFest 2017
Is there a room for Room?

- https://www.youtube.com/watch?v=BHiKSnOaoh4

Florina Muntenescu talk at realm.io

- https://goo.gl/dNYY3S

And official doc

- https://developer.android.com/training/data-storage/room/index.html

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Thank you!

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