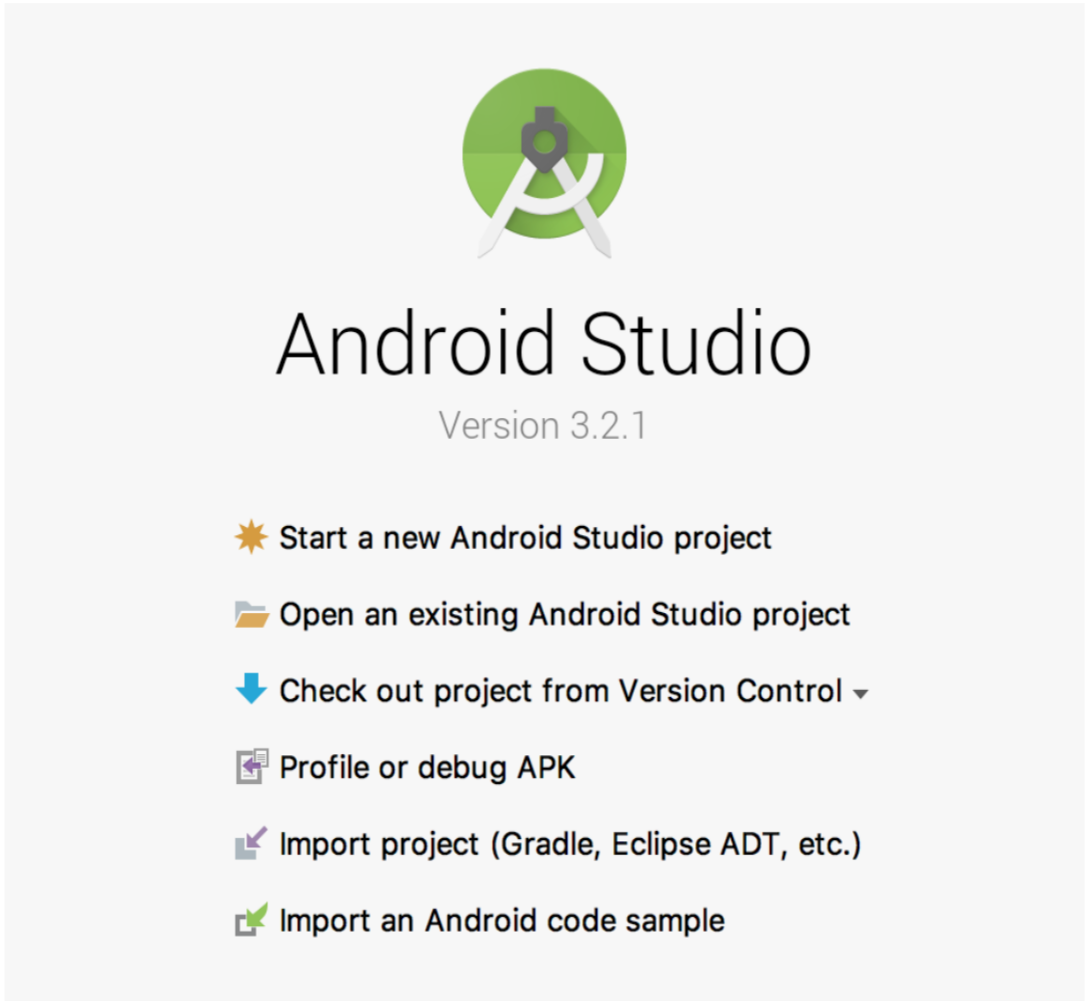
Are you looking for a good architecture for complex Android projects? Have you heard about Clean Architecture but don’t know what all the fuss is about?
In this tutorial you’ll learn the basics of Clean Architecture, including:

- Why it’s important to use architecture patterns in software
- What *Clean Architecture* is
- What *SOLID* principles of development are
- When to use Clean Architecture and SOLID principles
- How to implement Clean Architecture on Android

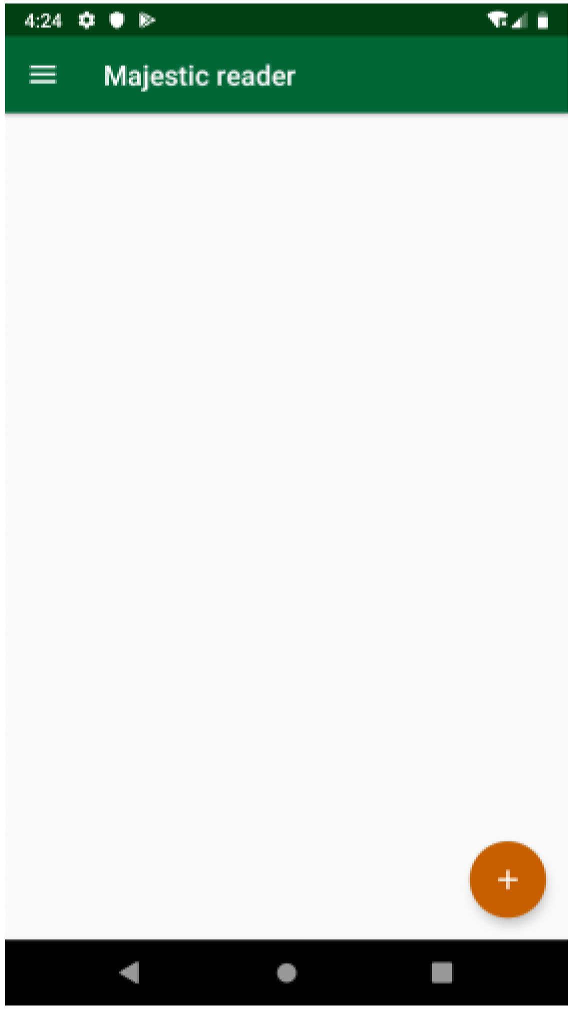
Note: This tutorial assumes you know the basics of Android development with Kotlin. If you’re new to Kotlin, check out our Kotlin introduction tutorial. If you’re completely new to Android development, read through our Beginning Android Development tutorials to familiarize yourself with the basics.

Getting Started

There has always been an open debate, on which architectural pattern to use on Android. Since the early days, you got the feeling that things weren’t right, the way they were set up. This, in turn, caused a lot of people to struggle with architecture in general.
However, for quite a long time, there have been talks about writing your applications in a *clean* way. Furthermore, one of the most influential persons in the global programmer community, Robert C. Martin, also known as Uncle Bob, has written a book, specifically on this topic.
Because the Clean architecture can be used in any application and platform, not just Android, it’s very informative to understand the idea behind it, and why it’s a good solution, for most problems we find nowadays, as programmers. With that in mind, in this tutorial, you’ll learn how to use the *Clean architecture* pattern to build a *Majestic Reader* app, a simple PDF reader.
To get started, download the *Majestic Reader* project using the *Download Materials* button at the top or bottom of this tutorial. Open the project in Android Studio 3.2 or later by selecting *Open an existing Android Studio project* on the Android Studio welcome screen:


Android Studio
Version 3.2.1
Start a new Android Studio project
Open an existing Android Studio project
Check out project from Version Control
Profile or debug APK
Import project (Gradle, Eclipse ADT, etc.)
Import an Android code sample

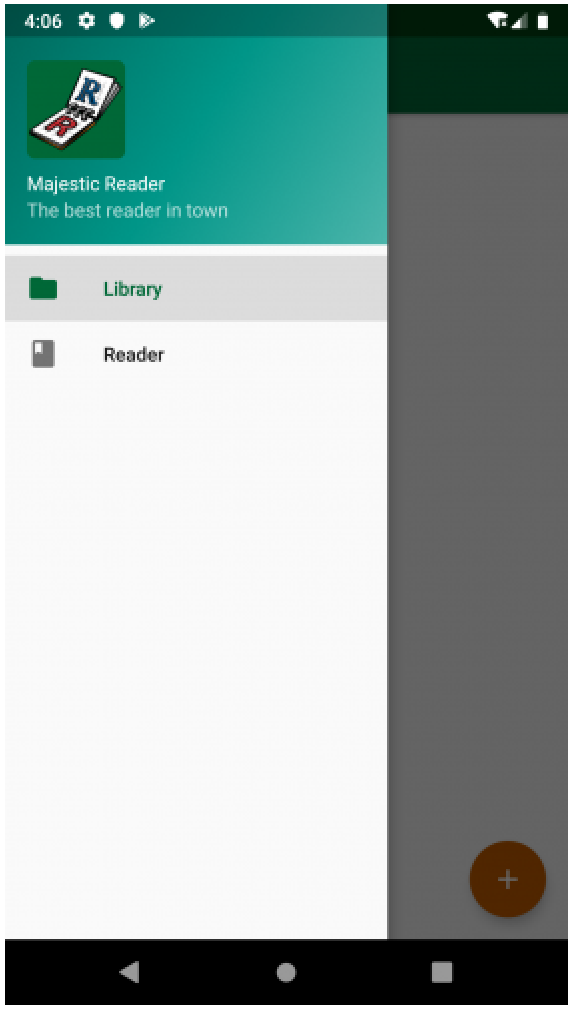
In case something goes wrong, due to sync issues, simply press the Gradle sync button, and everything should be fine! Finally, *build and run* the project. You should see that the main screen of the app is currently empty:

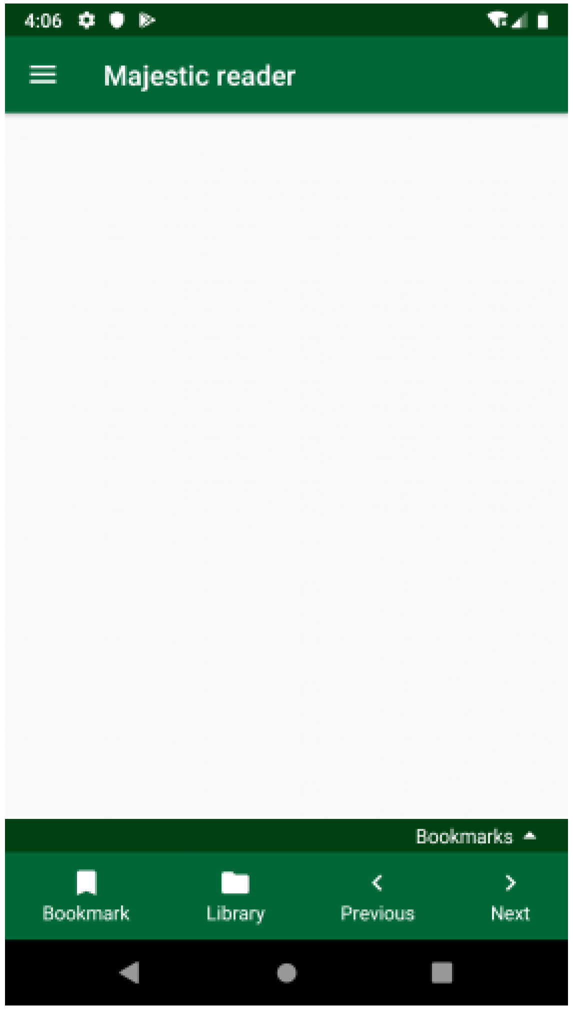


The app consists of two screens:

A list of PDF documents in your library.

A PDF document reader.


4:06
Majestic Reader
The best reader in town
Library
Reader



Currently, those are dummy screens. Your job is to implement library and reader functionality using Clean Architecture.

Clean Architecture

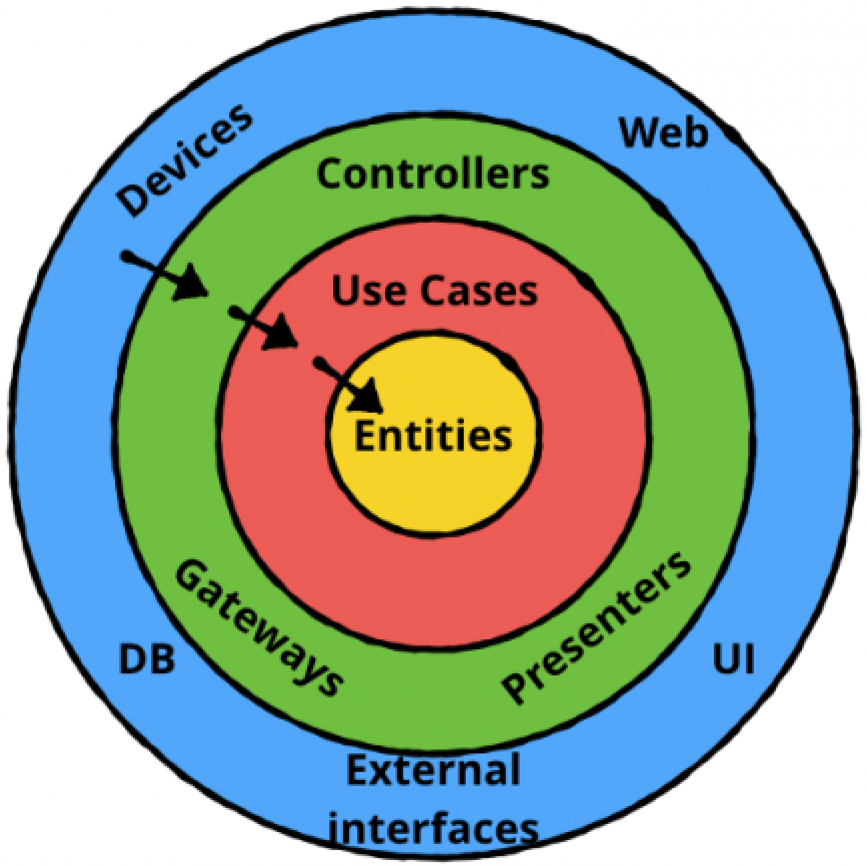
You might be wondering: Why should I use an architecture? I'm better than that. Well, bear with me.

Why Architecture Is Important

All architectures have one common goal — to manage the complexity of your application. You may not need to worry about it on a smaller project, but it becomes a lifesaver on larger ones.

How does Clean Architecture approach the problem?

You might have seen this graph already:



The circles represent different levels of software in your app. There are two key things to note:

The center circle is the most abstract, and the outer circle is the most concrete. This is called the *Abstraction Principle*. The Abstraction Principle specifies that inner circles should contain business logic, and outer circles should contain implementation details.

Another principle of Clean Architecture is the *Dependency Rule*. This rule specifies that each circle can depend only on the nearest inward circle — this is what makes the architecture work.

The outer circle represents the concrete mechanisms that are specific to the platform such as networking and database access. Moving inward, each circle is more abstract and higher-level. The center circle is the most abstract and contains business logic, which doesn't rely on the platform or the framework you're using.

Additional benefits of using an architecture when structuring app code include:

Parts of the code get decoupled, and easier to reuse and test.

There's a method to the madness. When someone else works on your code, they can learn the app's architecture and will understand it better.

SOLID Principles

Five design principles make software design more understandable, flexible and maintainable. Those principles are:

Single Responsibility: Each software component should have only one reason to change – one responsibility.

Open-closed: You should be able to extend the behavior of a component, without breaking its usage, or modifying its extensions.

Liskov Substitution: If you have a class of one type, and any subclasses of that class, you should be able to represent the base class usage with the subclass, without breaking the app.

Interface Segregation: It's better to have many smaller interfaces than a large one, to prevent the class from implementing the methods that it doesn't need.

Dependency Inversion: Components should depend on abstractions rather than concrete implementations. Also higher level modules shouldn't depend on lower level modules.

Clean Architecture maximizes the use of these principles.

Layers of Clean Architecture

There are different opinions about how many layers Clean Architecture should have. The architecture doesn't define exact layers but instead lays out the foundation. The idea is that you adapt the number of layers to your needs.

To keep things simple, you'll use five layers:

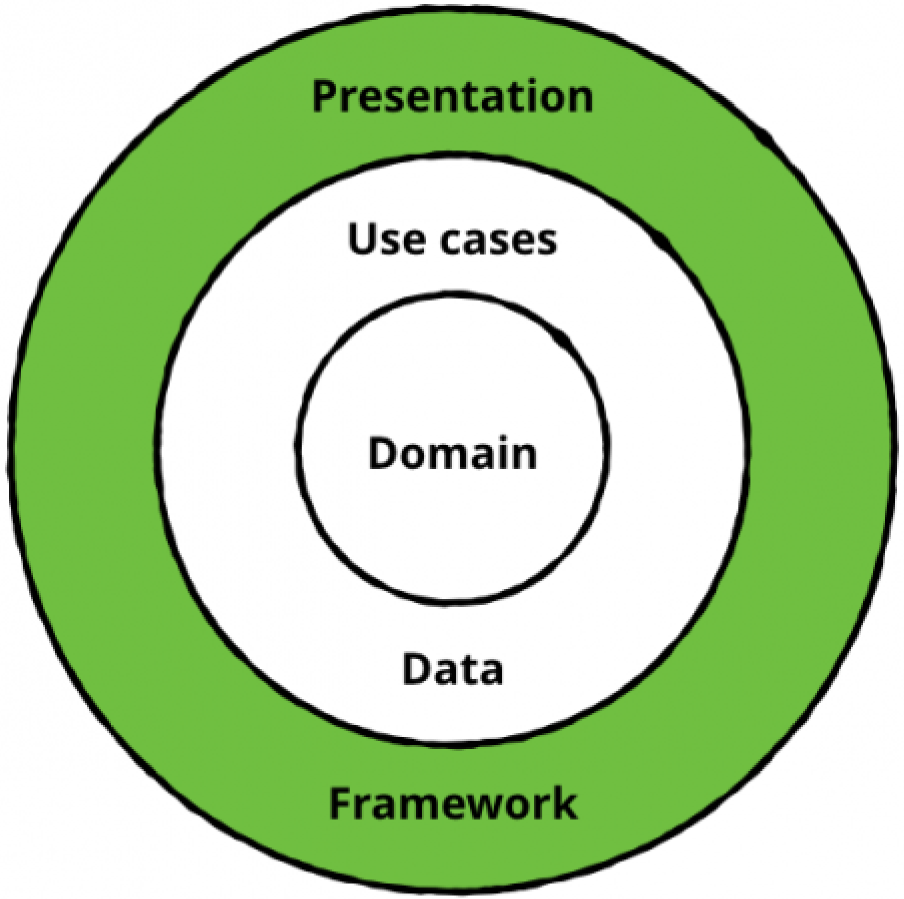
Presentation: A layer that interacts with the UI.

Use cases: Sometimes called interactors. Defines actions the user can trigger.

Domain: Contains the business logic of the app.

Data: Abstract definition of all the data sources.

Framework: Implements interaction with the Android SDK and provides concrete implementations for the data layer.



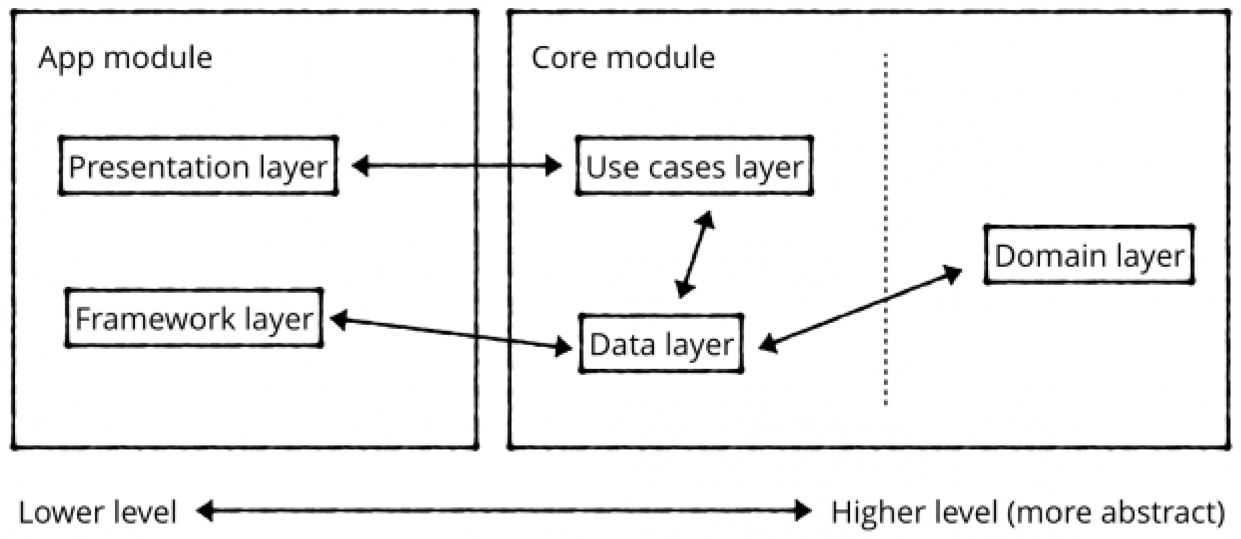
Layers marked green depend on Android SDK.

Project Structure

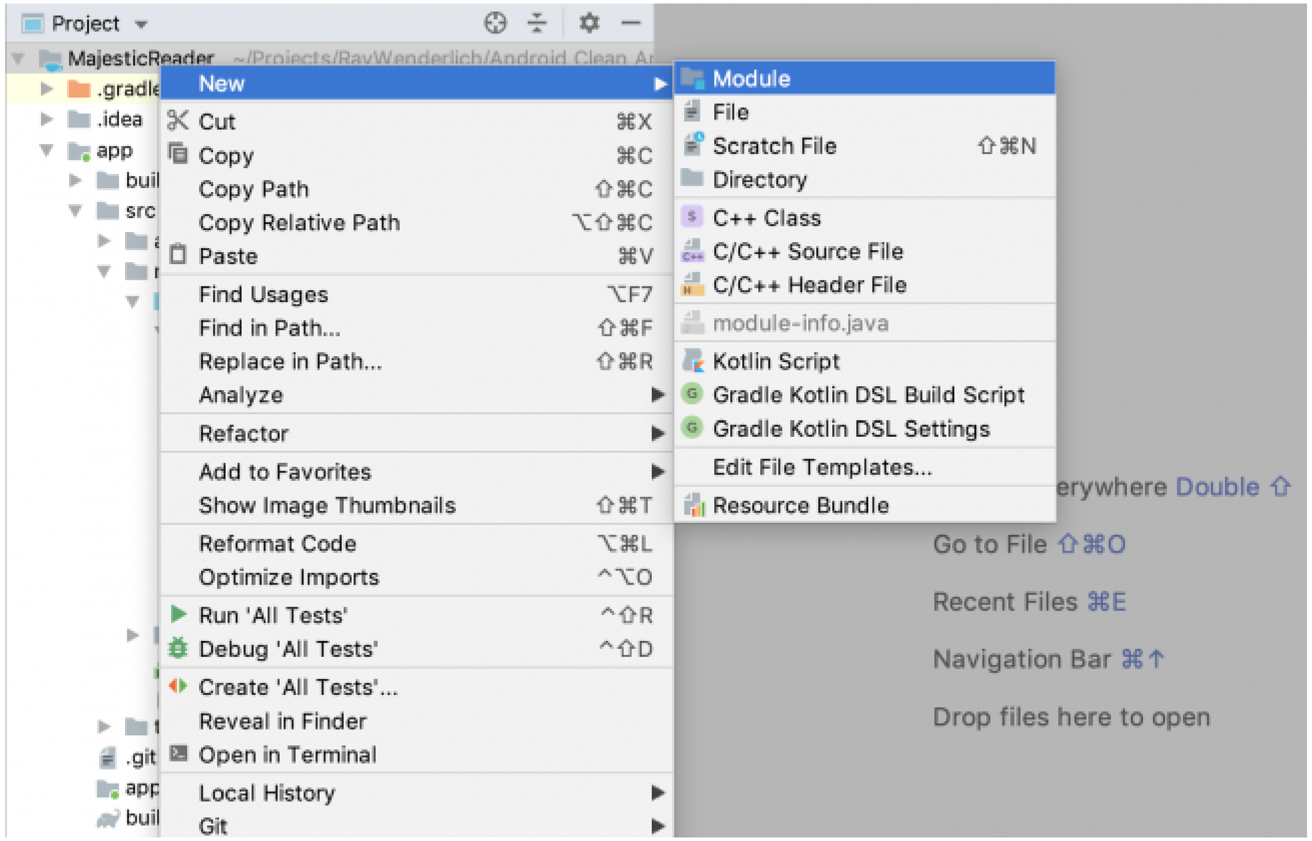
Since Clean architecture can be applied anywhere, it's important to know how you'll implement it on Android.
You'll split the project into two modules:

- The existing *app* module.
- A new *core* module that will hold all the code that doesn't depend on Android SDK.

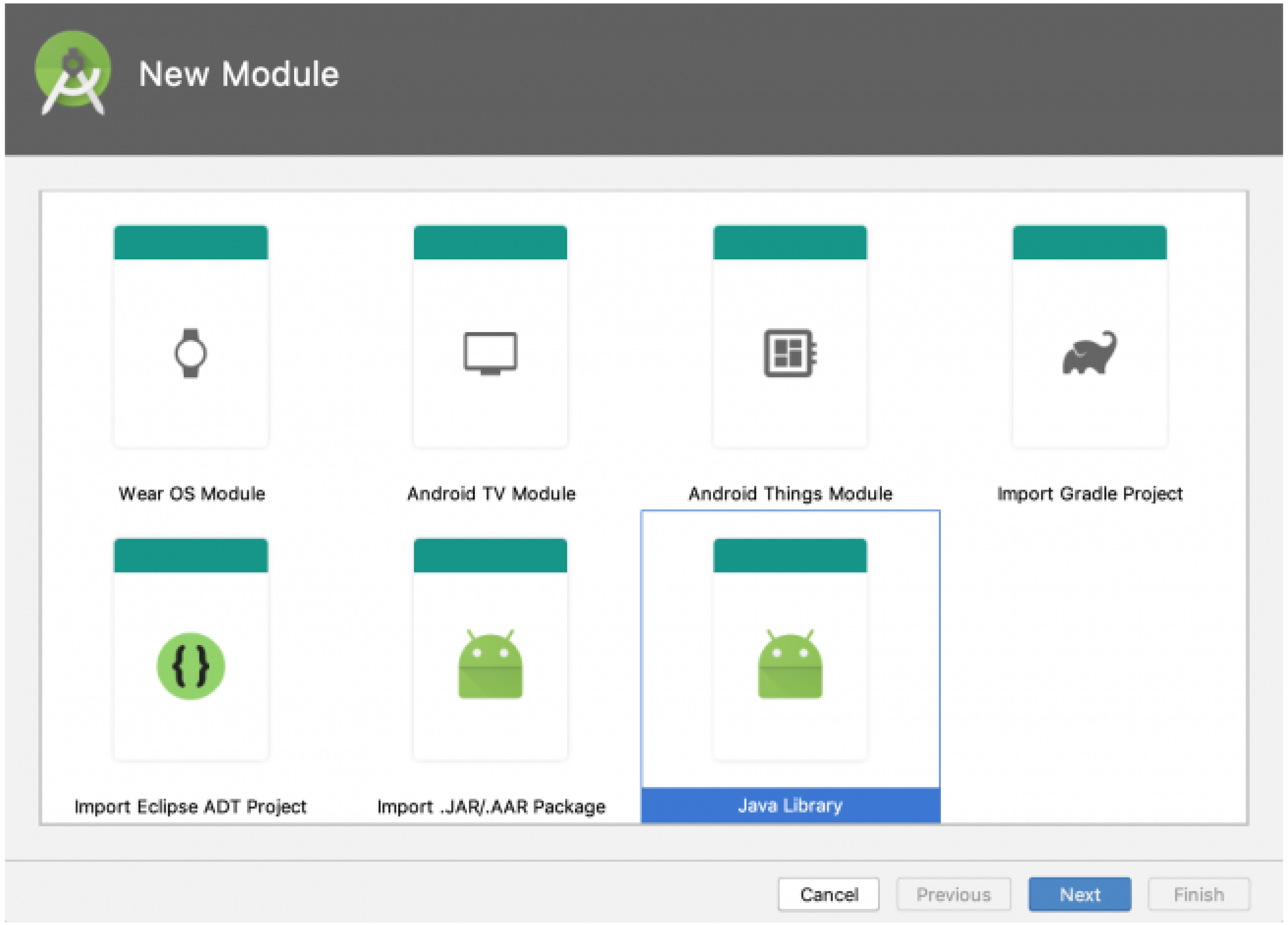
The following graph shows communication between the layers and how they are arranged in modules:



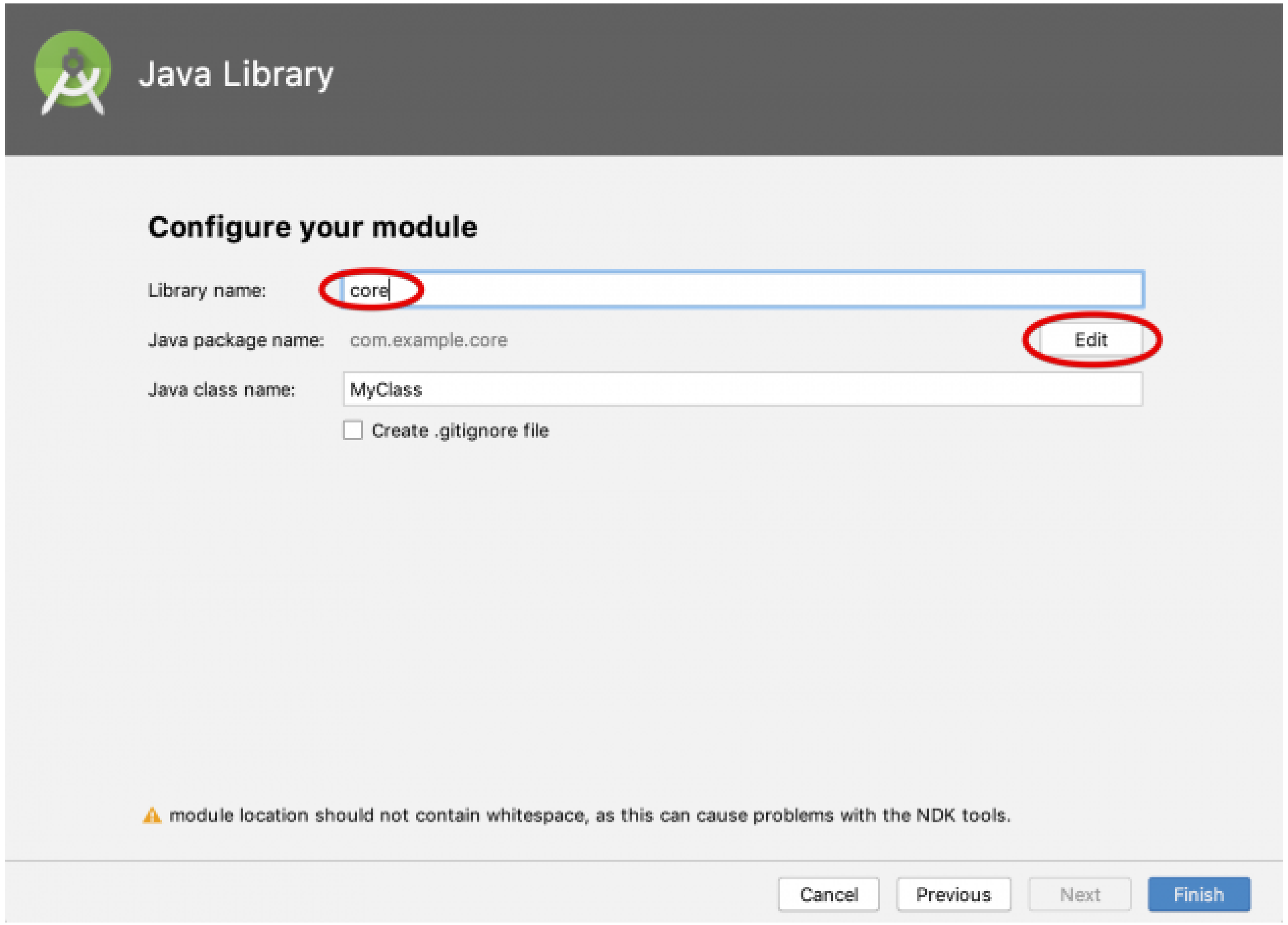
The app module is already there, so start by creating a *core* module.
Right click on *MajesticReader* in Project explorer and select *New* ▸ *Module* or select *File* ▸ *New* ▸ *New Module*.



In the wizard, select *Java library* and click “Next”.



Under Library name, type *core*.



Configure your module

Library name: core

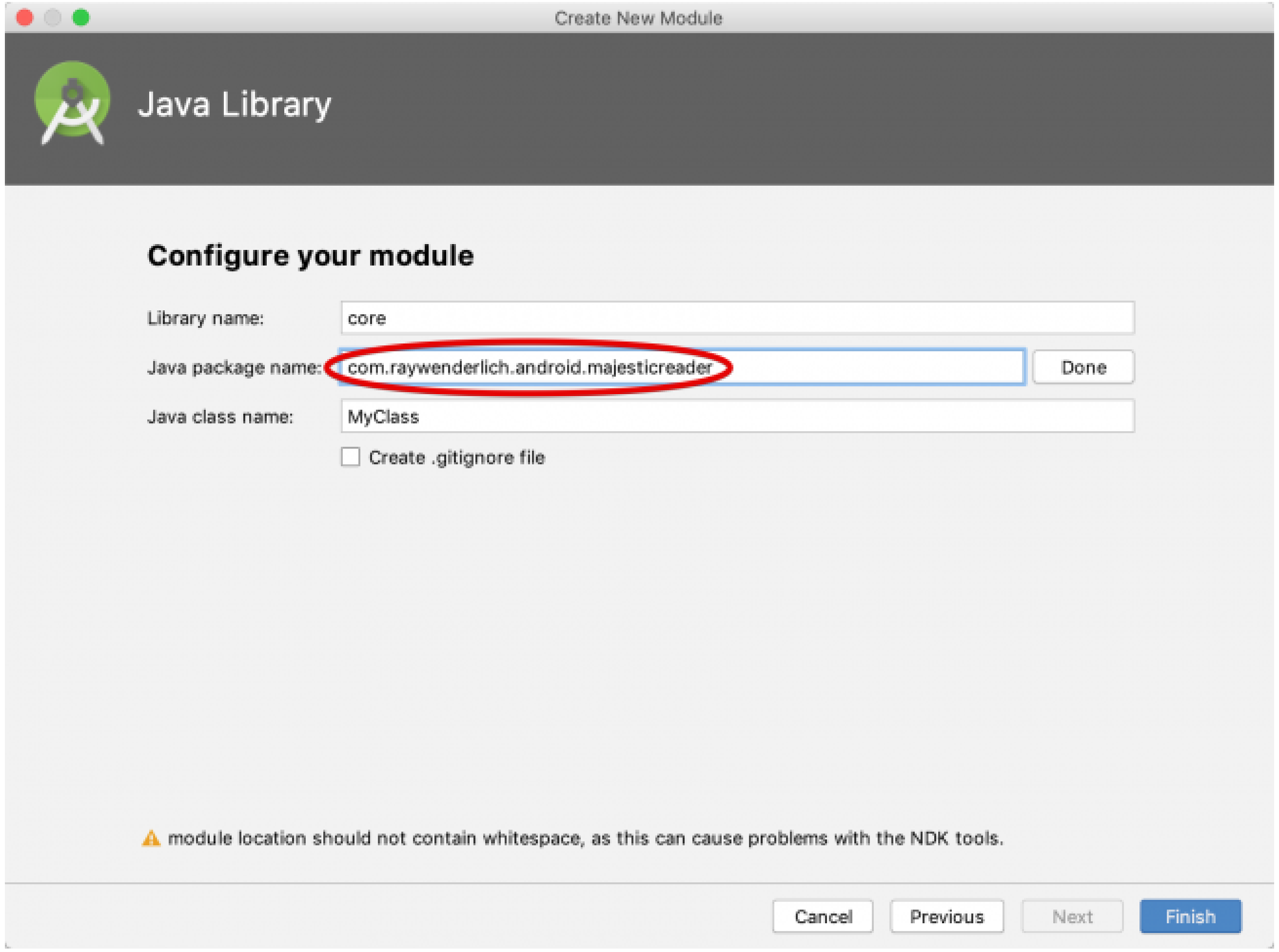
Java package name: com.example.core Edit

Java class name: MyClass

☐ Create .gitignore file

module location should not contain whitespace, as this can cause problems with the NDK tools.

Click on the *Edit* button next to the Java package name field and type in *com.raywenderlich.android.majesticreader*. Then, click *Done*.



Configure your module

Library name: core

Java package name: com.raywenderlich.android.majesticreader

Java class name: MyClass

Create .gitignore file

module location should not contain whitespace, as this can cause problems with the NDK tools.

Ignore Java Class Name and click on *Finish*.
Wait for the gradle to sync. Then, open *build.gradle* in the *core* module and add the following after the first apply plugin line:

```
apply plugin: 'kotlin'
```

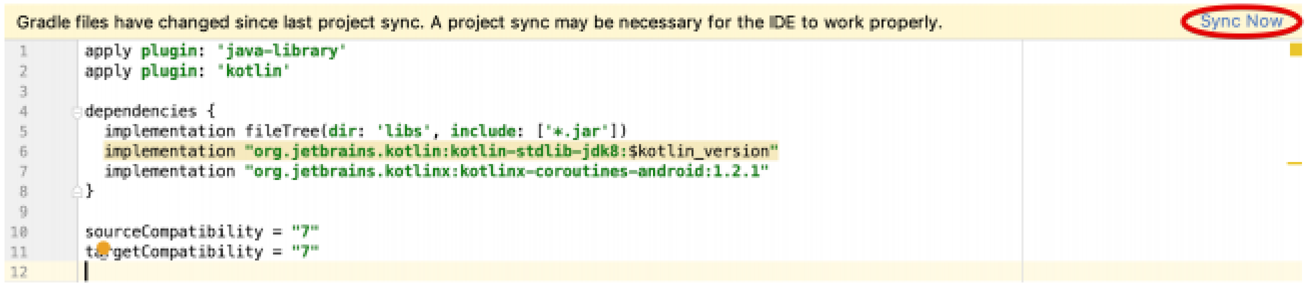
In the `dependencies` section, add two more dependencies:

```
implementation "org.jetbrains.kotlin:kotlin-stdlib-jdk8:$kotlin_version"
implementation "org.jetbrains.kotlinx:kotlinx-coroutines-android:1.2.1"
```

Next, reference the core module from the app module.
Open *build.gradle* in the *app* module and add the following line under the dependencies block:

```
implementation project(':core')
```

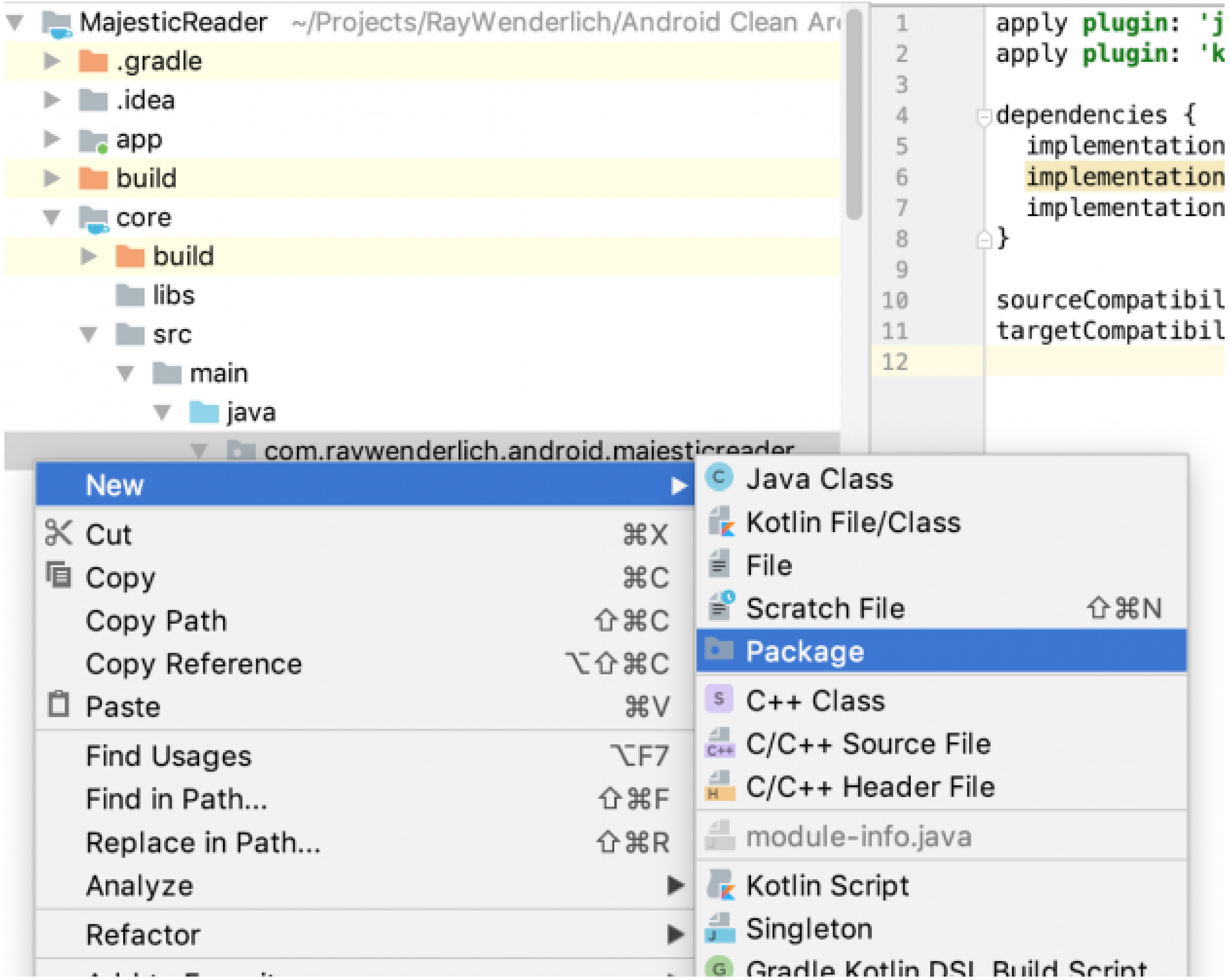
Click *Sync Now* in the top-right corner on the message strip and wait for the Gradle to sync.



Gradle files have changed since last project sync. A project sync may be necessary for the IDE to work properly. Sync Now

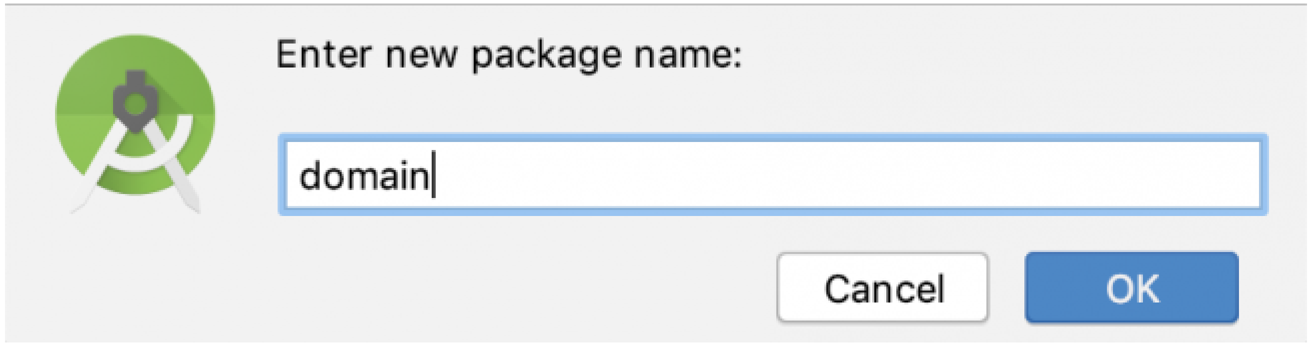
```
apply plugin: 'java-library'
apply plugin: 'kotlin'

dependencies {
  implementation fileTree(dir: 'libs', include: ['*.jar'])
  implementation "org.jetbrains.kotlin:kotlin-stdlib-jdk8:$kotlin_version"
  implementation "org.jetbrains.kotlinx:kotlinx-coroutines-android:1.2.1"
}

sourceCompatibility = "7"
targetCompatibility = "7"
```

Next, select *com.raywenderlich.adroid.majesticreader* in the core module. Right-click and select *New* ‣ *Package*

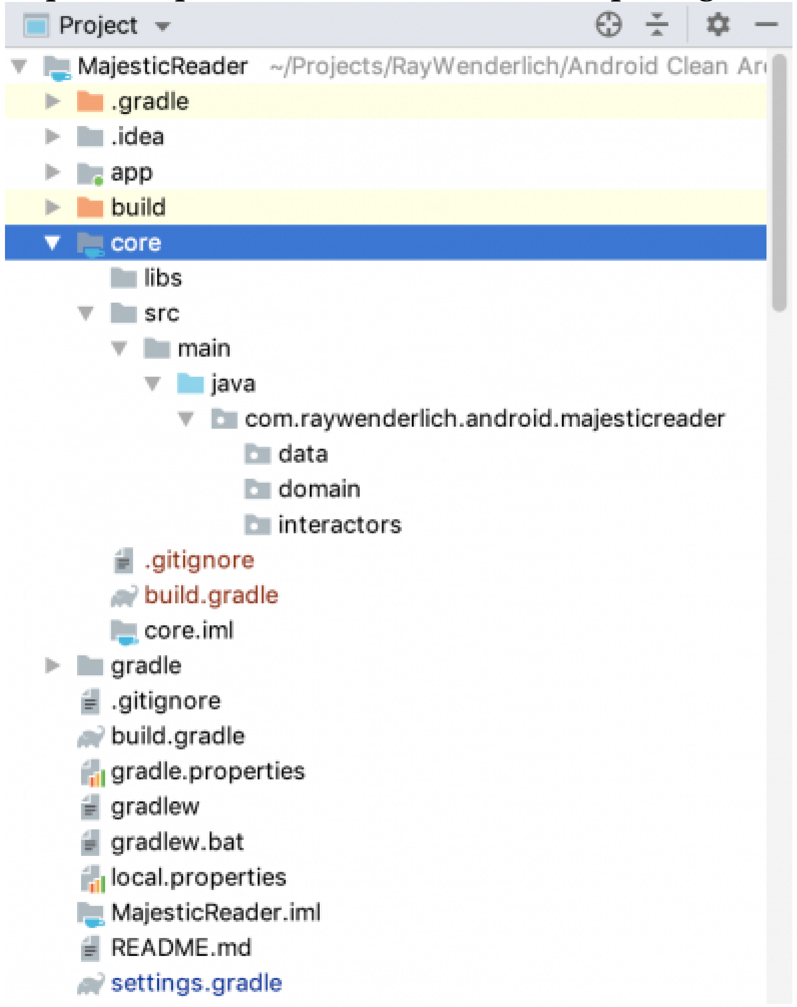


```
apply plugin: 'j
apply plugin: 'k

dependencies {
  implementation
  implementation
  implementation
}

sourceCompatibil
targetCompatibil
```

Type in *domain* for the name of the new package.



Repeat the process and create two more packages: *data* and *interactors*.



```
Project
▼ MajesticReader  ~/Projects/RayWenderlich/Android Clean Ar
  ▶ .gradle
  ▶ .idea
  ▶ app
  ▶ build
  ▼ core
      libs
    ▼ src
      ▼ main
        ▼ java
          ▼ com.raywenderlich.android.majesticreader
              data
              domain
              interactors
      .gitignore
      build.gradle
      core.iml
  ▶ gradle
    .gitignore
    build.gradle
    gradle.properties
    gradlew
    gradlew.bat
    local.properties
    MajesticReader.iml
    README.md
    settings.gradle
```

Feel free to delete the Java class created by the new module wizard. Now, you have to implement each of the layers independently. :]

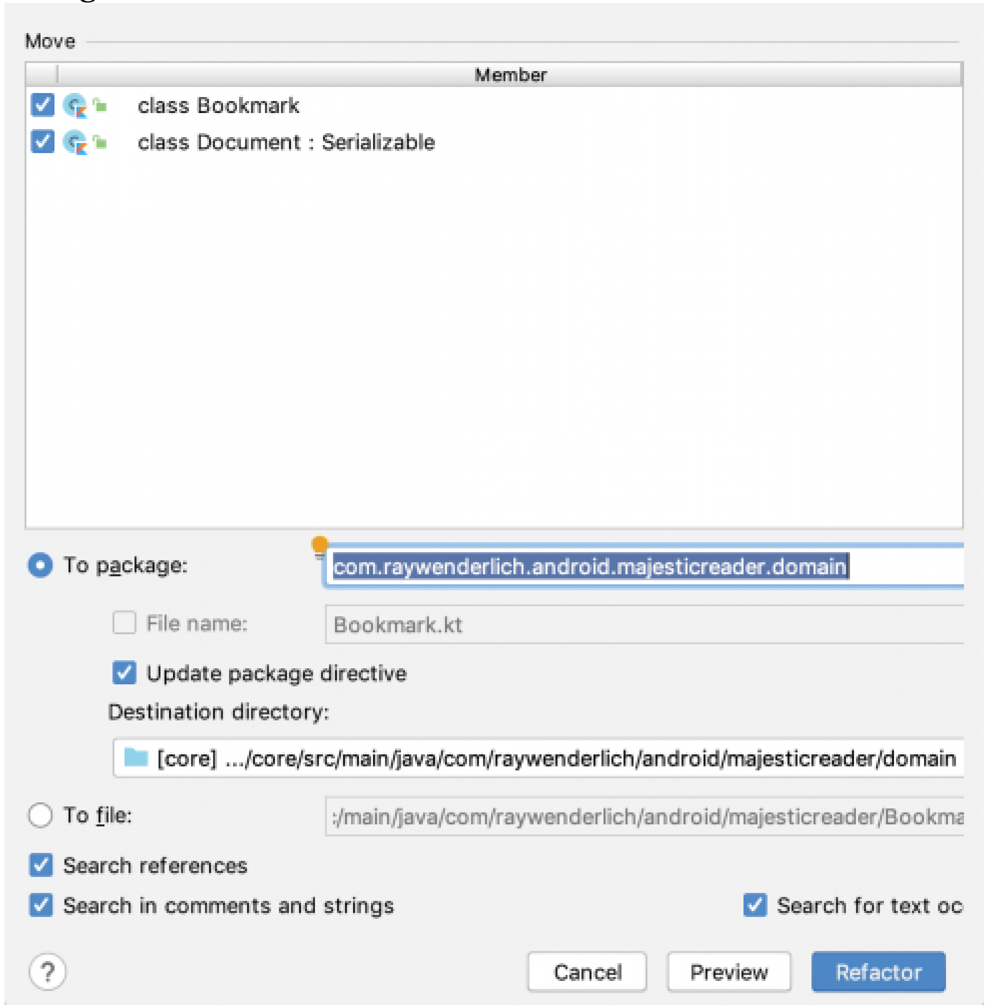
The Data and Business Logic Layers

You'll work your way from the centermost abstract layers to the outer, more concrete layers.

The Domain Layer

The Domain layer contains all the models and business rules of your app.

Move the `Bookmark` and `Document` models provided in the starter project to the *core* module. Select *Bookmark* and *Document* files from *app* module and drag them to the *com.raywenderlich.android.majesticreader.domain* package in the *core* module. You'll see a dialog:



Move

	Member
✓	class Bookmark
✓	class Document : Serializable

● To package: com.raywenderlich.android.majesticreader.domain

☐ File name: Bookmark.kt

✓ Update package directive

Destination directory:

[core] .../core/src/main/java/com/raywenderlich/android/majesticreader/domain

○ To file: :/main/java/com/raywenderlich/android/majesticreader/Bookma

✓ Search references

✓ Search in comments and strings ✓ Search for text oc

Click on *Refactor* to finish the process.

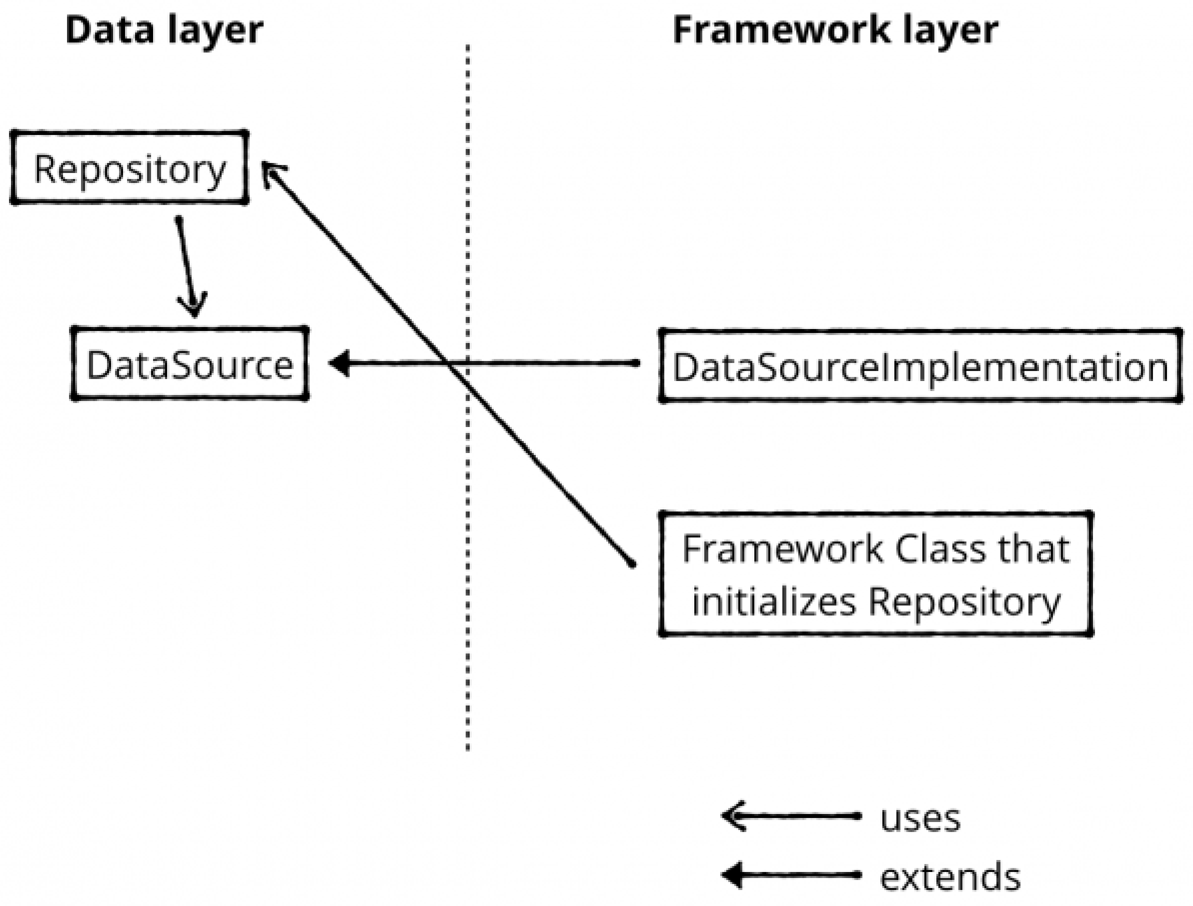
The Data Layer

This layer provides abstract definitions for accessing data sources like a database or the internet. You'll use *Repository pattern* in this layer.

The main purpose of the *repository pattern* is to abstract away the concrete implementation of data access. To achieve this, you'll add one interface and one class for each model:

`DataSource` interface: The interface that the Framework layer must implement.

`Repository` class: Provides methods for accessing the data that delegate to `DataSource`.



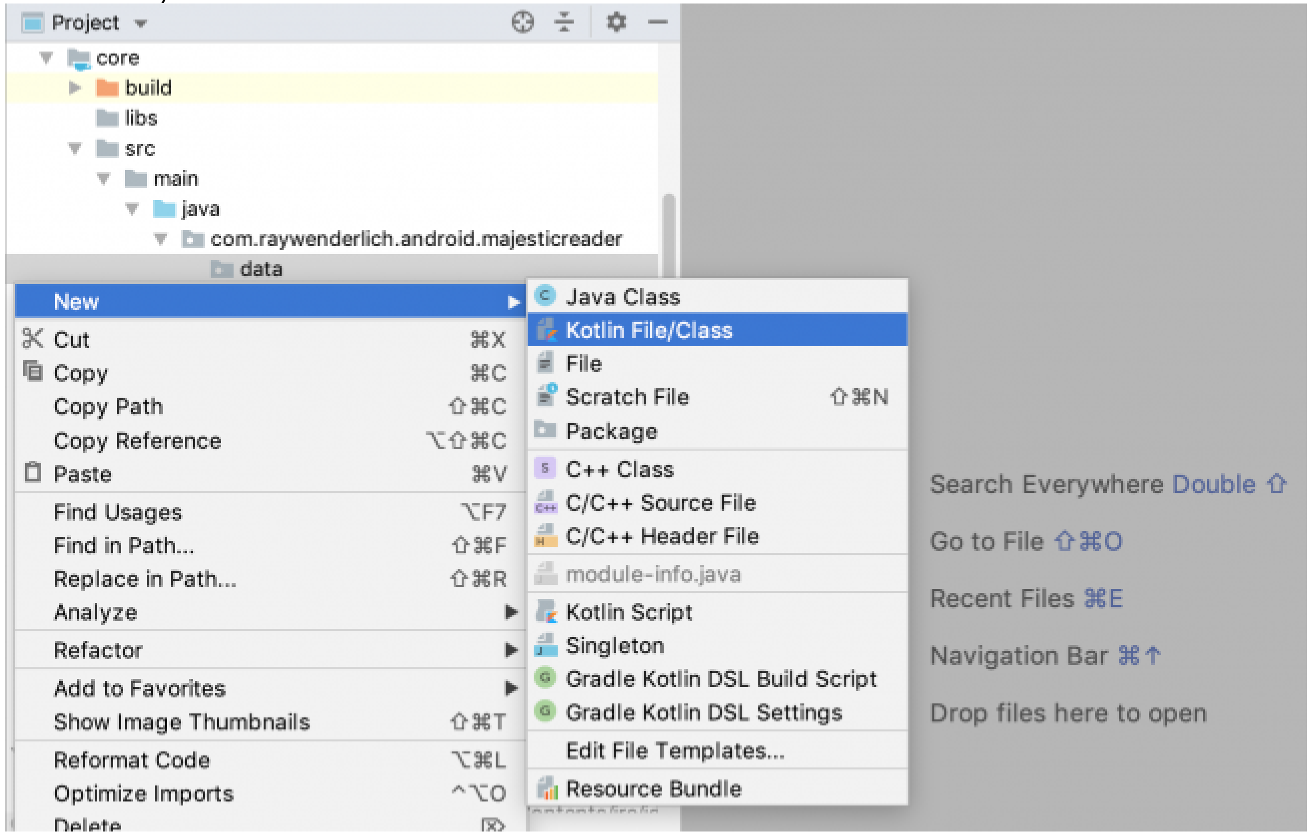
Using the repository pattern is a good example of the *Dependency Inversion Principle* because:

A Data layer which is of a higher, more abstract level doesn't depend on a framework, lower-level layer.

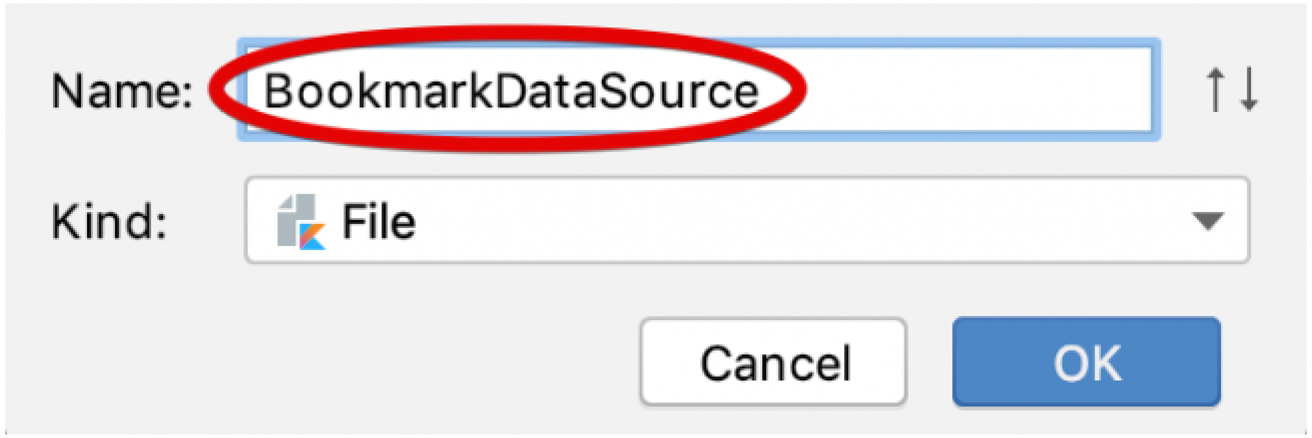
The repository is an abstraction of Data Access and it does not depend on details. It depends on abstraction.

Adding Repositories

Select *com.raywenderlich.android.majesticreader.data* in the core module. Add a new Kotlin file by right-clicking and selecting *New ▸ Kotlin File/Class*.



Type *BookmarkDataSource* in the dialog.



Click *Finish*. Open the new file and paste the following code after the first line:

```
import com.raywenderlich.android.majesticreader.domain.Bookmark
import com.raywenderlich.android.majesticreader.domain.Document

interface BookmarkDataSource {

  suspend fun add(document: Document, bookmark: Bookmark)

  suspend fun read(document: Document): List<Bookmark>

  suspend fun remove(document: Document, bookmark: Bookmark)
}
```

You'll use this interface to provide the `Bookmark` data access from the Framework layer. Repeat the process and add another interface named `DocumentDataSource`:

```
import com.raywenderlich.android.majesticreader.domain.Document

interface DocumentDataSource {

  suspend fun add(document: Document)

  suspend fun readAll(): List<Document>

  suspend fun remove(document: Document)
}
```

Repeat the process and add the last data source named `OpenDocumentDataSource`:

```
import com.raywenderlich.android.majesticreader.domain.Document

interface OpenDocumentDataSource {

  fun setOpenDocument(document: Document)

  fun getOpenDocument(): Document
}
```

This data source will take care of storing and retrieving the currently opened PDF document. Next, add a new Kotlin file named `BookmarkRepository` to the same package and copy and paste the following code:

```
import com.raywenderlich.android.majesticreader.domain.Bookmark
import com.raywenderlich.android.majesticreader.domain.Document

class BookmarkRepository(private val dataSource: BookmarkDataSource) {
  suspend fun addBookmark(document: Document, bookmark: Bookmark) =
    dataSource.add(document, bookmark)

  suspend fun getBookmarks(document: Document) = dataSource.read(document)

  suspend fun removeBookmark(document: Document, bookmark: Bookmark) =
    dataSource.remove(document, bookmark)
}
```

This is the *Repository* that you'll use to add, remove and fetch stored bookmarks in the app. Note that you mark all the methods with the `suspend`modifier. This allows you to use coroutine-powered mechanisms in Room, for simpler threading.
Note: If you want to know more about Coroutines check out the official Kotlin documentation or our Kotlin Coroutines book!
As an exercise, try adding `DocumentRepository`.

```
import com.raywenderlich.android.majesticreader.domain.Document

class DocumentRepository(
    private val documentDataSource: DocumentDataSource,
    private val openDocumentDataSource: OpenDocumentDataSource) {

  suspend fun addDocument(document: Document) = documentDataSource.add(document)

  suspend fun getDocuments() = documentDataSource.readAll()

  suspend fun removeDocument(document: Document) = documentDataSource.remove(document)

  fun setOpenDocument(document: Document) = openDocumentDataSource.setOpenDocument(document)
  fun getOpenDocument() = openDocumentDataSource.getOpenDocument()
}
```

Reveal

The Use Cases Layer

This layer converts and passes user actions, also known as use cases, to inner layers of the application.

Majestic Reader has two key functionalities:

Showing and managing a list of documents in a library.

Enabling the user to open a document and manage bookmarks in it.

From that, you can list the actions users should be able to perform:

Adding a bookmark to a currently open document.

Removing a bookmark from a currently open document.

Getting all bookmarks for currently open documents.

Adding a new document to the library.

Removing a document from the library.

Getting documents in the library.

Setting currently opened documents.

Getting currently opened documents.

Your next task is to create a class that represents each use case.

Create a new Kotlin file named *AddBookmark* in *com.raywenderlich.android.majesticreader.interactors*. Add the following code after the package statement:

```
import com.raywenderlich.android.majesticreader.data.BookmarkRepository
import com.raywenderlich.android.majesticreader.domain.Bookmark
import com.raywenderlich.android.majesticreader.domain.Document

class AddBookmark(private val bookmarkRepository: BookmarkRepository) {
  suspend operator fun invoke(document: Document, bookmark: Bookmark) =
      bookmarkRepository.addBookmark(document, bookmark)
}
```

Each use case class has only one function that invokes the use case. For convenience, you're overloading the invoke operator. This enables you to simplify the function call on `AddBookmark` instance to `addBookmark()` instead of `addBookmark.invoke()`.

Note: For more details on overloading operators, see the official Kotlin documentation .

Adding The Remaining Use Cases

Repeat this procedure and add the classes for the remaining actions:

`AddDocument`

```
import com.raywenderlich.android.majesticreader.data.DocumentRepository
import com.raywenderlich.android.majesticreader.domain.Document

class AddDocument(private val documentRepository: DocumentRepository) {
  suspend operator fun invoke(document: Document) = documentRepository.addDocument(document)
}
```

Reveal
`GetBookmarks`

```
import com.raywenderlich.android.majesticreader.data.BookmarkRepository
import com.raywenderlich.android.majesticreader.domain.Document

class GetBookmarks(private val bookmarkRepository: BookmarkRepository) {

  suspend operator fun invoke(document: Document) = bookmarkRepository.getBookmarks(document)
}
```

Reveal
`GetDocuments`

```
import com.raywenderlich.android.majesticreader.data.DocumentRepository

class GetDocuments(private val documentRepository: DocumentRepository) {
  suspend operator fun invoke() = documentRepository.getDocuments()
}
```

Reveal
`GetOpenDocument`

```
import com.raywenderlich.android.majesticreader.data.DocumentRepository

class GetOpenDocument(private val documentRepository: DocumentRepository) {
  operator fun invoke() = documentRepository.getOpenDocument()
}
```

Reveal
`RemoveBookmark`

```
import com.raywenderlich.android.majesticreader.data.BookmarkRepository
import com.raywenderlich.android.majesticreader.domain.Bookmark
import com.raywenderlich.android.majesticreader.domain.Document

class RemoveBookmark(private val bookmarksRepository: BookmarkRepository) {
  suspend operator fun invoke(document: Document, bookmark: Bookmark) = bookmarksRepository
      .removeBookmark(document, bookmark)
}
```

Reveal

`RemoveDocument`

```
import com.raywenderlich.android.majesticreader.data.DocumentRepository
import com.raywenderlich.android.majesticreader.domain.Document

class RemoveDocument(private val documentRepository: DocumentRepository) {
  suspend operator fun invoke(document: Document) = documentRepository.removeDocument(document)
}
```

Reveal

`SetOpenDocument`

```
import com.raywenderlich.android.majesticreader.data.DocumentRepository
import com.raywenderlich.android.majesticreader.domain.Document

class SetOpenDocument(private val documentRepository: DocumentRepository) {
  operator fun invoke(document: Document) = documentRepository.setOpenDocument(document)
}
```

Reveal

Framework and UI

This concludes the implementation of the three inner layers in the core module. You're now ready to move on to remaining layers: *Framework* and *Presentation*. Both of those layers depend on Android SDK, so you'll place them in the `app` module.

The Framework Layer

The Framework layer holds implementations of interfaces defined in the Data layer.

Your next task is to provide implementations of Data source interfaces from the Data layer. Start with `OpenDocumentDataSource`. It will store the currently open document in memory and is the simplest one.

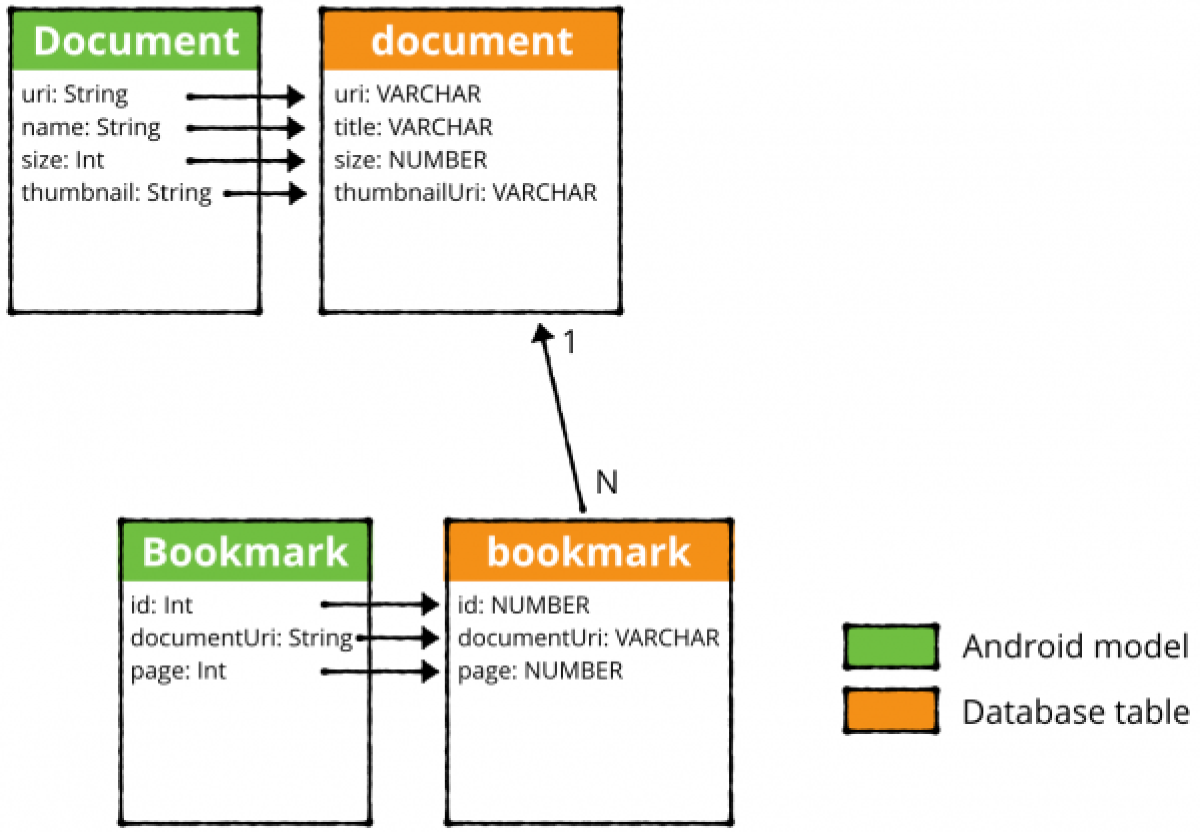
Create a new file in *app* module in *com.raywenderlich.android.majesticreader.framework* named `InMemoryOpenDocumentDataSource`. Paste the following after the first line:

```
import com.raywenderlich.android.majesticreader.data.OpenDocumentDataSource
import com.raywenderlich.android.majesticreader.domain.Document

class InMemoryOpenDocumentDataSource : OpenDocumentDataSource {

  private var openDocument: Document = Document.EMPTY

  override fun setOpenDocument(document: Document) {
    openDocument = document
    }

    override fun getOpenDocument() = openDocument
  }
```

This is an implementation of `OpenDocumentDataSource` from the Data layer. Currently, the open document is stored in memory, so the implementation is pretty straightforward.

Adding Remaining Data Sources

You will use the remaining data sources to delegate and persist data in the database, using the Room library. The classes required for persisting `Bookmarks` and `Document` via Room are in the *db* subpackage.



Note: for more information on Room, check our Room tutorial .
Create a new Kotlin file named *RoomBookmarkDataSource* in *framework*. Add the following code in the new file:

```
import android.content.Context
import com.raywenderlich.android.majesticreader.data.BookmarkDataSource
import com.raywenderlich.android.majesticreader.domain.Bookmark
import com.raywenderlich.android.majesticreader.domain.Document
import com.raywenderlich.android.majesticreader.framework.db.BookmarkEntity
import com.raywenderlich.android.majesticreader.framework.db.MajesticReaderDatabase

class RoomBookmarkDataSource(context: Context) : BookmarkDataSource {

  // 1
  private val bookmarkDao = MajesticReaderDatabase.getInstance(context).bookmarkDao()

  // 2
  override suspend fun add(document: Document, bookmark: Bookmark) =
    bookmarkDao.addBookmark(BookmarkEntity(
      documentUri = document.url,
      page = bookmark.page
    ))

  override suspend fun read(document: Document): List<Bookmark> = bookmarkDao
      .getBookmarks(document.url).map { Bookmark(it.id, it.page) }

  override suspend fun remove(document: Document, bookmark: Bookmark) =
    bookmarkDao.removeBookmark(
        BookmarkEntity(id = bookmark.id, documentUri = document.url, page = bookmark.page)
    )
}
```

Here’s what the code is doing, step by step:

1. Use `MajesticReaderDatabase` to get an instance of `BookmarkDao` and store it in local field.
2. Call add, read and remove methods from Room implementation.

Create a new Kotlin file named *RoomDocumentDataSource* in `framework`. Add the following code in the new file:

```
import android.content.Context
import com.raywenderlich.android.majesticreader.data.DocumentDataSource
import com.raywenderlich.android.majesticreader.domain.Document
import com.raywenderlich.android.majesticreader.framework.db.DocumentEntity
import com.raywenderlich.android.majesticreader.framework.db.MajesticReaderDatabase

class RoomDocumentDataSource(val context: Context) : DocumentDataSource {

  private val documentDao = MajesticReaderDatabase.getInstance(context).documentDao()

  override suspend fun add(document: Document) {
      val details = FileUtil.getDocumentDetails(context, document.url)
      documentDao.addDocument(
          DocumentEntity(document.url, details.name, details.size, details.thumbnail)
      )
    }

    override suspend fun readAll(): List<Document> = documentDao.getDocuments().map {
      Document(
          it.uri,
          it.title,
          it.size,
          it.thumbnailUri
      )
    }

    override suspend fun remove(document: Document) = documentDao.removeDocument(
        DocumentEntity(document.url, document.name, document.size, document.thumbnail)
    )
  }
```

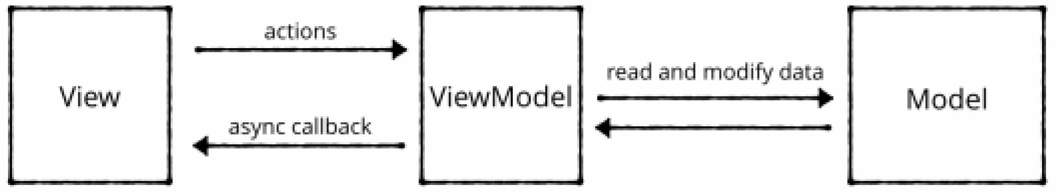
Now, what's left to do is to connect all the dots, and display the data.

The Presentation Layer

This layer contains the User Interface-related code. This layer is in the same circle as the framework layer, so you can depend on its classes.

Using MVVM

You'll be using the MVVM pattern in this layer because it's supported by Android Jetpack. Note that it doesn't matter which pattern you use for this layer and you are free to use what suits your needs best, be it MVP, MVI or something else.
For a quick introduction, here's a diagram:



MVVM pattern consists of three components:

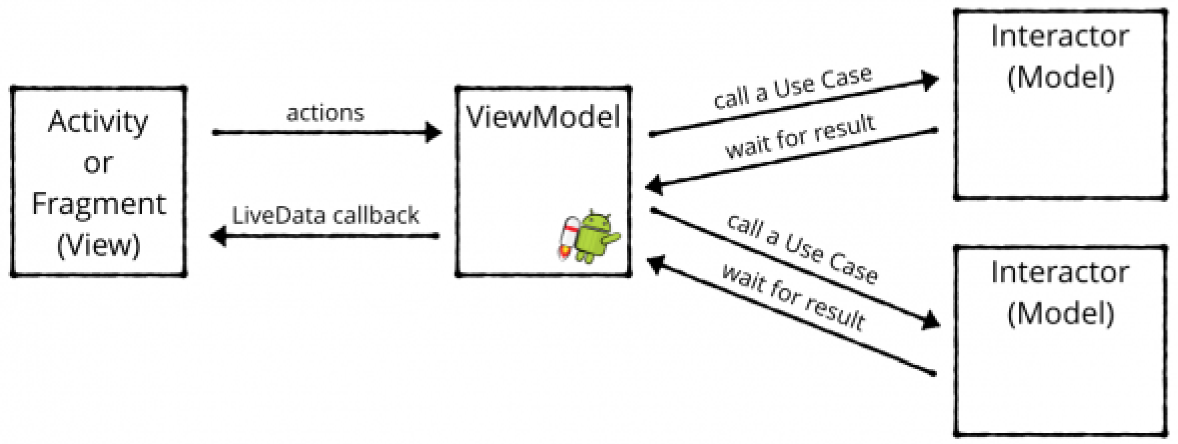
View: responsible for drawing the UI to the user

Model: Contains business logic and data.

ViewModel: Acts as a bridge between data and UI.

Note: For more information about MVVM, check out official documentation and our tutorial!

In Clean Architecture, instead of relying on Models, you'll communicate with Interactors from the Use Case layer.



This layer contains the user interface related code, powered by Android Jetpack! :]

Providing Sources

Before moving on to implementing the presentation layer, you need a way to provide the Data sources to the data layer. You should usually do this using *dependency injection*. It is the process of separating provider functions or factories for dependencies, and their usage. This makes your classes cleaner, as they don't create dependencies in their constructors.

Note: To fully leverage Clean Architecture you can use a dependency injection framework like Dagger 2 or Koin.

To keep things simple you'll manually implement an easy way to provide dependencies to your ViewModels.

First, replace the empty `Interactors` class in the framework namespace with the data class that holds all interactors:

```
import com.raywenderlich.android.majesticreader.interactors.*

data class Interactors(
    val addBookmark: AddBookmark,
    val getBookmarks: GetBookmarks,
    val deleteBookmark: RemoveBookmark,
    val addDocument: AddDocument,
    val getDocuments: GetDocuments,
    val removeDocument: RemoveDocument,
    val getOpenDocument: GetOpenDocument,
    val setOpenDocument: SetOpenDocument
)
```

You’ll use it to access interactors from ViewModels.
Open `MajesticReaderApplication` and replace `onCreate()` with the following, making sure you add all the necessary imports:

```
override fun onCreate() {
  super.onCreate()

  val bookmarkRepository = BookmarkRepository(RoomBookmarkDataSource(this))
  val documentRepository = DocumentRepository(
      RoomDocumentDataSource(this),
      InMemoryOpenDocumentDataSource()
  )

  MajesticViewModelFactory.inject(
      this,
      Interactors(
          AddBookmark(bookmarkRepository),
          GetBookmarks(bookmarkRepository),
          RemoveBookmark(bookmarkRepository),
          AddDocument(documentRepository),
          GetDocuments(documentRepository),
          RemoveDocument(documentRepository),
          GetOpenDocument(documentRepository),
          SetOpenDocument(documentRepository)
      )
  )
}
```

This injects all the dependencies into `MajesticViewModelFactory`. It creates ViewModels in the app and passes interactor dependencies to them.
Note: For more details on ViewModel factories, check the official documentation .
That concludes everything required for dependency injection. Now back to the Presentation layer.

Implementing MVVM

Open *LibraryViewModel.kt* in *com.raywenderlich.android.majesticreader.presentation.library*.
The ViewModel contains functions for loading the list of documents and adding a new one to the list. It serves as a connection between the UI and the interactors, or use cases.
First, replace `loadDocuments()` with the following:

```
fun loadDocuments() {
  GlobalScope.launch {
    documents.postValue(interactors.getDocuments())
    }
  }
```

This fetches the list of documents from the library using the `GetDocuments` interactor, from within a coroutine, which you start by calling `launch()`. Once done, you post the result to the `documents` LiveData.

Note: You shouldn't rely on `GlobalScope` often, in your code, but for the sake of simplicity, you will use it in this project.

Next, for `addDocument()`, you want to additionally call `loadDocuments()` after adding a new Document:

```
fun addDocument(uri: Uri) {
  GlobalScope.launch {
    withContext(Dispatchers.IO) {
      interactors.addDocument(Document(uri.toString(), "", 0, ""))
    }
    loadDocuments()
  }
}
```

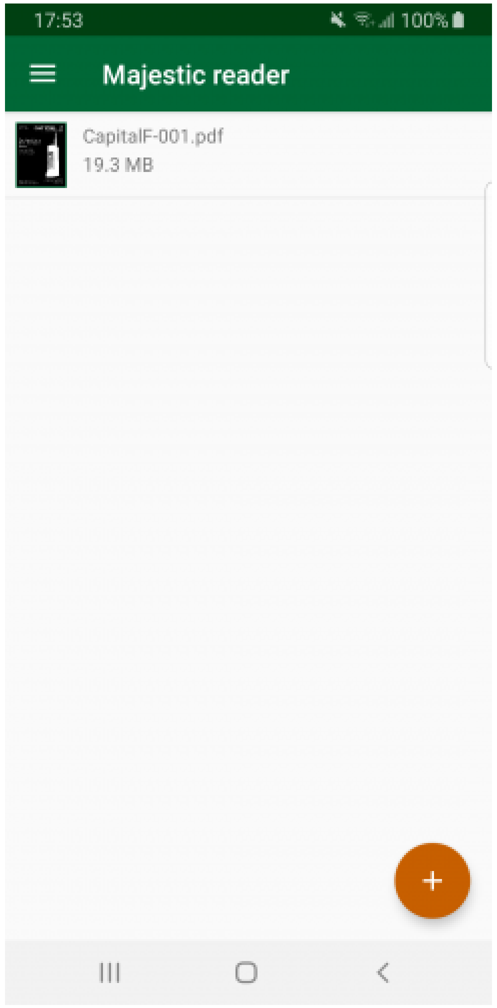
To add a new document, you first launch a coroutine, as before, then use `withContext()`, to move the database insert to an IO-optimized thread, and suspending until insertion completes. In the end, you load the documents again, to update the list.

Finally, `setOpenDocument()` calls the appropriate interactor:

```
fun setOpenDocument(document: Document) {
  interactors.setOpenDocument(document)
}
```

Now `build and run` the app. You can now add new documents to the library. At last, you can bear the fruits of your labor! :]

Tap the floating action button. You'll see a screen for picking a document from your storage. After you add a document, you'll see it on the list.



There is one more screen left — the reader screen.

Reading Documents

Open `ReaderViewModel` in *com.raywenderlich.android.majesticreader.presentation.reader*. There are a few places marked with `// TODO`comments that you'll add code to.

Here's an outline of the `ReaderViewModel` with functions that `ReaderFragment` will call on user actions:

`openDocument()`: Opens the PDF document.

`openBookmark()`: Navigates to the given bookmark in the document.

`openPage()`: Opens a given page in the document.

`nextPage()`: Navigates to the next page.

`previousPage()`: Navigates to the previous page.

`toggleBookmark()`: Adds or removes the current page from document bookmarks.
`toggleInLibrary()`: Adds or removes the open document from the library.
`ReaderFragment` will get a `Document` to display as an argument when it's created.
Look for the first `// TODO` comment in `ReaderViewModel`. Add the following code in its place:

```
addSource(document) { document ->
  GlobalScope.launch {
    postValue(interactors.getBookmarks(document))
  }
}
```

This will change the value of `bookmarks` each time you change the `document`. It will fill with up to date bookmarks, which you get from the interactors, within a coroutine. Your bookmarks field should now look like the following:

```
val bookmarks = MediatorLiveData<List<Bookmark>>().apply {
  addSource(document) { document ->
    GlobalScope.launch {
      postValue(interactors.getBookmarks(document))
    }
  }
}
```

The `document` holds the document parsed from Fragment arguments. `bookmarks` holds the list of bookmarks in the current document. `ReaderFragment` will subscribe to it to get the list of available bookmarks.

Rendering PDFs

To render the PDF document pages, use the `PdfRenderer`, which is available in Android SDK since API level 21.
Note: Fore more info on PdfRenderer check the official documentation .
`currentPage` holds the reference to `PdfRenderer.Page` that you currently display, if any. `renderer` holds a reference to the PdfRenderer used for rendering the document. Each time you change the `document`'s internal `value`, you create a new instance of PdfRenderer for the document and store in the `renderer`.
`hasPreviousPage` and `hasNextPage` rely on `currentPage`. They use LiveData transformations. `hasPreviousPage` returns true if the index of `currentPage` is larger than zero. `hasNextPage` returns true if the index of `currentPage` is less than the page count minus one – if the user hasn't reached the end. This data then dictates how the UI should appear and behave, in the `ReaderFragment`.
Note: For more details on LiveData transformations, see the official documentation .

Adding the Library Functionality

`isCurrentPageBookmarked()` returns true if a bookmark for the currently shown page exists. Find `isInLibrary()`. It should return true if the open document is already in the library. Replace it with:

```
private suspend fun isInLibrary(document: Document) =
    interactors.getDocuments().any { it.url == document.url }
```

This will use `GetDocuments` to get a list of all documents in the library and check if it contains one that matches the currently open document. Since this is a suspend function, change the `isInLibrary` `LiveData` code to the following:

```
val isInLibrary: MediatorLiveData<Boolean> = MediatorLiveData<Boolean>().apply {
  addSource(document) { document -> GlobalScope.launch { postValue(isInLibrary(document)) } }
}
```

In the end, the `LiveData` relations are really simple. `isBookmarked` relies on `isCurrentPageBookmarked()` – it will be true if there is a bookmark for the current page. Every time `document`, `currentPage` or `bookmarks` change, `isBookmarked` will receive an update and change, as well.
Look for the next `// TODO` comment in `loadArguments()`.
Put the following code in its place:

```
// 1
currentPage.apply {
  addSource(renderer) { renderer ->
    GlobalScope.launch {
      val document = document.value

      if (document != null) {
        val bookmarks = interactors.getBookmarks(document).lastOrNull()?.page ?: 0
        postValue(renderer.openPage(bookmarks))
      }
    }
  }
}

// 2
val documentFromArguments = arguments.get(DOCUMENT_ARG) as Document? ?: Document.EMPTY

// 3
val lastOpenDocument = interactors.getOpenDocument()

// 4
document.value = when {
  documentFromArguments != Document.EMPTY -> documentFromArguments
  documentFromArguments == Document.EMPTY && lastOpenDocument != Document.EMPTY -> lastOpenDocument
  else -> Document.EMPTY
}

// 5
document.value?.let { interactors.setOpenDocument(it) }
```

Here’s what the above code is doing, step by step.

. Initializes `currentPage` to be set to the first page or first bookmarked page if it exists.

. Gets `Document` passed to `ReaderFragment`.

. Gets the last document that was opened from `GetOpenDocument`.

. Sets the value of `document` to the one passed to `ReaderFragment` or falls back to `lastOpenDocument` if nothing was passed.

. Sets the new open document by calling `SetOpenDocument`.

Opening and Bookmarking Documents

Next, you'll implement `openDocument()`. Replace it with the following code:

```
fun openDocument(uri: Uri) {
  document.value = Document(uri.toString(), "", 0, "")
  document.value?.let { interactors.setOpenDocument(it) }
}
```

This creates a new `Document` that represents the document that was just open and passes it to `SetOpenDocument`.
Next, implement `toggleBookmark()`. Replace it with the following:

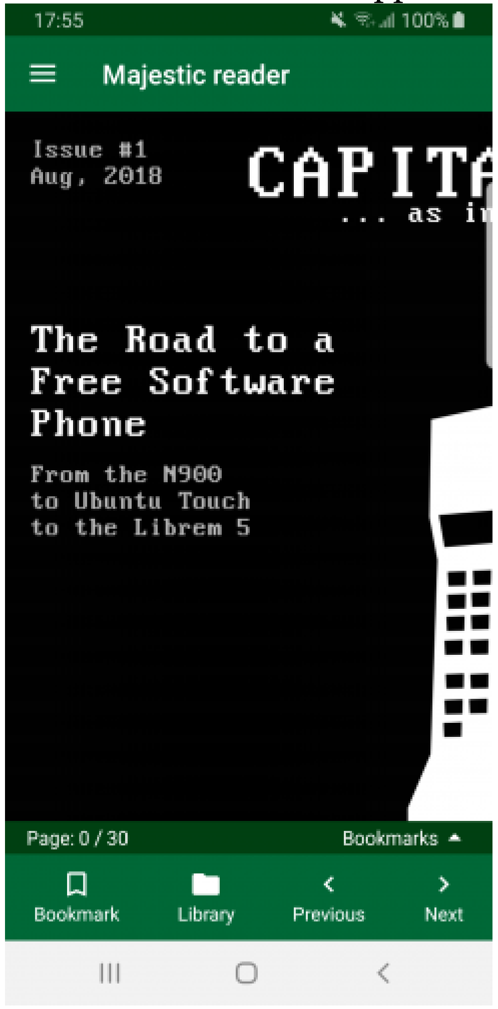
```
fun toggleBookmark() {
  val currentPage = currentPage.value?.index ?: return
  val document = document.value ?: return
  val bookmark = bookmarks.value?.firstOrNull { it.page == currentPage }

  GlobalScope.launch {
    if (bookmark == null) {
      interactors.addBookmark(document, Bookmark(page = currentPage))
    } else {
      interactors.deleteBookmark(document, bookmark)
    }

    bookmarks.postValue(interactors.getBookmarks(document))
  }
}
```

In this function, you either delete or add a bookmark, depending on if it's already in your database, and then you update the `bookmarks`, to refresh the UI.
Finally, implement `toggleInLibrary()`. Replace it with the following:

```
fun toggleInLibrary() {
  val document = document.value ?: return
```

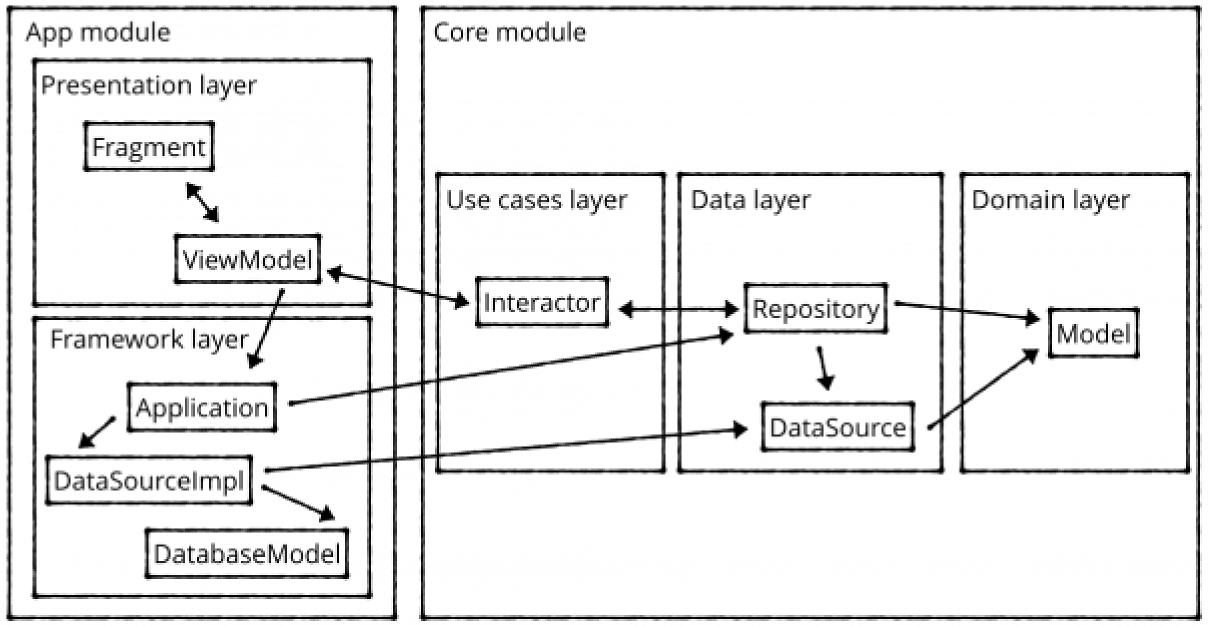
```
    GlobalScope.launch {
      if (isInLibrary.value == true) {
        interactors.removeDocument(document)
      } else {
        interactors.addDocument(document)
      }

      isInLibrary.postValue(isInLibrary(document))
    }
  }
```

Now *build and run* the app. Now you can open the document from your library by tapping it! :]



Conclusion

That’s it! You have a working PDF reader, and you’ve mastered Clean Architecture on Android! Congratulations!
Here’s a graph that gives an overview of Clean Architecture in combination with MVVM:



The three most important things to remember are:

The communication between layers: Only outer layers can depend on inner layers.

The number of layers is arbitrary: Customize it to your needs.

Things become more abstract in inner circles.

Pros of using Clean Architecture:

Code is more decoupled and testable.

You can replace the framework and presentation layers and port your app to a different platform.

It’s easier to maintain the project and add new features.

Cons of using Clean Architecture:

You’ll have to write more code, but it pays off.

You have to learn and understand Clean Architecture to work on the project.

When to Use Clean Architecture

It’s important to note that Clean architecture isn’t a silver bullet solution, but can be general, for any platform. You should decide, based on the project if it suits your needs. For example, if your project is big and complex, has a lot of business logic – then the Clean architecture brings clear benefits. On the other hand, for smaller and simpler projects those benefits might not be worth it – you'll just end up writing more code and adding some complexity with all the layers, investing more time along the way.