Writing truly testable code

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Why tests?

- Codebase grows
  -> **chances** of making a mistake **go up**
- Software gets released
  -> **cost** of a mistake **goes up**

-> Fear of introducing modifications!

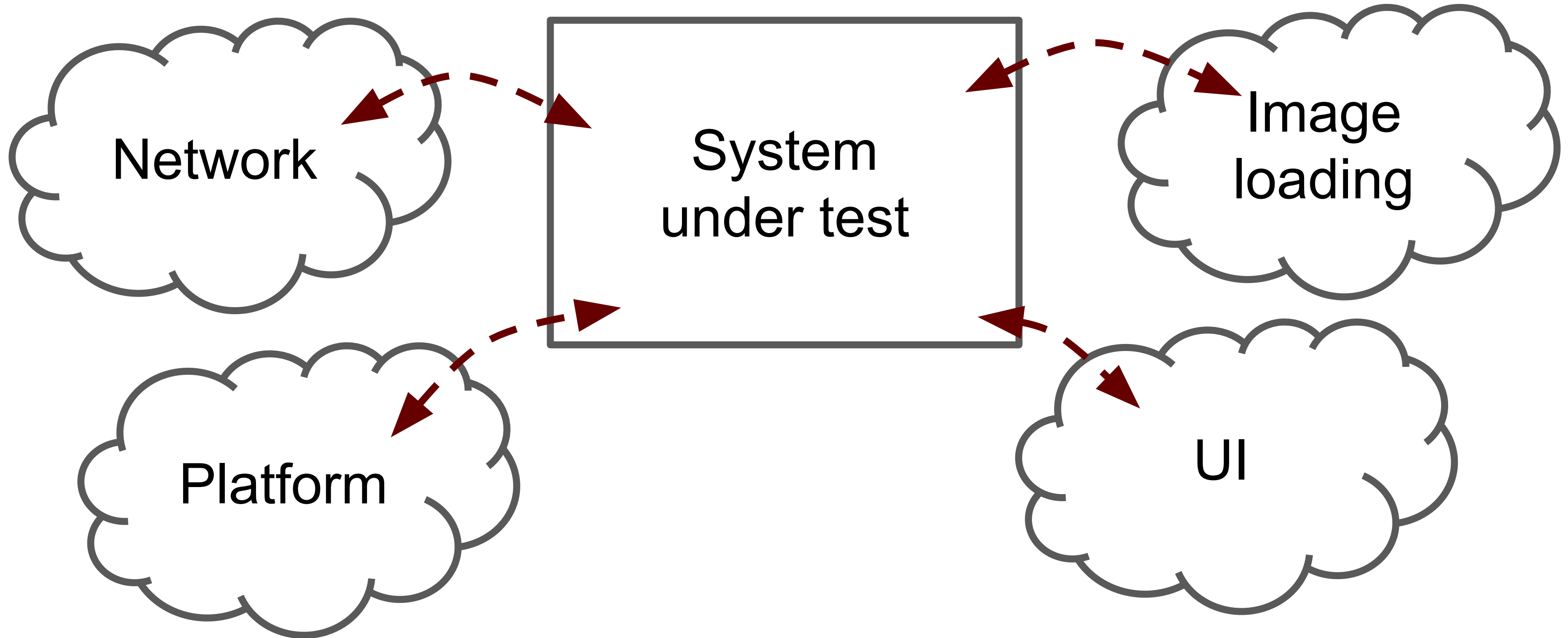
The two major issues

- Managing system complexity
  -> Rich Hickey **"Simple Made Easy"**
- Testing the system
  -> this talk

Our first test

Our first test attempt

What could possibly go wrong?



Agenda

- Truly testable is ...
- 3 rules of truly testable code
- Testability in practice
- How to start?

Truly testable is…

What is a test?

PASS

VALIDATE

Truly testable is…

all
inputs and outputs
are under control

3 rules of truly testable code

Rule #1

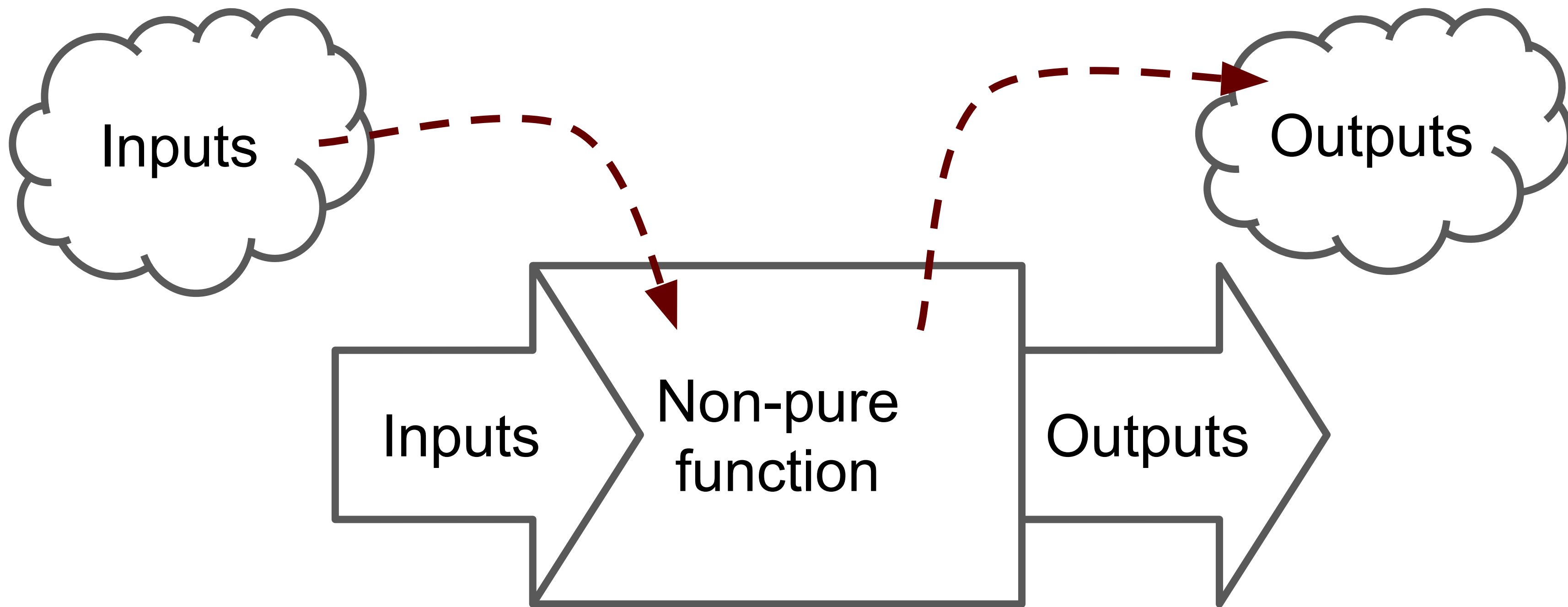
Testing a function

```
f(Arg[1], … , Arg[N]) -> (R[1], … , R[L])
```

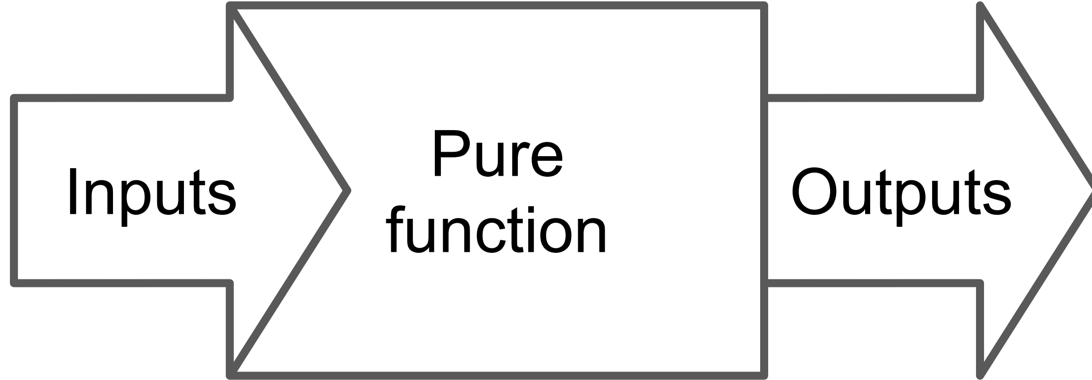
A non-pure function

```kotlin
fun nextItemDescription(prefix: String): String {
    GLOBAL_VARIABLE++
    return "$prefix: $GLOBAL_VARIABLE"
}
```

A non-pure function

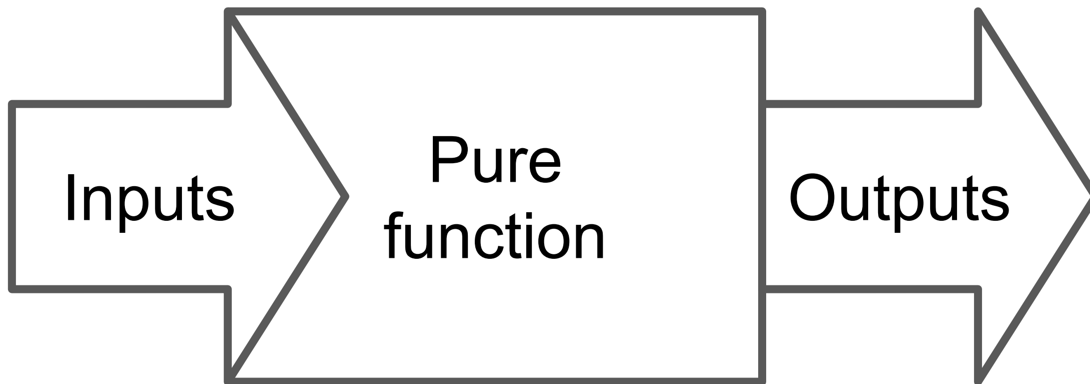


A pure function



A pure function

```
fun itemDescription(prefix: String, itemIndex: Int): String {
   return "$prefix: $itemIndex"
}
```



A function is easy to test if

```
f(Arg[1], … , Arg[N]) -> (R[1], … , R[L])
```

`Arg[i]` and **`R[i]`** are explicit: passed through parameters and returned as results

Rule #1

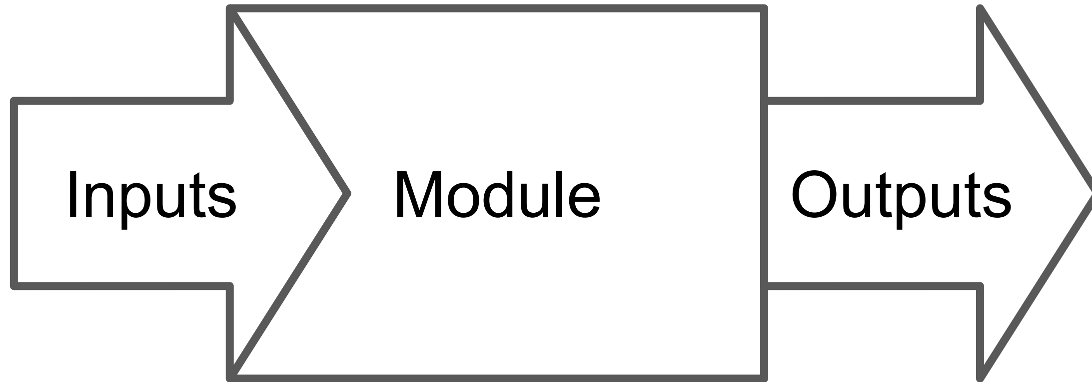
Pass
arguments & results
explicitly

Rule #2

Testing a module

```
M(In[1], … , In[N]) -> (Out[1], … , Out[L])
```

Testing a module



Module inputs

```
class Module(
        val title: String, // input

) {




}
```

Module inputs

```
class Module(
      val title: String, // input

) {
   fun doSomething() {    // input



      // ...
   }
}
```

Module inputs

```
class Module(
        val title: String, // input
        val dependency: Explicit   // dependency
) {
    fun doSomething() {    // input
        val explicit = dependency.getCurrentState()  // input


        // ...
    }
}
```

Module inputs

```
class Module(
        val title: String, // input
        val dependency: Explicit   // dependency
) {
    fun doSomething() {    // input
        val explicit = dependency.getCurrentState()  // input
        val implicit = Implicit.getCurrentState()    // input

        // ...
    }
}
```

Module inputs

```
class Module(
        val title: String, // input
        val dependency: Explicit   // dependency
) {
    fun doSomething() {    // input
        val explicit = dependency.getCurrentState()  // input
        val implicit = Implicit.getCurrentState()    // input

        // ...
    }
}
```

Module outputs

```
class Module(

) {
    var state = "Some state"

    fun doSomething() {
        state = "New state"                    // output




        // ...
    }
}
```

Module outputs

```
class Module(
        val dependency: Explicit    // dependency
) {
    var state = "Some state"

    fun doSomething() {
        state = "New state"                          // output

        dependency.setCurrentState("New state") // output

        // ...
    }
}
```

Module outputs

```
class Module(
      val dependency: Explicit   // dependency
) {
   var state = "Some state"

   fun doSomething() {
      state = "New state"                  // output

      dependency.setCurrentState("New state") // output
      Implicit.setCurrentState("New state")   // output
      // ...
   }
}
```

Module outputs

```
class Module(
        val dependency: Explicit   // dependency
) {
    var state = "Some state"

    fun doSomething() {
        state = "New state"                      // output

        dependency.setCurrentState("New state") // output
        Implicit.setCurrentState("New state")   // output
        // ...
    }
}
```

Module inputs

```
In[1], … , In[N]
```

- **Interactions** with module API and dependencies API
- **Values** passed through the interactions
- **Order** of the interactions
- **Timings** between the interactions

Module outputs

```
Out[1], … , Out[N]
```

- **Interactions** with module API and dependencies API
- **Values** passed through the interactions
- **Order** of the interactions
- **Timings** between the interactions
- Modifications of the module **state**

Testing a module

```
M(In[1], … , In[N]) -> (Out[1], … , Out[L])
   given, when               then
```

Test = call of the function + validation of the outputs

A module is easy to test if

```
M(In[1], … , In[N]) -> (Out[1], … , Out[L])
```

`In[i]` and `Out[i]` are passed through
module API or explicit dependencies API.

Rule #2

Pass dependencies explicitly

Rule #3

Explicit arguments & dependencies
==
full control ?

Explicit dependency test

```
class Module(explicit: Explicit) {
    val tripled = 3 * explicit.getValue()
}
```

Explicit dependency test

```
class Module(explicit: Explicit) {
    val tripled = 3 * explicit.getValue()
}

@Test
fun testValueGetsTripled() {




}
```

Explicit dependency test

```
class Module(explicit: Explicit) {
    val tripled = 3 * explicit.getValue()
}

@Test
fun testValueGetsTripled() {
    // prepare Explicit dependency

    val result = Module( ??? ).tripled


}
```

Explicit dependency test

```
class Module(explicit: Explicit) {
    val tripled = 3 * explicit.getValue()
}

@Test
fun testValueGetsTripled() {
    // prepare Explicit dependency

    val result = Module( ??? ).tripled
    val expected = 15

}
```

Explicit dependency test

```
class Module(explicit: Explicit) {
    val tripled = 3 * explicit.getValue()
}

@Test
fun testValueGetsTripled() {
    // prepare Explicit dependency

    val result = Module( ??? ).tripled
    val expected = 15
    assertThat(result).isEqualTo(expected)
}
```

Explicit dependency test

```
class Module(explicit: Explicit) {
    val tripled = 3 * explicit.getValue()
}

@Test
fun testValueGetsTripled() {
    // prepare Explicit dependency

    val result = Module( ??? ).tripled
    val expected = 15
    assertThat(result).isEqualTo(expected)
}
```

‘Explicit’ as a Singleton

```
// ‘object’ stands for Singleton in Kotlin
object Explicit {
    fun getValue(): Int = ...
}
```

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    fun getValue(): Int = ...
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@Test
fun testValueGetsTripled() {
    val result = Module( ??? ).tripled
    val expected = 15
    assertThat(result).isEqualTo(expected)
}
```

‘Explicit’ as a final class

```
// Classes are final by default in Kotlin
class Explicit {
   fun getValue(): Int = ...
}
```

‘Explicit’ as a final class

```
// Classes are final by default in Kotlin
class Explicit {
   fun getValue(): Int = ...
}

@Test
fun testValueGetsTripled() {
    val result = Module( ??? ).tripled
    val expected = 15
    assertThat(result).isEqualTo(expected)
}
```

‘Explicit’ as an Interface

```
interface Explicit {
    fun getValue(): Int

    class Impl: Explicit {
        override fun getValue(): Int = ...
    }
}
```

‘Explicit’ as an Interface

```
@Test
fun testValueGetsTripled() {
    // prepare Explicit dependency




    val result = Module( ??? ).tripled
    val expected = 15
    assertThat(result).isEqualTo(expected)
}
```

‘Explicit’ as an Interface

```kotlin
@Test
fun testValueGetsTripled() {
    val mockedExplicit = object : Explicit {
        override fun getValue(): Int = 5
    }

    val result = Module(mockedExplicit).tripled
    val expected = 15
    assertThat(result).isEqualTo(expected)
}
```

‘Explicit’ as an Interface

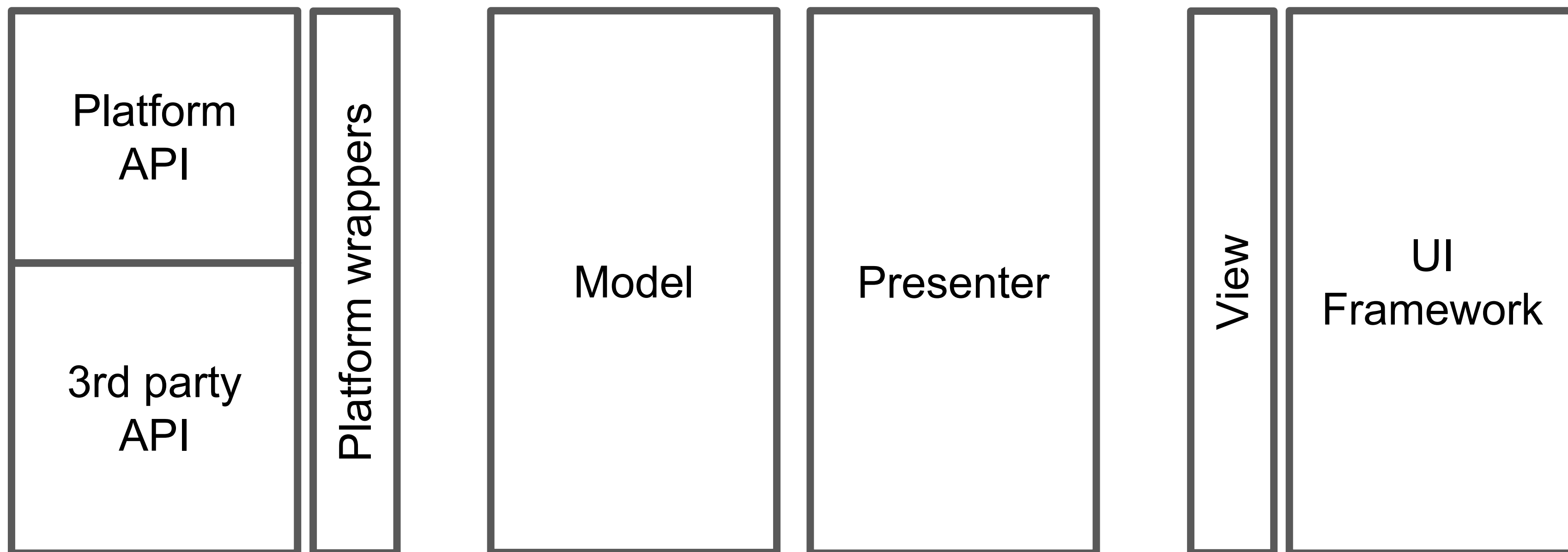
```
@Test
fun testValueGetsTripled() {
    val mockedExplicit = object : Explicit {
        override fun getValue(): Int = 5
    }

    val result = Module(mockedExplicit).tripled
    val expected = 15
    assertThat(result).isEqualTo(expected)
}
```

Rule #3

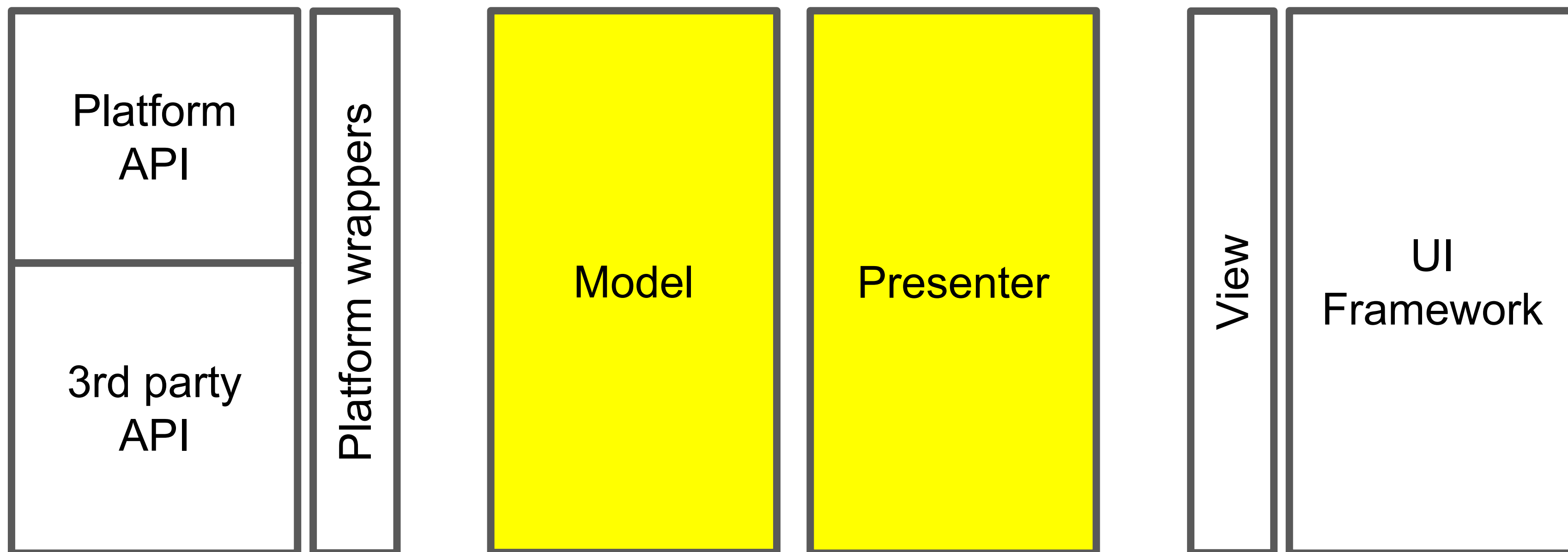
Make sure you can mock dependencies

Testability in practice

MVP. Overview



MVP. Overview



Practical aspects

1. Understand **explicits**
2. Locate **implicits** and convert them to **explicits**
3. Mock dependencies in tests
4. Abstract away the platform
5. Consider extracting implementation details

Testability in practice.

Understanding explicits

Explicit inputs

```
class ModuleInputs(
       input: String,




) {




}
```

Explicit inputs

```
class ModuleInputs(
        input: String,
        inputLambda: () -> String,


) {



}
```

Explicit inputs

```
class ModuleInputs(
        input: String,
        inputLambda: () -> String,
        inputObservable: Observable<String>,

) {



}
```

Explicit inputs

```
class ModuleInputs(
        input: String,
        inputLambda: () -> String,
        inputObservable: Observable<String>,

) {


   fun passInput(input: String) { }
}
```

Explicit inputs

```
class ModuleInputs(
        input: String,
        inputLambda: () -> String,
        inputObservable: Observable<String>,
        dependency: Explicit
) {
    private val someField = dependency.getInput()

    fun passInput(input: String) { }
}
```

Explicit inputs

```
class ModuleInputs(
        input: String,
        inputLambda: () -> String,
        inputObservable: Observable<String>,
        dependency: Explicit
) {
    private val someField = dependency.getInput()

    fun passInput(input: String) { }
}
```

Explicit outputs

```
class ModuleOutputs(


) {

    fun getOutput(): String = "Output"




}
```

Explicit outputs

```
class ModuleOutputs(
        outputLambda: (String) -> Unit,

) {

    fun getOutput(): String = "Output"

    init {
        outputLambda("Output")

    }
}
```

Explicit outputs

```
class ModuleOutputs(
        outputLambda: (String) -> Unit,

) {
    val outputObservable = Observable.just("Output")
    fun getOutput(): String = "Output"

    init {
        outputLambda("Output")

    }
}
```

Explicit outputs

```
class ModuleOutputs(
        outputLambda: (String) -> Unit,
        dependency: Explicit
) {
    val outputObservable = Observable.just("Output")
    fun getOutput(): String = "Output"

    init {
        outputLambda("Output")
        dependency.passOutput("Output")
    }
}
```

Explicit outputs

```
class ModuleOutputs(
        outputLambda: (String) -> Unit,
        dependency: Explicit
) {
    val outputObservable = Observable.just("Output")
    fun getOutput(): String = "Output"

    init {
        outputLambda("Output")
        dependency.passOutput("Output")
    }
}
```

Testability in practice.

Top 5 Implicits

#5: Statics and Singletons

```
class Module {
   private val state = Implicit.getCurrentState()
}
```

#5: Statics and Singletons

```
class Module(dependency: Explicit) {
    private val state = dependency.getCurrentState()
}
```

#5: Statics and Singletons

```
class Module(dependency: Explicit) {
   private val state = dependency.getCurrentState()
}
```

#4: Random generators

```
class Module {
   private val fileName = "some-file${Random().nextInt()}"
}
```

#4: Random generators

```
class Module(rng: Rng) {
   private val fileName = "some-file${rng.nextInt()}"
}
```

#4: Random generators

```
class Module(rng: Rng) {
   private val fileName = "some-file${rng.nextInt()}"
}
```

#3: File system & other storage

```
class Module {
   fun initStorage(path: String) {
          File(path).createNewFile()







   }
}
```

#3: File system & other storage

```
class Module {
    fun initStorage(path: String): FileCreationError? {
        return if (File(path).createNewFile()) {
            null
        } else {
            FileCreationError.Exists
        }




    }
}
```

#3: File system & other storage

```
class Module {
   fun initStorage(path: String): FileCreationError? = try {
       if (File(path).createNewFile()) {
           null
       } else {
           FileCreationError.Exists
       }
   } catch (e: SecurityException) {
       FileCreationError.Security(e)
   } catch (e: Exception) {
       FileCreationError.Other(e)
   }
}
```

#3: File system & other storage

```kotlin
class Module {
   fun initStorage(path: String): FileCreationError? = try {
       if (File(path).createNewFile()) {
           null
       } else {
           FileCreationError.Exists
       }
   } catch (e: SecurityException) {
       FileCreationError.Security(e)
   } catch (e: Exception) {
       FileCreationError.Other(e)
   }
}
```

#3: File system & other storage

```
class Module(private val fileCreator: FileCreator) {
    fun initStorage(path: String): FileCreationError? = try {
        if (fileCreator.createNewFile(path)) {
            null
        } else {
            FileCreationError.Exists
        }
    } catch (e: SecurityException) {
        FileCreationError.Security(e)
    } catch (e: Exception) {
        FileCreationError.Other(e)
    }
}
```

#3: File system & other storage

```kotlin
class Module(private val fileCreator: FileCreator) {
    fun initStorage(path: String): FileCreationError? = try {
        if (fileCreator.createNewFile(path)) {
            null
        } else {
            FileCreationError.Exists
        }
    } catch (e: SecurityException) {
        FileCreationError.Security(e)
    } catch (e: Exception) {
        FileCreationError.Other(e)
    }
}
```

#2: Time

```
class Module {
    private val nowTime = System.currentTimeMillis()
    private val nowDate = Date()
    // and all other time/date APIs
}
```

#2: Time

```
class Module(time: TimeProvider) {
    private val nowTime = time.nowMillis()
    private val nowDate = time.nowDate()
    // and all other time/date APIs
}
```

#2: Time

```
class Module(time: TimeProvider) {
    private val nowTime = time.nowMillis()
    private val nowDate = time.nowDate()
    // and all other time/date APIs
}
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
   val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
           .format(timestamp)
}
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
   val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
           .format(timestamp)
}

fun test() {




}
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
    val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
            .format(timestamp)
}

fun test() {
    val mobiusConfStart = 1492758000L



}
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
    val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
            .format(timestamp)
}

fun test() {
    val mobiusConfStart = 1492758000L
    val expected = ""
    val actual = MyTimePresenter(timestamp).formattedTimestamp
    assertThat(actual).isEqualTo(expected)
}
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
   val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
           .format(timestamp)
}

fun test() {
   val mobiusConfStart = 1492758000L
   val expected = "2017-04-21 10:00"
   val actual = MyTimePresenter(timestamp).formattedTimestamp
   assertThat(actual).isEqualTo(expected)
}
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
   val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
           .format(timestamp)
}

fun test() {
   val mobiusConfStart = 1492758000L
   val expected = "2017-04-21 10:00"
   val actual = MyTimePresenter(timestamp).formattedTimestamp
   assertThat(actual).isEqualTo(expected)
}
>> `actual on dev machine` = "2017-04-21 10:00"
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
   val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
           .format(timestamp)
}

fun test() {
   val mobiusConfStart = 1492758000L
   val expected = "2017-04-21 10:00"
   val actual = MyTimePresenter(timestamp).formattedTimestamp
   assertThat(actual).isEqualTo(expected)
}
>> `actual on dev machine` = "2017-04-21 10:00"
>> `actual on CI`          = "2017-04-21 07:00"
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
   val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
           .format(timestamp)
}

fun test() {
   val mobiusConfStart = 1492758000L
   val expected = "2017-04-21 10:00"
   val actual = MyTimePresenter(timestamp).formattedTimestamp
   assertThat(actual).isEqualTo(expected)
}
>> `actual on dev machine` = "2017-04-21 10:00" // UTC +3
>> `actual on CI`          = "2017-04-21 07:00" // UTC
```

#1: Formatting & Locales

```
class MyTimePresenter(timestamp: Long) {
   val formattedTimestamp = SimpleDateFormat("yyyy-MM-dd HH:mm")
           .format(timestamp)
}

fun test() {
   val mobiusConfStart = 1492758000L
   val expected = "2017-04-21 10:00"
   val actual = MyTimePresenter(timestamp).formattedTimestamp
   assertThat(actual).isEqualTo(expected)
}
>> `actual on dev machine` = "2017-04-21 10:00" // UTC +3
>> `actual on CI`          = "2017-04-21 07:00" // UTC
```

#1: Formatting & Locales

Same for

1. `NumberFormat`
2. `Currency`
3. `Locale`
4. `TimeZone`
5. ...

Testability in practice.

Mocking

Interfaces still work everywhere

```
interface MyService {
   fun doSomething()
   class Impl(): MyService {
       override fun doSomething() { /* ... */ }
   }
}
```

Interfaces still work everywhere

```
interface MyService {
   fun doSomething()
   class Impl(): MyService {
       override fun doSomething() { /* ... */ }
   }
}

class TestService: MyService {
   override fun doSomething() { /* ... */ }
}
```

Interfaces still work everywhere

```
interface MyService {
   fun doSomething()
   class Impl(): MyService {
       override fun doSomething() { /* ... */ }
   }
}

class TestService: MyService {
   override fun doSomething() { /* ... */ }
}

val mockService = mock<MyService>()
```

Interfaces still work everywhere

```
interface MyService {
   fun doSomething()
   class Impl(): MyService {
       override fun doSomething() { /* ... */ }
   }
}

class TestService: MyService {
   override fun doSomething() { /* ... */ }
}

val mockService = mock<MyService>()
```

Extracting singletons

```
object Implicit {
   fun getCurrentState(): String = "State"
}

class SomeModule {
   init {
       val state = Implicit.getCurrentState()
   }
}
```

Extracting singletons

```
interface StateProvider {
   fun getCurrentState(): String
}

object Implicit {
   fun getCurrentState(): String = "State"
}

class SomeModule {
   init {
       val state = Implicit.getCurrentState()
   }
}
```

Extracting singletons

```
interface StateProvider {
   fun getCurrentState(): String
}

object Implicit: StateProvider {
   override fun getCurrentState(): String = "State"
}

class SomeModule {
   init {
       val state = Implicit.getCurrentState()
   }
}
```

Extracting singletons

```
interface StateProvider {
   fun getCurrentState(): String
}

object Implicit: StateProvider {
   override fun getCurrentState(): String = "State"
}

class SomeModule(stateProvider: StateProvider) {
   init {
       val state = stateProvider.getCurrentState()
   }
}
```

Extracting singletons

```kotlin
interface StateProvider {
   fun getCurrentState(): String
}

object Implicit: StateProvider {
   override fun getCurrentState(): String = "State"
}

class SomeModule(stateProvider: StateProvider) {
   init {
       val state = stateProvider.getCurrentState()
   }
}
```

Other alternatives

Mockito 2 for mocking **final**

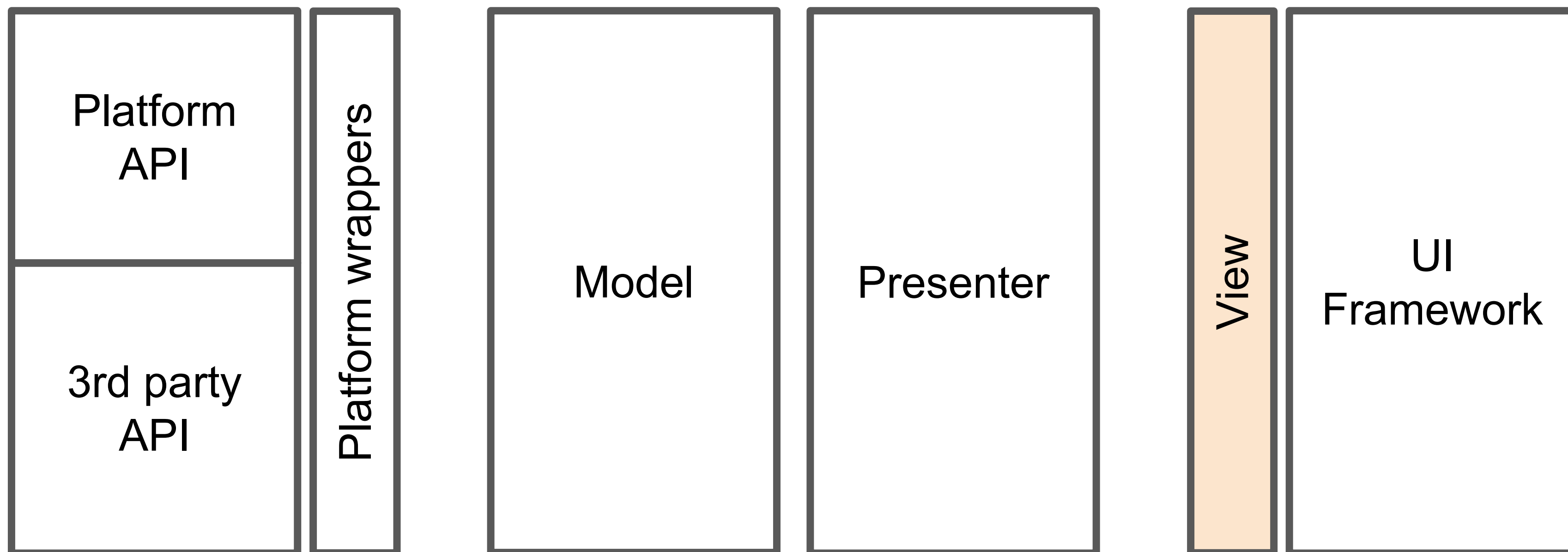
PowerMock for mocking **final**, **static**, **singletons**, …

- Indicate design issues; can be avoided
- Might blow up at some point

Testability in practice.

Abstracting away the platform

MVP. View layer



Presenter isolation

View layer approaches

- Activity implements View
- View as a separate class

Activity implements View

```
class SplashPresenter(view: SplashView) {
   init {
       view.showLoading()
   }
}
```

Activity implements View

```
interface SplashView {
   fun showLoading()
}
```

Activity implements View

```
interface SplashView {
   fun showLoading()
}

class SplashActivity: Activity {
   override fun onCreate() {

   }



}
```

Activity implements View

```
interface SplashView {
    fun showLoading()
}

class SplashActivity: Activity, SplashView {
    override fun onCreate() {

    }
    override fun showLoading() {
        findViewById(R.id.progress).show()
    }
}
```

Activity implements View

```
interface SplashView {
   fun showLoading()
}

class SplashActivity: Activity, SplashView {
   override fun onCreate() {
       SplashPresenter(view = this)
   }
   override fun showLoading() {
       findViewById(R.id.progress).show()
   }
}
```

Activity implements View

```kotlin
interface SplashView {
   fun showLoading()
}

class SplashActivity: Activity, SplashView {
   override fun onCreate() {
      SplashPresenter(view = this)
   }
   override fun showLoading() {
      findViewById(R.id.progress).show()
   }
}
```

View as a separate class

```
// Same as before
class SplashPresenter(view: SplashView) {
   init {
       view.showLoading()
   }
}
```

View as a separate class

```
interface SplashView {
   fun showLoading()







}
```

View as a separate class

```kotlin
interface SplashView {
    fun showLoading()


    class Impl : SplashView {
        override fun showLoading() {

        }
    }
}
```

View as a separate class

```
interface SplashView {
   fun showLoading()


   class Impl(private val viewRoot: View) : SplashView {
       override fun showLoading() {
           viewRoot.findViewById(R.id.progress).show()
       }
   }
}
```

View as a separate class

```
interface SplashView {
    fun showLoading()

    // Platform lives inside of Impl
    class Impl(private val viewRoot: View) : SplashView {
        override fun showLoading() {
            viewRoot.findViewById(R.id.progress).show()
        }
    }
}
```

View as a separate class

```
class SplashActivity: Activity {

    override fun onCreate() {








    }
}
```

View as a separate class

```
class SplashActivity: Activity {

    override fun onCreate() {
        // Platform View class
        val rootView: View = ...




    }
}
```

View as a separate class

```
class SplashActivity: Activity {

    override fun onCreate() {
        // Platform View class
        val rootView: View = ...

        SplashPresenter(
                view = SplashView.Impl(rootView)
        )
    }
}
```

View as a separate class

```
class SplashActivity: Activity {

    override fun onCreate() {
        // Platform View class
        val rootView: View = ...

        SplashPresenter(
                view = SplashView.Impl(rootView)
        )
    }
}
```

Presenter is isolated from the platform

```
@Test
fun testLoadingIsShown() {
    val mockedView = mock<SplashView>()




}
```

Presenter is isolated from the platform

```
@Test
fun testLoadingIsShown() {
    val mockedView = mock<SplashView>()

    SplashPresenter(mockedView)


}
```

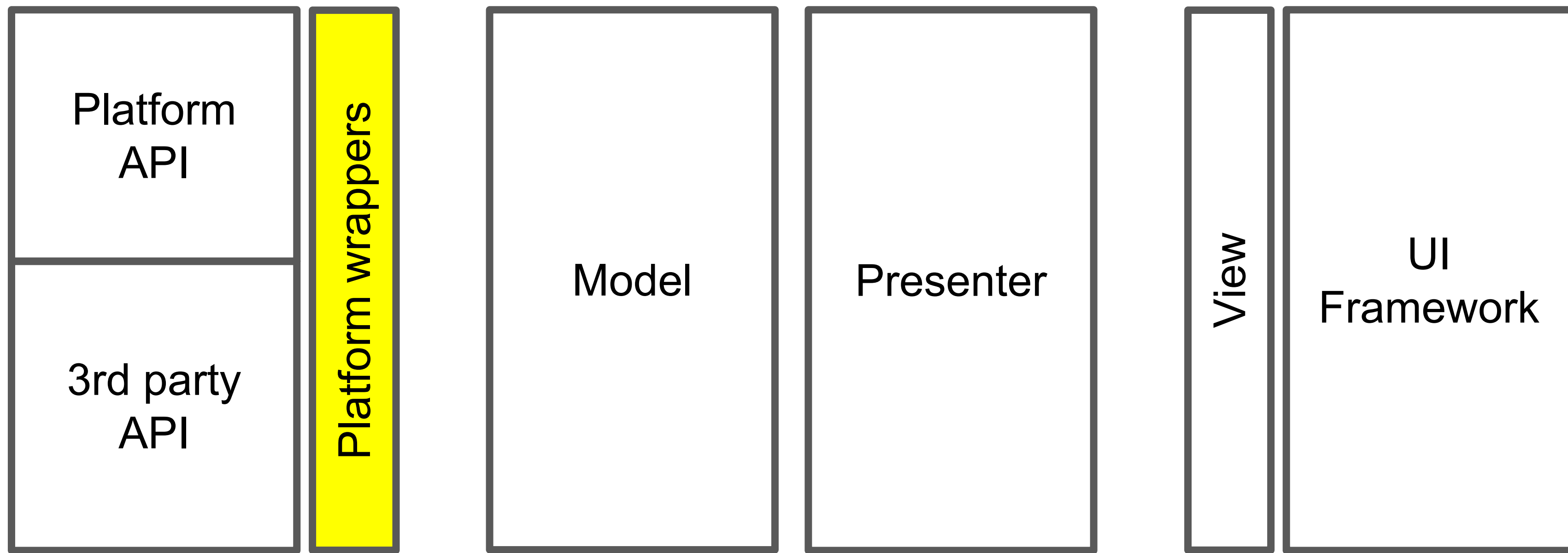
Presenter is isolated from the platform

```
@Test
fun testLoadingIsShown() {
    val mockedView = mock<SplashView>()

    SplashPresenter(mockedView)

    verify(mockedView).showLoading()
}
```

Presenter is isolated from the platform

```
@Test
fun testLoadingIsShown() {
    val mockedView = mock<SplashView>()

    SplashPresenter(mockedView)

    verify(mockedView).showLoading()
}
```

MVP. Platform wrappers



Model isolation

You can not modify

- Platform APIs
- 3rd party APIs

They can exist in different forms

- Static methods
- Singletons
- Final classes
- Non-final classes

They can exist in different forms

- Static methods
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They can exist in different forms

- Static methods
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- Final classes
- Non-final classes

Creating a wrapper

```
class Module {
    init {
        ThirdParty.doSomething()
    }
}
```

Creating a wrapper

```
interface Wrapper {
    fun doSomething()

    class Impl: Wrapper {
        override fun doSomething() {
            ThirdParty.doSomething()
        }
    }
}
```

Applying the wrapper

```
class Module {
    init {
        ThirdParty.doSomething()
    }
}
```

Applying the wrapper

```
class Module(wrapper: Wrapper) {
    init {
        wrapper.doSomething()
    }
}
```

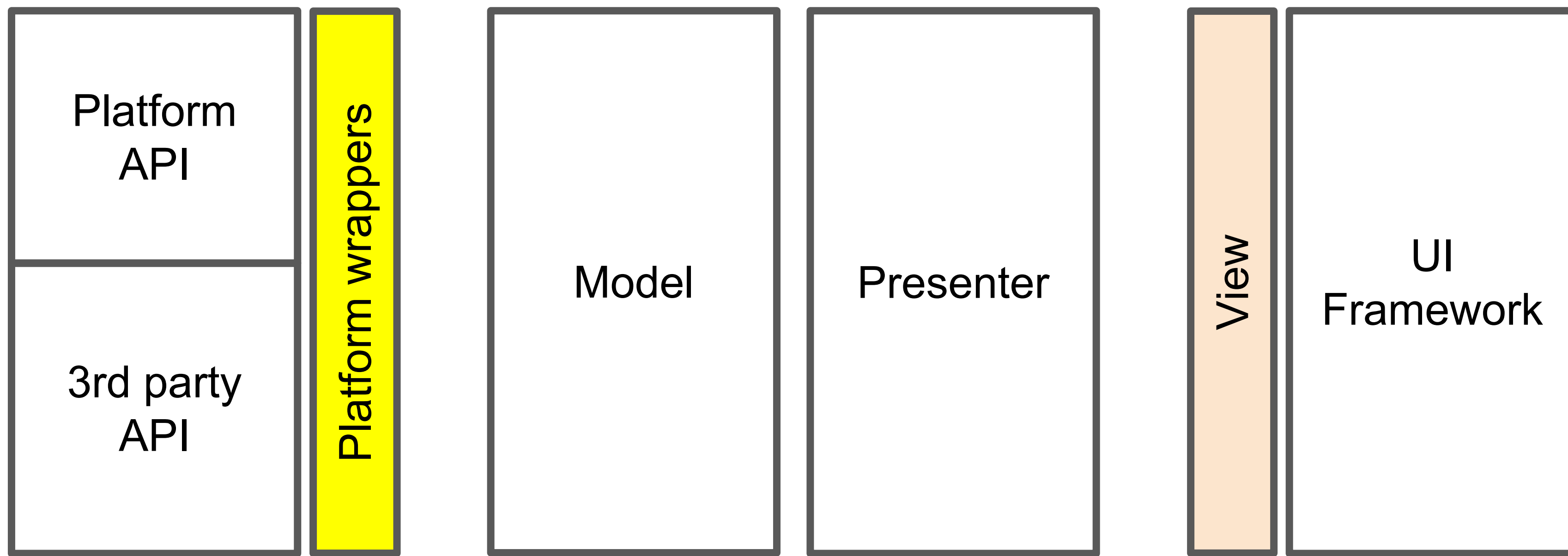
Applying the wrapper

```
class Module(wrapper: Wrapper) {
    init {
        wrapper.doSomething()
    }
}
```

Wrapper extra benefits

- Fixes poor Platform API design
- Single Responsibility instead of God objects
- Easy to apply 3rd party API changes

MVP. Platform wrappers vs View



Accessing resources

Accessing string ids

```
class SplashPresenter(view: SplashView, resources: Resources) {
   init {
       view.setTitle(resources.getString(R.string.welcome))
       view.showLoading()
   }
}
```

Accessing string ids

```
class SplashPresenter(view: SplashView, resources: Resources) {
    init {
        view.setTitle(resources.getString(R.string.welcome))
        view.showLoading()
    }
}

interface Resources {
    fun getString(id: Int): String
}
```

Accessing string ids

```
class SplashPresenter(view: SplashView, resources: Resources) {
    init {
        view.setTitle(resources.getString(R.string.welcome))
        view.showLoading()
    }
}
```

Accessing string ids

```
public final class R {
   public static final class string {
       public static final int welcome=0x7f050000;
   }
}
```

Implementation details

Implementation details

```
class SomeModule(input: String) {
   val state = calculateInitialState(input)
   // Pure
   private fun calculateInitialState(input: String): String =
           "Some complex computation for $input"
}
```

Implementation details

```
class SomeModule(input: String) {
    val state = calculateInitialState(input)
    // Pure
    private fun calculateInitialState(input: String): String =
            "Some complex computation for $input"
}
```

Implementation details

```
class SomeModule(input: String) {
    val state = calculateInitialState(input)
    // Pure
    private fun calculateInitialState(input: String): String =
            "Some complex computation for $input"
}

class AnotherModule(input: String) {
    val state = calculateInitialState(input)
    // Pure
    private fun calculateInitialState(input: String): String =
            "Some complex computation for $input"
}
```

Implementation details

```
class SomeModule(input: String) {
    val state = calculateInitialState(input)
    // Pure
    private fun calculateInitialState(input: String): String =
            "Some complex computation for $input"
}

object StateCalculator {
    fun calculateInitialState(input: String): String =
            "Some complex computation for $input"
}
```

Implementation details

```
class SomeModule(input: String) {
   val state = StateCalculator.calculateInitialState(input)
}

class AnotherModule(input: String) {
   val state = StateCalculator.calculateInitialState(input)
}

object StateCalculator {
   fun calculateInitialState(input: String): String =
           "Some complex computation for $input"
}
```

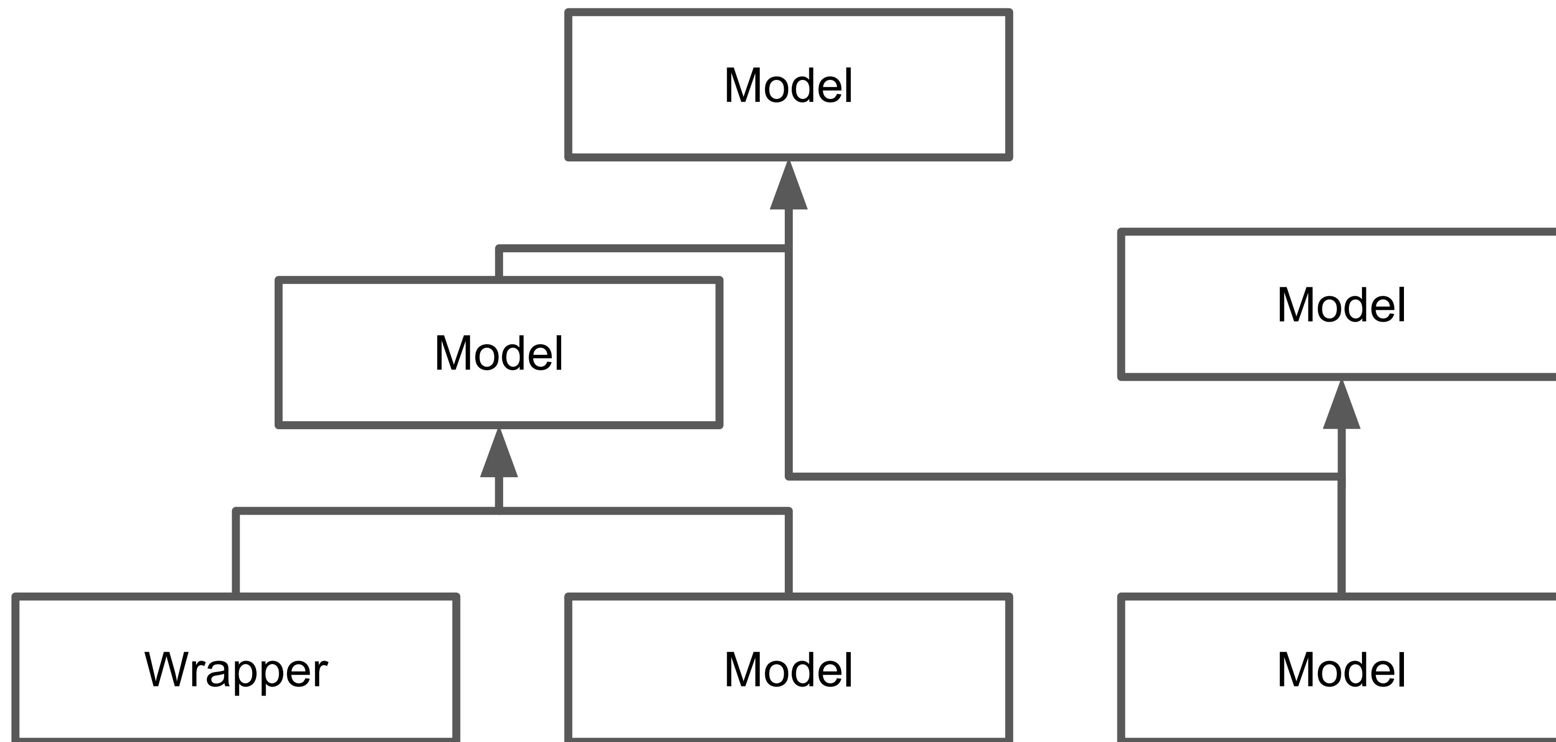
Implementation details

```
class SomeModule(input: String, stateCalculator: StateCalculator){
   val state = stateCalculator.calculateInitialState(input)
}

interface StateCalculator {
   fun calculateInitialState(input: String): String
   class Impl: StateCalculator {
       override fun calculateInitialState(input: String): String =
               "Some complex computation for $input"
   }
}
```

How to start?

Start with Models



Start with Models

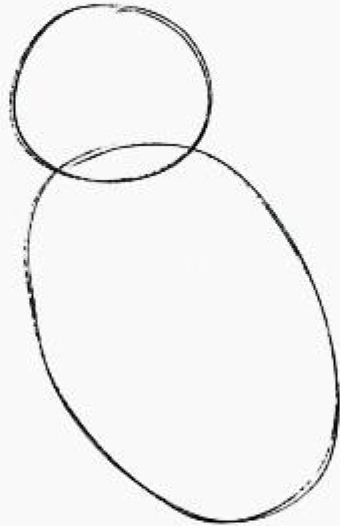


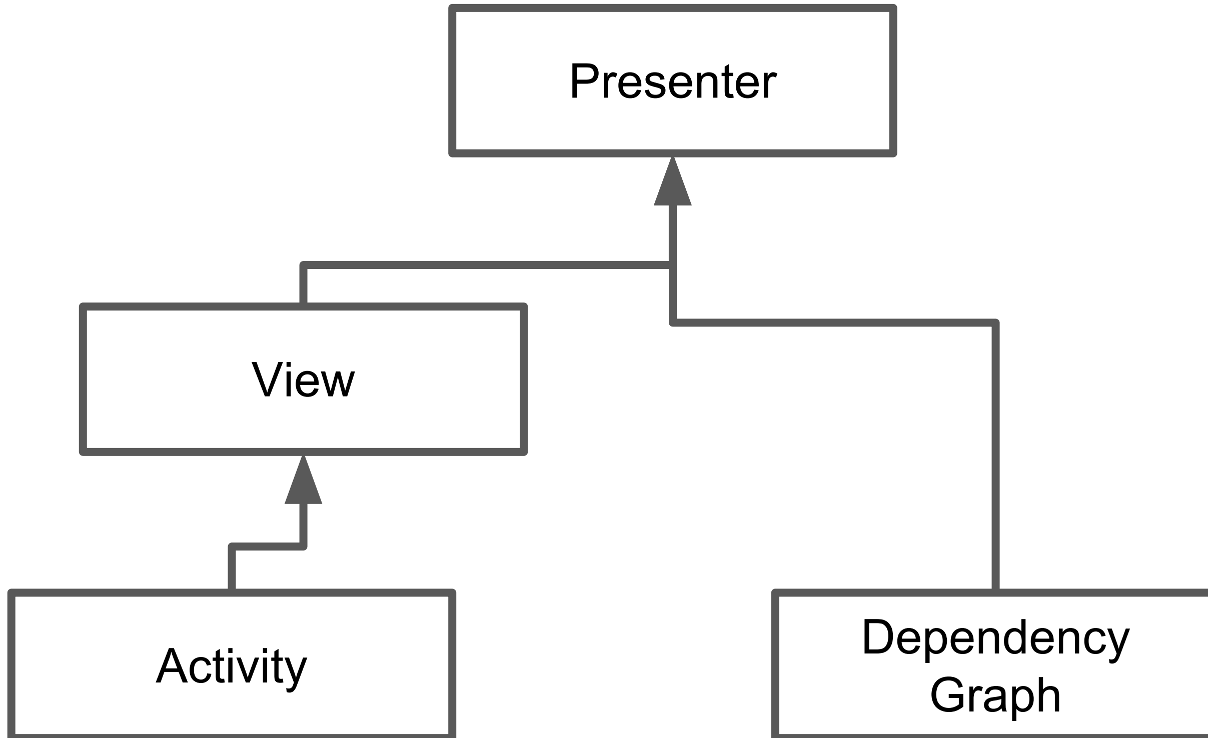
Fig 1. Draw two circles

Fig 2. Draw the rest of the damn Owl

As a result

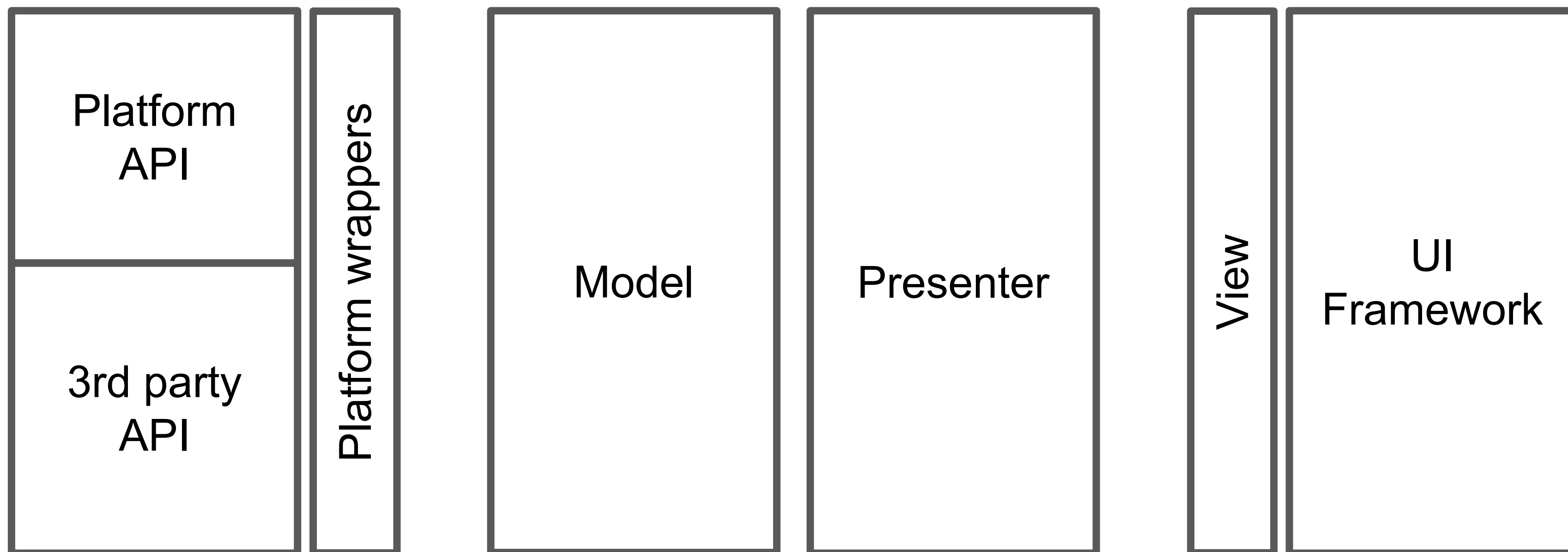
- **Implicit** dependencies (singletons) become **explicit** (passed through DI)
- Initialization flow gets explicit
- Models become easy to test

And then

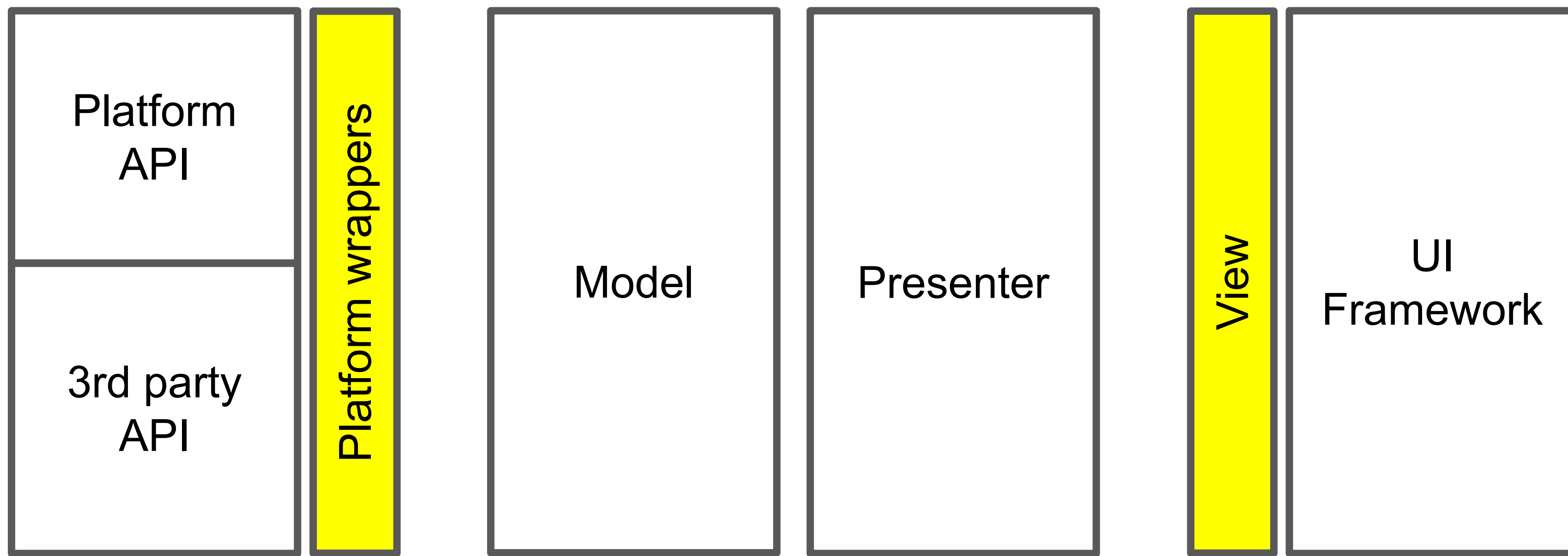


What’s next?

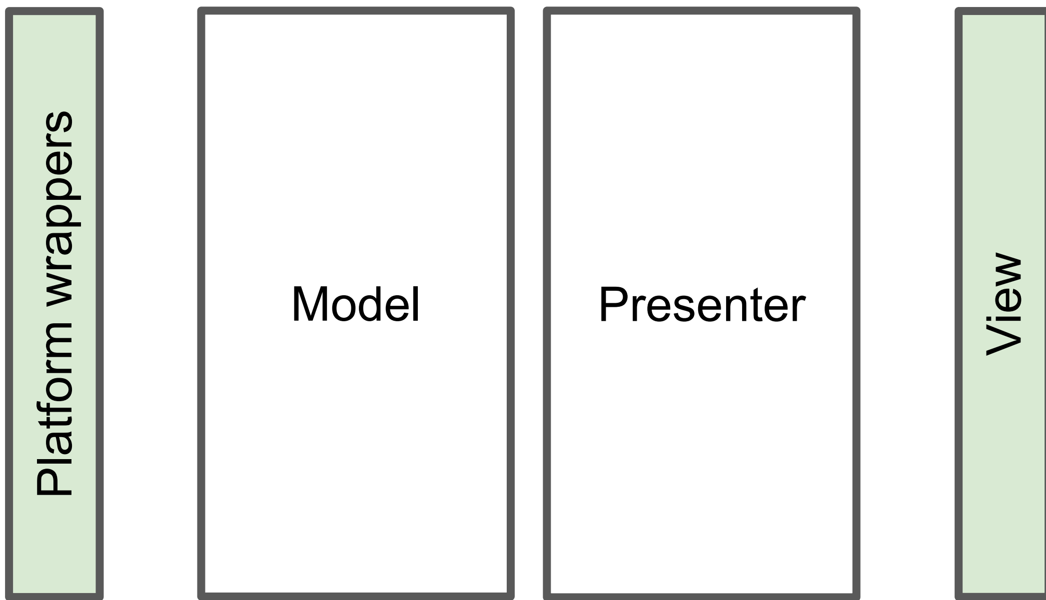
MVP. Integration tests



MVP. Integration tests



MVP. Integration tests



To summarize

3 rules

- Pass arguments and return results **explicitly**
- Pass dependencies **explicitly**
- Make sure **you can mock** dependencies

Learning the art of programming, like most other disciplines, consists of first learning the rules and then learning when to break them.

Joshua Bloch, Effective Java

Questions?

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