Responsible Design

for Android™

Part 1: Dancing with the SDK

J. B. Rainsberger

Responsible Design for Android

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Contents

1 A Tiny Slice

I chose a tiny slice of a feature to start: displaying **You have *n* transactions** on the app's opening screen. This feature carves a thin, but deep slice through the entire system, and allows me to focus on displaying dynamic information on the screen. It also provides a relatively simple, quick win.

The test list

I can only think of two tests: `1` transaction and any other number, with the singular/plural of "transaction" the only difference. I think I'll ignore this minor difference for the moment, leaving a "test list" with a single test on it.

Presenter-First Design

I expect to use the typical presenter-first (or controller-first[1]) approach to building any feature for this app. This approach tends to fit perfectly for any GUI-based application. If you're not familiar with Presenter-First Design, then I recommend you read a few articles on the topic.[2] In the meantime, I'll summarise the key points.

- Test-drive the Presenter by stubbing/mocking the Model and View.
- While implementing the Presenter, design the contracts of the Model and View.
- Keep the Presenter thin; move behavior into the Model or View.
- Specify the Presenter's behavior in terms of a purely abstract UI.
- The Presenter cannot refer to its context, meaning its caller.

When I design presenter-first, code tends to flow from the Presenter into the Model or View.

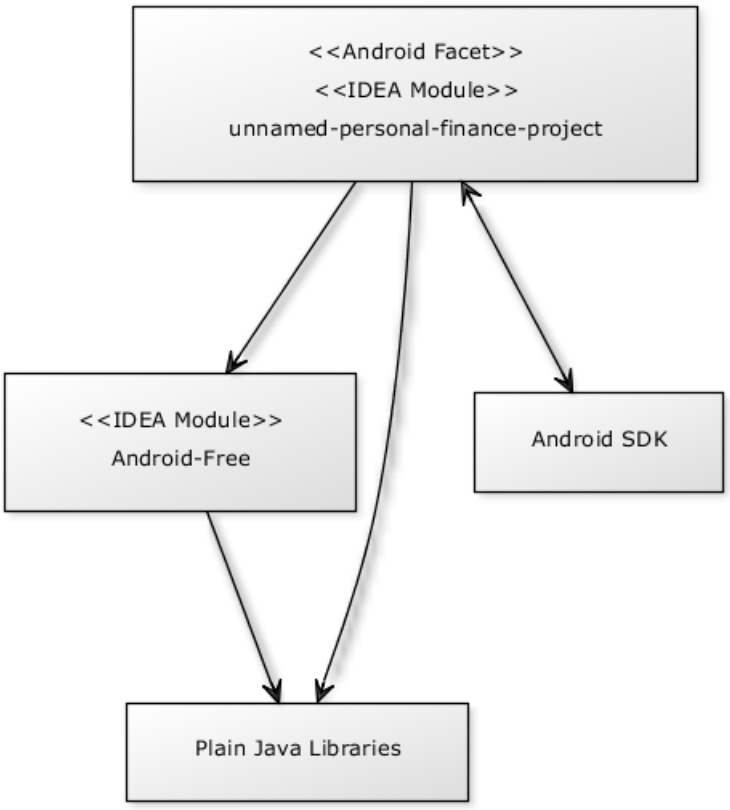
View or `View`?

Android has a class named `View`, which you might easily confuse with the generic concept of a View. This makes it tricky for both of us. Whenever you see "View", you can assume that I mean the generic concept. If I want to refer to the class `View`, then I will fall all over myself to clarify that. I hope that helps.

[1] If you feel more comfortable referring the Presenter as the "Controller", then please do. I make no significant distinction between the two ideas.
[2] http://www.atomicobject.com/pages/Presenter+First

Setting the project up for success

Before writing a single line of code, I create two IDE modules: an Android module and an Android-Free module. I can save myself hours of grief by configuring these modules to avoid cyclic dependencies by following one simple rule: the Android module may refer to the Android-Free module, but not the reverse.



I always look for code in the Android module that can move to the Android-Free module

If you want to see how I did this in IDEA, see this appendix.

If you've never worked with Android before, or simply don't have the Android tools installed, then you'll need to do that, too. I intend to replace this note with another appendix, but for now, follow these basic instructions.

1. Download the SDK tools[a]
2. Follow the instructions here[b] to install the right packages (click on tools and 4.0.3)

I've used v4.0.3 of the Android Tools for this project, and I hope that's not horribly

out of date by the time you read this.

[a] http://developer.android.com/sdk/index.html#ExistingIDE
[b] http://developer.android.com/sdk/installing/adding-packages.htm

Ignoring Android for the moment

Now that I've created this warm, dry place where I can write code without worrying about Android, I choose to start here. I will build a Model/View/Presenter (MVP) triad triggered by launching the app. Following the Presenter-First Design approach, I start by implementing the Presenter in order to discover the contracts of the Model and View. I choose the conventional name `render()` for the Presenter method that responds to visiting the screen, as opposed to pressing a button or tapping a widget. When rendering the screen, then, the View should display "You have *n* transactions", so I add a method to the contract of the View. Stepping into the role of the Presenter, I need something to give me *n*, and that sounds like a Model responsibility, so I add a method to the contract of the Model to tell me how many transactions it has. This gives me enough to write the first test.

The first code sample: Snapshot 10

The following code is from Snapshot 10 of the code base. You can find the code base at http://github.com/jbrains/TrackEveryPenny[3] and this particular version is tagged `snapshot_10`. I will introduce the next code sample more simply with the heading "Snapshot 20".

Snapshot 10: the first test

```
1  package ca.jbrains.upfp.mvp;
2
3  import org.jmock.*;
4  import org.jmock.integration.junit4.JMock;
5  import org.junit.Test;
6  import org.junit.runner.RunWith;
7
8  @RunWith(JMock.class)
9  public class RenderYouHaveNTransactionsOnBrowseTransactionsScreenTest {
10   private Mockery mockery = new Mockery();
11
12   @Test
13   public void zero() throws Exception {
```

[3] http://github.com/jbrains/TrackEveryPenny

```
14      final BrowseTransactionsModel model
15          = mockery.mock(BrowseTransactionsModel.class);
16      final BrowseTransactionsView view
17          = mockery.mock(BrowseTransactionsView.class);
18      final BrowseTransactionsPresenter presenter
19          = new BrowseTransactionsPresenter(model, view);
20
21      mockery.checking(
22          new Expectations() {{
23            allowing(model).countTransactions();
24            will(returnValue(0));
25
26            oneOf(view).setNumberOfTransactions(0);
27          }});
28
29      presenter.render();
30    }
31  }
```

The implementations offer no surprises.

Snapshot 10: give the Model to the View

```
1   package ca.jbrains.upfp.mvp;
2
3   public class BrowseTransactionsPresenter {
4     private final BrowseTransactionsModel model;
5     private final BrowseTransactionsView view;
6
7     public BrowseTransactionsPresenter(
8         BrowseTransactionsModel model,
9         BrowseTransactionsView view
10    ) {
11      this.model = model;
12      this.view = view;
13    }
14
15    public void render() {
16      view.setNumberOfTransactions(model.countTransactions());
17    }
18  }
```

```
package ca.jbrains.upfp.mvp;

public interface BrowseTransactionsModel {
  int countTransactions();
}
```

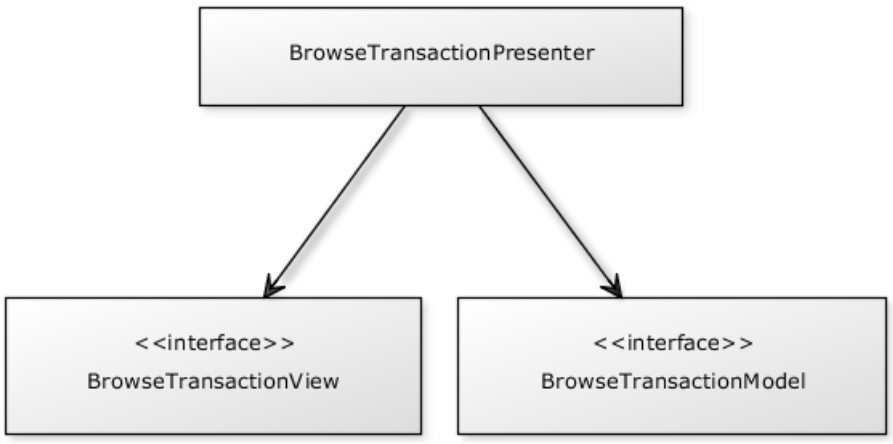
```
package ca.jbrains.upfp.mvp;

public interface BrowseTransactionsView {
  void setNumberOfTransactions(int numberOfTransactions);
}
```

I have named this micro-feature "Browse Transactions", with an eye towards displaying not only the number of transactions, but also a summary of transactions, probably filtered by the date. This represents slightly speculative design, but given how easily I can rename types, I don't feel worried about the name.

In retrospect, however, I don't like including the words "Browse Transaction Screen" in the test. At the time I wrote the test, I expected to display "You have *n* transactions" on that screen, but neither the test nor the production code depend at all on this decision, **and indeed, that is the point!** Even though I've successfully structured the code to avoid depending on its context, I've let the context sneak in to the name, something I will fix before putting this feature away.

At first, I thought I'd ignored the poor grammar of "You have 1 transactions" in this test, but I later realised that formatting "1 transaction" instead of "1 transactions" belongs to the View, and I haven't implemented it yet. I note this and add it to the test list for implementing the View, which I will do next.

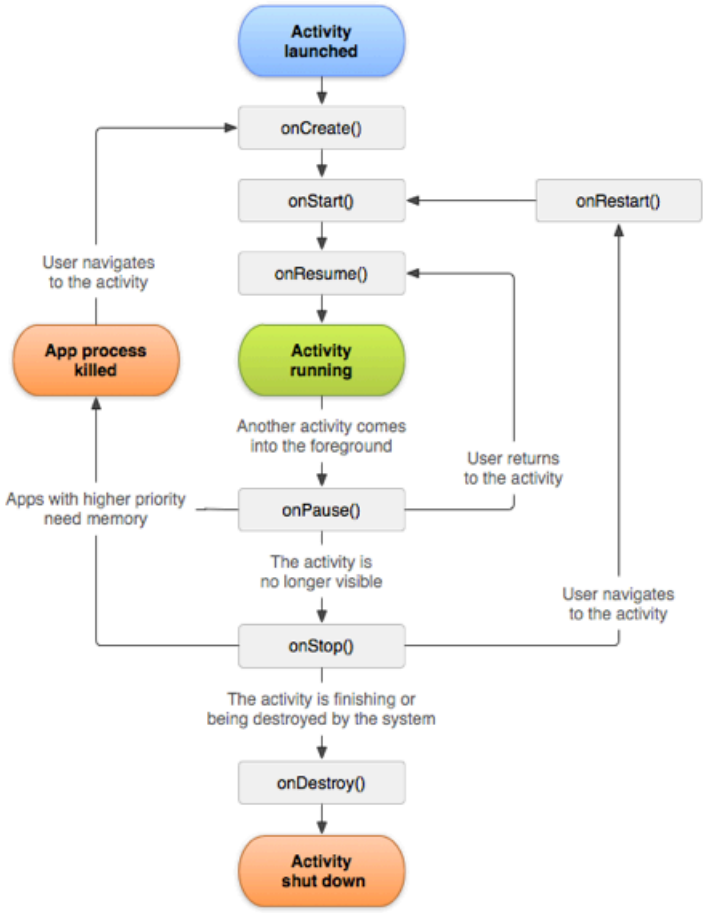
A snapshot of the design



So far, so good

Exploring the Android Activity lifecycle

As part of the hacking I did back when I was finding my bearings, I learned a little about the lifecycle of an Activity, which appears to represent a screen. I dug into the Android development documentation and found a handy diagram that summarises the lifecycle.



Smells like EJB to me

This diagram tells me that `onResume()` should invoke `presenter.render()`. If this causes any problems, then I'll walk "up the stack" on the lifecycle diagram, first to `onStart()`, then to `onCreate()`.

Do I need an error case for `presenter.render()`? I don't think so, and I hope not. Right now, the Presenter will throw any `RuntimeExceptions` up the stack and probably crash the app, so I need to develop a strategy for handling exceptions inside the Activity. I add this to my backlog.

What's done

- Snapshot 10: Presenter handles displaying 0 transactions.

What's left to do

- Decide how the Activity will handle Presenter throwing exceptions to it. Normal operation or should Presenter not throw exceptions?
- Implement Android View.
  - Check singular/plural text when displaying "1 transaction"/"3 transactions"
- Fake out Model in Android Activity for now, since we can only read it.
- Do a little manual inspection to make sure we haven't messed anything up.

2 Implementing the View

I want to implement the View, meaning interface `BrowseTransactionsView`, to display text on an Android screen. I decide to have the Activity implement the View directly, since whatever implementation I choose will have to depend on the Android SDK, and the Activity already does that. This gives me on opportunity to learn some Robolectric[1] basics.

Presenter implements the right View behavior

I started with a simple happy path test, checking that the Activity displays the correct number of transactions.

Snapshot 20: the new test

```
1  package ca.jbrains.upfp.view.android.test;
2
3  import android.widget.TextView;
4  import ca.jbrains.upfp.*;
5  import com.xtremelabs.robolectric.RobolectricTestRunner;
6  import org.junit.Test;
7  import org.junit.runner.RunWith;
8
9  import static org.junit.Assert.assertEquals;
10
11 @RunWith(RobolectricTestRunner.class)
12 public class DisplayNumberOfTransactionsTest {
13   @Test
14   public void happyPath() throws Exception {
15     final BrowseTransactionsActivity
16         browseTransactionsActivity
17         = new BrowseTransactionsActivity();
18
19     browseTransactionsActivity.onCreate(null);
20
21     browseTransactionsActivity.displayNumberOfTransactions(
22         12);
23
24     final TextView transactionsCountView
25         = (TextView) browseTransactionsActivity
```

[1] A library for test-driving Android SDK client code, which you can find at http://pivotal.github.com/robolectric/index.html

```
26          .findViewById(R.id.transactionsCount);
27
28      assertEquals(
29          "12", transactionsCountView.getText().toString()
30      );
31    }
32  }
```

Now I wish I had checked the entire text "You have 12 transactions", as it would have reminded me to check the case "You have 1 transaction". At the time, I assumed that I would turn this text into an Android resource, but I still haven't done that as of the moment I wrote this sentence. Since I don't know exactly how to do this right now, I add this task to my list.

Snapshot 20: a naive implementation

```
diff --git a/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java \
b/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
index 985b08d..50fa839 100644
--- a/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
+++ b/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
@@ -246,4 +246,15 @@ public class BrowseTransactionsActivity extends Activi\
ty {
    public TextView categoryView() {
      return (TextView) findViewById(R.id.category);
    }
+
+  public void displayNumberOfTransactions(
+      int transactionCount
+  ) {
+    final TextView transactionsCountView
+        = (TextView) findViewById(R.id.transactionsCount);
+
+    transactionsCountView.setText(
+        String.format(
+            "%1$d", transactionCount));
+  }
 }
```

I had hacked around before starting this book in order to get a basic feel for the Android SDK, but I made the mistake of refactoring away from my spike, rather than throwing it away and starting again. It will take me a couple of days to fix up all the code samples to make it look like I'd started from scratch, rather than refactor away from the spike, and I plan to do that *after* I've completed the first draft of the book.

Rather than flood you with a very long code sample, click here to view the layout file[a]. Look for the field `transactionsCount`, which `DisplayNumberOfTransactionsTest` would have forced me to add, if I hadn't already created it.

So how did I know to check `R.id.transactionsCount` in my test? I learned about the relationship between the layout XML document and the Android-generated class `R` when I hacked together my first screen. If I hadn't done that, then I'd have written a Learning Test to discover how to gain access to a layout element in the Activity.

[a] https://raw.github.com/jbrains/TrackEveryPenny/snapshot_20/res/layout/main.xml

For a moment I considered whether to handle a negative number of transactions, only because Java's primitives force me to. I don't know whether I should consider such a mistake likely or not, and I can handle it easily, so I decide to handle this case.

Snapshot 30: the new test

```
diff --git a/src/test/java/ca/jbrains/upfp/view/android/test/DisplayNumberO\
fTransactionsTest.java b/src/test/java/ca/jbrains/upfp/view/android/test/Di\
splayNumberOfTransactionsTest.java
index 4145d8d..45ae1a2 100644
--- a/src/test/java/ca/jbrains/upfp/view/android/test/DisplayNumberOfTransa\
ctionsTest.java
+++ b/src/test/java/ca/jbrains/upfp/view/android/test/DisplayNumberOfTransa\
ctionsTest.java
@@ -1,12 +1,13 @@
 package ca.jbrains.upfp.view.android.test;

 import android.widget.TextView;
+import ca.jbrains.toolkit.ProgrammerMistake;
 import ca.jbrains.upfp.*;
 import com.xtremelabs.robolectric.RobolectricTestRunner;
```

```
 import org.junit.Test;
 import org.junit.runner.RunWith;

-import static org.junit.Assert.assertEquals;
+import static org.junit.Assert.*;

 @RunWith(RobolectricTestRunner.class)
 public class DisplayNumberOfTransactionsTest {
@@ -29,4 +30,25 @@ public class DisplayNumberOfTransactionsTest {
         "12", transactionsCountView.getText().toString()
     );
   }
+
+  @Test
+  public void rejectNegativeNumber() throws Exception {
+    final BrowseTransactionsActivity
+        browseTransactionsActivity
+        = new BrowseTransactionsActivity();
+
+    browseTransactionsActivity.onCreate(null);
+
+    try {
+      browseTransactionsActivity
+          .displayNumberOfTransactions(-1);
+      fail(
+          "Why did you display a negative number of transactions?! " +
+          "That's crazy talk!");
+    } catch (ProgrammerMistake success) {
+      assertTrue(
+          success.getCause()
+              instanceof IllegalArgumentException);
+    }
+  }
 }
```

Here I use a trick that I learned from Nat Pryce's article "Throw Defect"[a]: I have created an unchecked exception class named `ProgrammerMistake` that I use whenever I want to signal an occurrence of something that ought not to happen. I have used it here to signal receiving a negative number of transactions, since no sane calculation involving a collection of transactions could answer a

> negative number. I have designed `ProgrammerMistake` as a trivial subclass of `RuntimeException` adding the constructors I need as I need them.
>
> [a] http://link.jbrains.ca/V9znH8

By throwing an exception, I put more pressure on the Activity to decide how to handle exceptions, which sounds like a fundamental design decision that I can't defer much longer.

The implementation does nothing surprising.

Snapshot 30: a Guard Clause

```
diff --git a/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java \
b/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
index 50fa839..cf2fceb 100644
--- a/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
+++ b/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
@@ -250,6 +250,13 @@ public class BrowseTransactionsActivity extends Activi\
ty {
   public void displayNumberOfTransactions(
       int transactionCount
   ) {
+    if (transactionCount < 0)
+      throw new ProgrammerMistake(
+          new IllegalArgumentException(
+              String.format(
+                  "number of transactions can't be negative, but it's %1$d\
",
+                  transactionCount)));
+
     final TextView transactionsCountView
         = (TextView) findViewById(R.id.transactionsCount);

```

Presenter implements the View interface

I'd intended for the Activity to implement the View, but I haven't done that yet. Instead, I've created a small Chunnel Problem in which the method signature in the Activity does not match the one in the View. I fix that by renaming the View method.

Snapshot 40: changing the View interface

```
diff --git a/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/BrowseTransactio\
nsView.java b/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/BrowseTransacti\
onsView.java
index a3a7ae8..500be98 100644
--- a/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/BrowseTransactionsView.\
java
+++ b/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/BrowseTransactionsView.\
java
@@ -1,5 +1,7 @@
 package ca.jbrains.upfp.mvp;

 public interface BrowseTransactionsView {
-  void setNumberOfTransactions(int numberOfTransactions);
+  void displayNumberOfTransactions(
+      int numberOfTransactions
+  );
 }
```

Snapshot 40: changing the View's clients to match

```
diff --git a/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/BrowseTransactio\
nsPresenter.java b/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/BrowseTran\
sactionsPresenter.java
index aaa1dcb..e001829 100644
--- a/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/BrowseTransactionsPrese\
nter.java
+++ b/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/BrowseTransactionsPrese\
nter.java
@@ -13,6 +13,7 @@ public class BrowseTransactionsPresenter {
   }

   public void render() {
-    view.setNumberOfTransactions(model.countTransactions());
+    view.displayNumberOfTransactions(
+        model.countTransactions());
   }
 }
```

```
diff --git a/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/RenderYouHaveNTr\
ansactionsOnBrowseTransactionsScreenTest.java b/AndroidFree/src/test/java/c\
a/jbrains/upfp/mvp/RenderYouHaveNTransactionsOnBrowseTransactionsScreenTest\
.java
index de519f3..4e29ad6 100644
--- a/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/RenderYouHaveNTransacti\
onsOnBrowseTransactionsScreenTest.java
+++ b/AndroidFree/src/test/java/ca/jbrains/upfp/mvp/RenderYouHaveNTransacti\
onsOnBrowseTransactionsScreenTest.java
@@ -23,7 +23,7 @@ public class RenderYouHaveNTransactionsOnBrowseTransactio\
nsScreenTest {
           allowing(model).countTransactions();
           will(returnValue(0));

-          oneOf(view).setNumberOfTransactions(0);
+          oneOf(view).displayNumberOfTransactions(0);
         }});

     presenter.render();
```

Now to make the Activity implement the View, I promote the View from the test source tree to a production source tree, since a production class–the Activity–now wants to use it.

Snapshot 50: moving the interface from test to production

```
 AndroidFree/src/{test => main}/java/ca/jbrains/upfp/mvp/BrowseTransactions\
View.java | 0
 src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java             \
          | 4 +++-
 2 files changed, 3 insertions(+), 1 deletion(-)
```

Snapshot 50: Activity implements View

```
diff --git a/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java \
b/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
index cf2fceb..52a11bc 100644
--- a/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
+++ b/src/main/java/ca/jbrains/upfp/BrowseTransactionsActivity.java
@@ -7,6 +7,7 @@ import android.view.View;
 import android.widget.*;
 import ca.jbrains.toolkit.ProgrammerMistake;
 import ca.jbrains.upfp.domain.*;
+import ca.jbrains.upfp.mvp.BrowseTransactionsView;
 import com.google.common.collect.Lists;
 import org.joda.time.LocalDate;
 import org.joda.time.format.*;
@@ -15,7 +16,8 @@ import java.io.*;
 import java.text.*;
 import java.util.ArrayList;

-public class BrowseTransactionsActivity extends Activity {
+public class BrowseTransactionsActivity extends Activity
+    implements BrowseTransactionsView {
   public static final DateTimeFormatter DATE_TIME_FORMATTER
       = DateTimeFormat.forPattern("yyyy-MM-dd");
   // REFACTOR Move down into Android-free model layer
```

Since the Activity now implements the View, I try to extract a more precise contract for the View, avoiding a mismatch between the Presenter's assumptions about the View and the implementation of the View. Rather than simply extract contract tests at random, I look at the Presenter's tests, scanning for which View methods it replaces with stubs or expectations. The Presenter sets only a single expectation on a single View method: `displayNumberOfTransactions()`. Expectations in one layer must correspond to actions in the next, meaning that since Presenter expects the View to `displayNumberOfTransactions(0)`, I need to check what happens in the View implementation when I ask it to `displayNumberOfTransactions(0)`. It so happens that I already have such a test, although it checks the value `12` instead of `0`. I see no fundamental difference between displaying "You have `0` transactions" and "You have `12` transactions", so the expectation that the Presenter sets on the View matches the action in a test for the View. This View test, then, makes a good candidate for a contract test for the view.

What a shame, then, that I didn't actually do this the first time around.

Instead, I extracted a contract test for the negative number of transactions case, since it seemed sensible to clarify what the View should do in that case.

Extracting Contract Tests

A Contract Test differs from an ordinary test in only one, crucial way: the Contract Test makes no reference to a particular implementation of the interface whose contract it describes.

In this example, I separate initialising `BrowseTransactionsActivity` from the rest of the methods `happyPath()` and `rejectNegativeNumber()` on `DisplayNumberOfTransactionsTest`, leaving behind in those tests only code that refers to the interface `BrowseTransactionsView`.

Snapshot 60: A contract test for the View

```
1  package ca.jbrains.upfp.view.test;
2
3  import ca.jbrains.toolkit.ProgrammerMistake;
4  import ca.jbrains.upfp.mvp.BrowseTransactionsView;
5  import org.junit.Test;
6
7  import static org.junit.Assert.*;
8
9  public abstract class BrowseTransactionsViewContract {
10   @Test
11   public void rejectNegativeNumber() throws Exception {
12     final BrowseTransactionsView browseTransactionsView
13         = initializeView();
14
15     try {
16       browseTransactionsView
17           .displayNumberOfTransactions(-1);
18
19       fail(
20           "Why did you display a negative number of " +
21           "transactions?! That's crazy talk!");
22     } catch (ProgrammerMistake success) {
23       assertTrue(
24           success.getCause()
25               instanceof IllegalArgumentException);
26     }
27   }
28
```

```
29    protected abstract BrowseTransactionsView initializeView();
30  }
```

Snapshot 60: Pull the contract up from the test

```
diff --git a/src/test/java/ca/jbrains/upfp/view/android/test/DisplayNumberO\
fTransactionsTest.java b/src/test/java/ca/jbrains/upfp/view/android/test/Di\
splayNumberOfTransactionsTest.java
index 45ae1a2..d49e8ec 100644
--- a/src/test/java/ca/jbrains/upfp/view/android/test/DisplayNumberOfTransa\
ctionsTest.java
+++ b/src/test/java/ca/jbrains/upfp/view/android/test/DisplayNumberOfTransa\
ctionsTest.java
@@ -1,16 +1,19 @@
 package ca.jbrains.upfp.view.android.test;

 import android.widget.TextView;
-import ca.jbrains.toolkit.ProgrammerMistake;
 import ca.jbrains.upfp.*;
+import ca.jbrains.upfp.mvp.BrowseTransactionsView;
+import ca.jbrains.upfp.view.test.BrowseTransactionsViewContract;
 import com.xtremelabs.robolectric.RobolectricTestRunner;
 import org.junit.Test;
 import org.junit.runner.RunWith;

-import static org.junit.Assert.*;
+import static org.junit.Assert.assertEquals;

 @RunWith(RobolectricTestRunner.class)
-public class DisplayNumberOfTransactionsTest {
+public class DisplayNumberOfTransactionsTest
+    extends BrowseTransactionsViewContract {
+
   @Test
   public void happyPath() throws Exception {
     final BrowseTransactionsActivity
@@ -31,24 +34,14 @@ public class DisplayNumberOfTransactionsTest {
     );
   }

-  @Test
-  public void rejectNegativeNumber() throws Exception {
```

```
38  +  @Override
39  +  protected BrowseTransactionsView initializeView() {
40       final BrowseTransactionsActivity
41           browseTransactionsActivity
42           = new BrowseTransactionsActivity();
43
44       browseTransactionsActivity.onCreate(null);
45
46  -    try {
47  -      browseTransactionsActivity
48  -          .displayNumberOfTransactions(-1);
49  -      fail(
50  -          "Why did you display a negative number of transactions?! " +
51  -          "That's crazy talk!");
52  -    } catch (ProgrammerMistake success) {
53  -      assertTrue(
54  -          success.getCause()
55  -              instanceof IllegalArgumentException);
56  -    }
57  +    return browseTransactionsActivity;
58     }
59   }
```

By inheriting the implementation of `BrowseTransactionsViewContract`, `DisplayNumberOfTransactionsTest` signals that the implementation it checks—`BrowseTransactionsActivity`—acts like a `BrowseTransactionsView`. When I connect the Presenter to the Activity, the two will just work together.

Since I now realise that I ought to have extracted the happy path as a contract test, I add this task to my list.

Looking more closely at the contract of the View, I notice that the Presenter does nothing to prevent invoking `displayNumberOfTransactions()` with a negative number, which would result in a `ProgrammerMistake`. This presents me with two options: test that the Presenter propagates the `ProgrammerMistake` when it tries to display "You have -1 transactions" or add a semantic constraint to the Model so that `countTransactions()` always returns 0 or higher. The latter option seems more intuitively sensible *and* avoids writing a fairly trivial test, so I add a task to implementing the Model to extract a contract test that checks that `countTransactions()` is never negative.

What's done

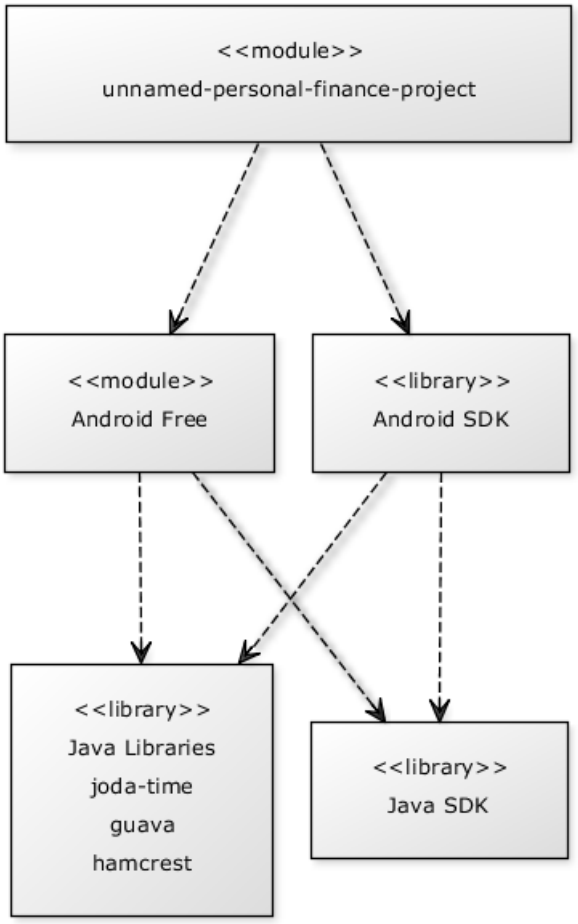
- Snapshot 20: Test-drove displaying the current transaction count in memory.
- Snapshot 30: We gracefully handle a negative number of transactions.

- Snapshot 40: Fixed the "Chunnel" problem between a class and the interface it's about to implement.
- Snapshot 50: BrowseTransactionsActivity now acts like a BrowseTransactionsView.
- Snapshot 60: Extracted a contract for BrowseTransactionsView from DisplayNumberOfTransactionsTest.

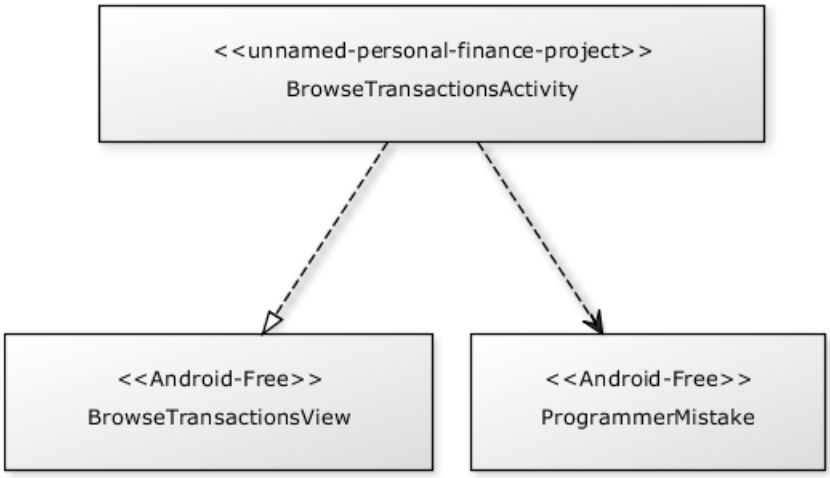
What's left to do

- Decide how Activity will handle Presenter throwing exceptions to it. Normal operation or should Presenter not throw exceptions?
- Fake out Model in Android Activity for now, since nothing can write to it.
- Do a little manual inspection to make sure we haven't messed anything up.
- Add to Model contract: `countTransactions() >= 0`; now View can safely blow up with ProgrammerMistake if it receives a negative number, so…
- Make Activity invoke the Presenter at the right lifecycle moments.

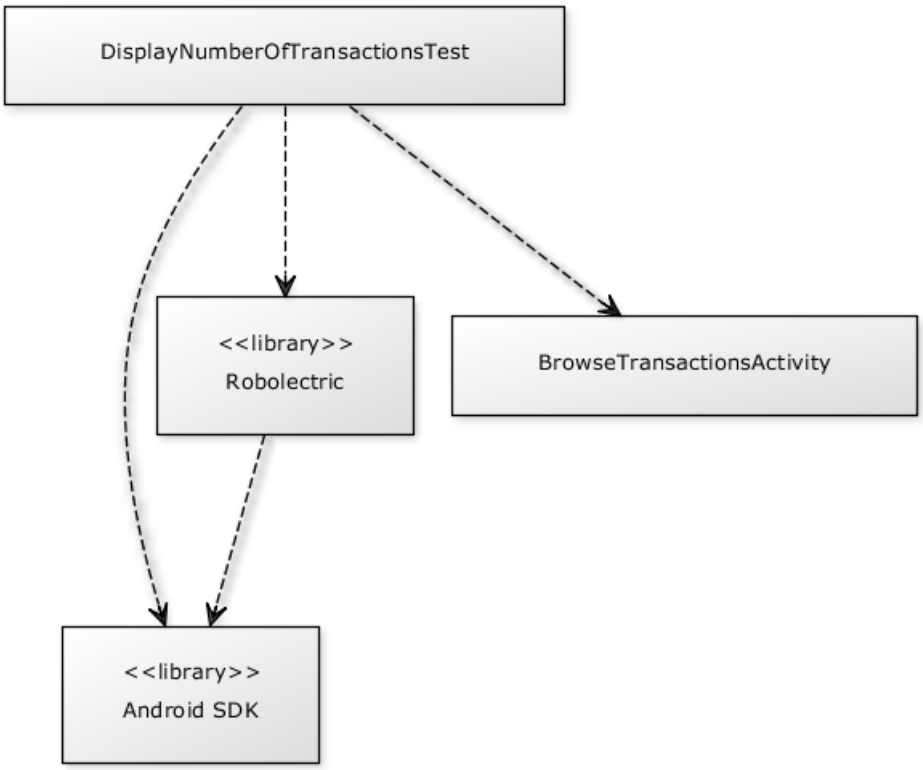
A recap of the current design



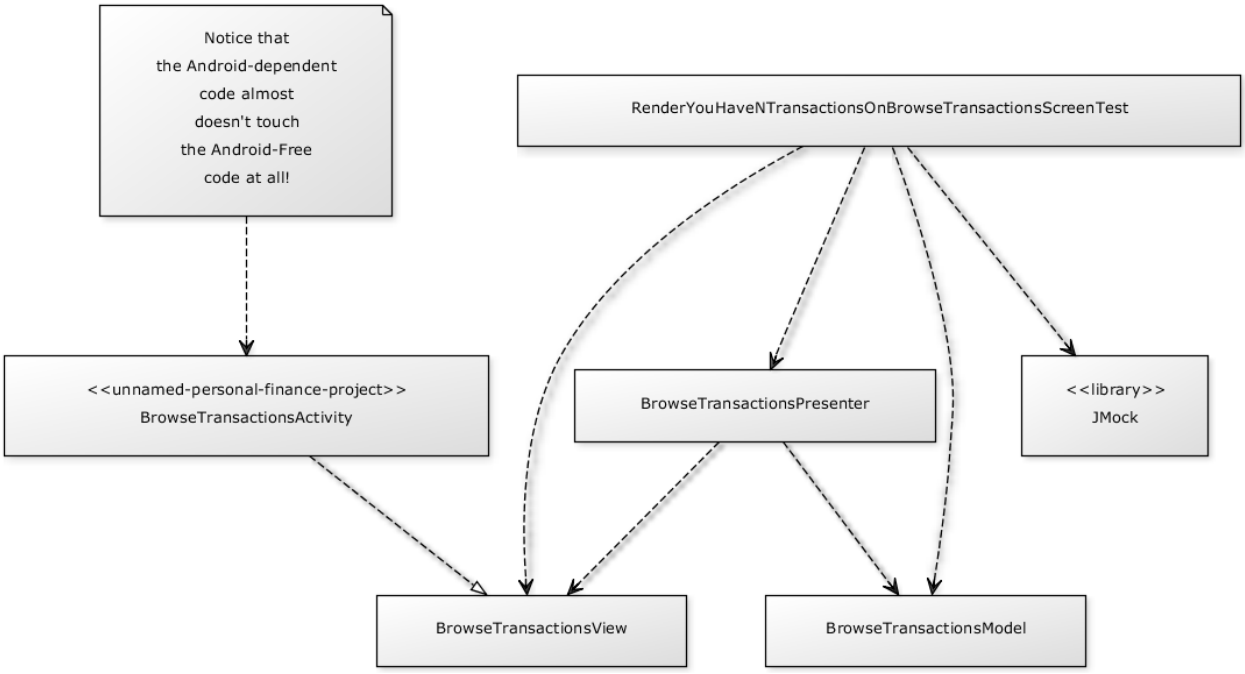
An ”architecture” view



Production classes



The Activity's tests



The Presenter's tests