Test the untested - our journey from zero coverage to automated testing

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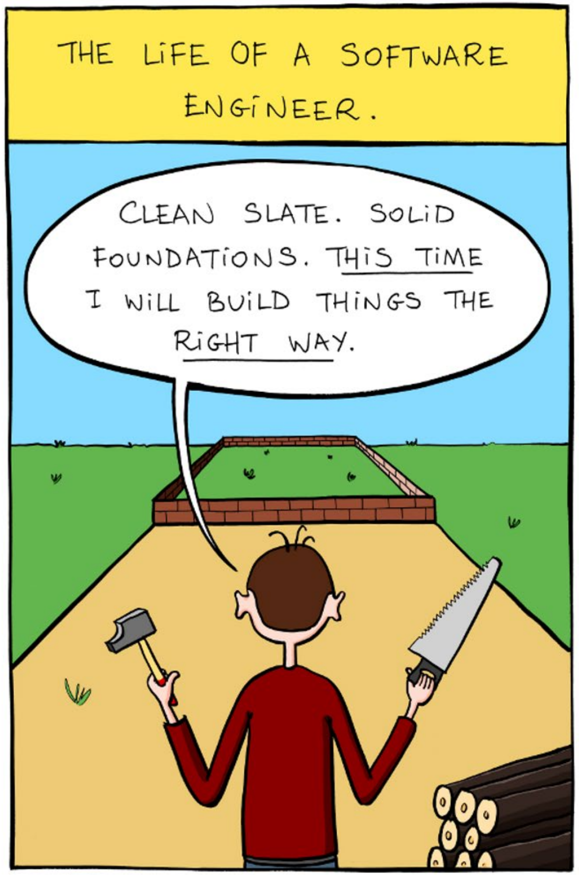
Architecture

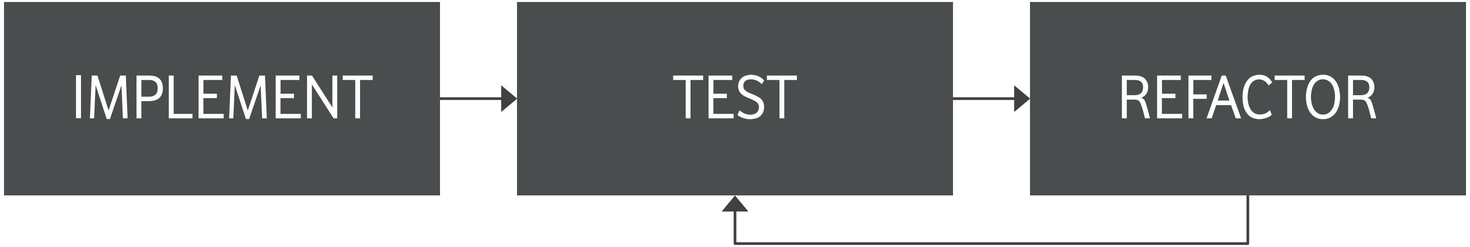

THE LIFE OF A SOFTWARE ENGINEER.
CLEAN SLATE. SOLID FOUNDATIONS. THIS TIME I WILL BUILD THINGS THE RIGHT WAY.

http://bonkersworld.net/building-software

Challenges

- Long lifetime of SDK
- Hard to update in case of errors
- High risk of regressions if code is edited

Perfect life



Our test approach

Before

MANUAL + CROWD

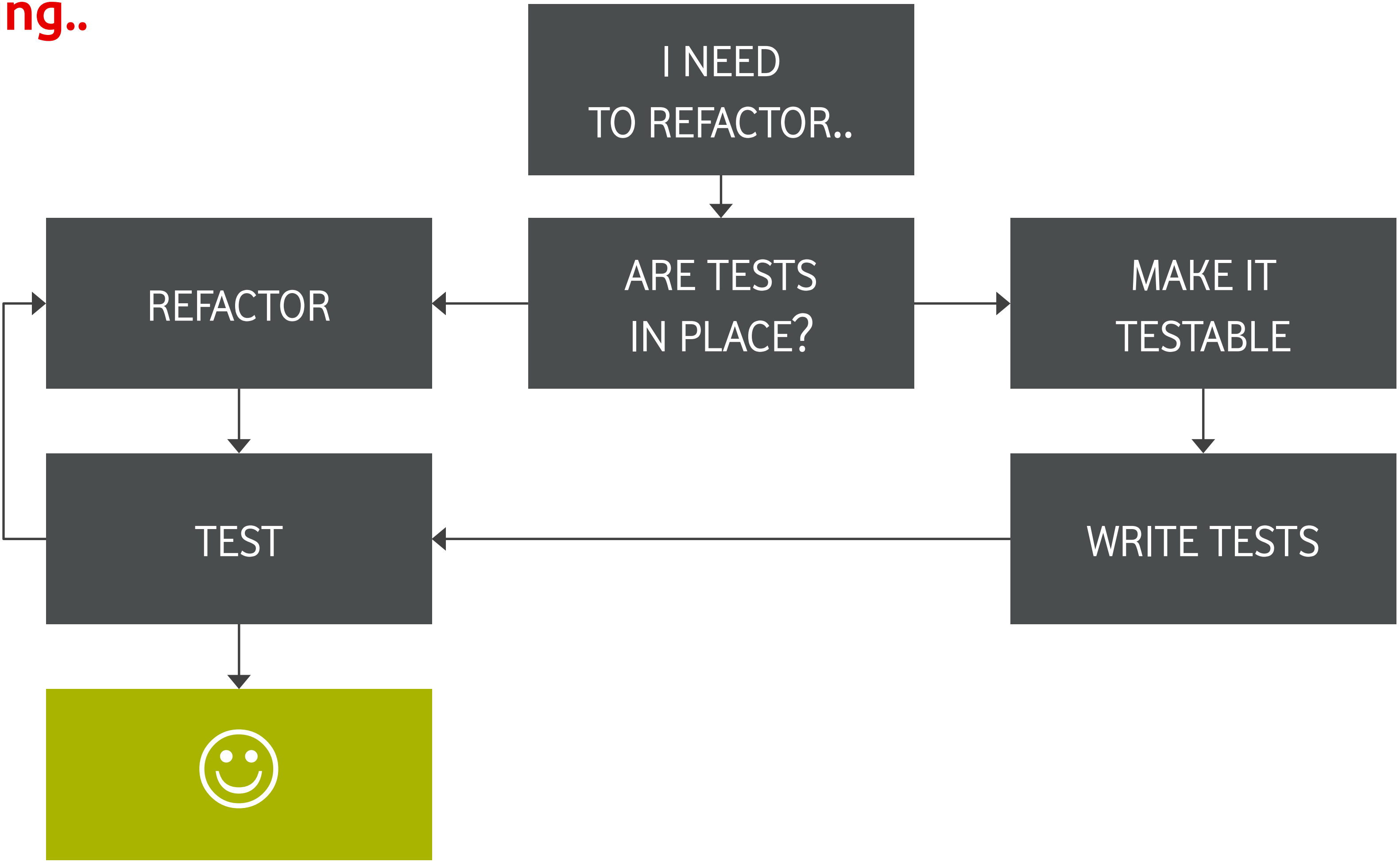
Our test approach

After

MANUAL + CROWD + AUTOMATED

Moving to testable code

Starting..



I NEED TO REFACTOR..

ARE TESTS IN PLACE?

REFACTOR

MAKE IT TESTABLE

TEST

WRITE TESTS

☺

Obstacles

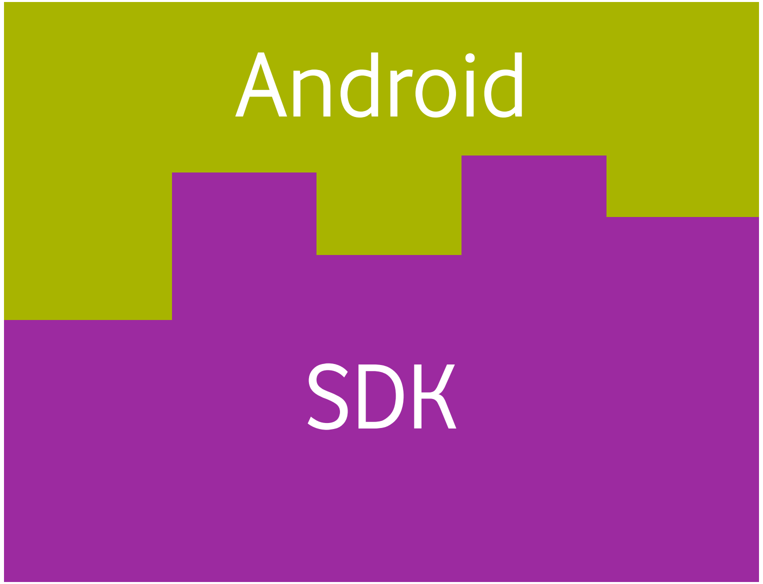
DEPENDENCIES

STATIC CALLS

CODE STRUCTURE

Resolving dependencies

Revising our architecture



```
public class MemoryLogger {

  private Database database;

  public MemoryLogger() {
    database = SDK.getDatabase();
  }

  public void logCurrentMemoryConsumption() {
     ActivityManager activityManager = (ActivityManager)
         SDK.getContext().getSystemService(Context.ACTIVITY_SERVICE);

     int pid = Process.myPid();

     MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

     database.updateMemoryConsumption(memInfos[0]);
  }
}
```

```
public class MemoryLogger {

  private Database database;

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  public void logCurrentMemoryConsumption() {
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  private Database database;

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    database = SDK.getDatabase();
  }

  public void logCurrentMemoryConsumption() {
    ActivityManager activityManager = (ActivityManager)
        SDK.getContext().getSystemService(Context.ACTIVITY_SERVICE);

    int pid = Process.myPid();

    MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

    database.updateMemoryConsumption(memInfos[0]);
  }
}
```

```java
public class MemoryLogger {

  private Database database;

  public MemoryLogger() {
    database = SDK.getDatabase();
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  public void logCurrentMemoryConsumption() {
     ActivityManager activityManager = (ActivityManager)
         SDK.getContext().getSystemService(Context.ACTIVITY_SERVICE);

     int pid = Process.myPid();

     MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

     database.updateMemoryConsumption(memInfos[0]);
  }
}
```

```
public class MemoryLogger {

  private Database database;

  public MemoryLogger() {
    database = SDK.getDatabase();
  }

  public void logCurrentMemoryConsumption() {
     IActivityManager activityManager = AndroidRuntime.getActivityManager();

     int pid = Process.myPid();

     MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

     database.updateMemoryConsumption(memInfos[0]);
  }
}
```

```
public class MemoryLogger {

  private Database database;

  public MemoryLogger() {
    database = SDK.getDatabase();
  }

  public void logCurrentMemoryConsumption() {
    IActivityManager activityManager = AndroidRuntime.getActivityManager();

    int pid = Process.myPid();

    MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

    database.updateMemoryConsumption(memInfos[0]);
  }
}
```

```
public class MemoryLogger {

  private Database database;

  public MemoryLogger(Database database) {
    this.database = database;
  }

  public void logCurrentMemoryConsumption() {
     IActivityManager activityManager = AndroidRuntime.getActivityManager();

     int pid = Process.myPid();

     MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

     database.updateMemoryConsumption(memInfos[0]);
  }
}
```

```
public class MemoryLogger {

  private Database database;

  public MemoryLogger(~~Database database~~) {
    ~~this.database = database;~~
  }

  public void logCurrentMemoryConsumption() {
     IActivityManager activityManager = AndroidRuntime.getActivityManager();

     int pid = Process.myPid();

     MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

     database.updateMemoryConsumption(memInfos[0]);
  }
}
```

```java
public class MemoryLogger {

  public MemoryLogger() {
  }

  public void logCurrentMemoryConsumption() {
     IActivityManager activityManager = AndroidRuntime.getActivityManager();

     int pid = Process.myPid();

     MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

     getDatabase().updateMemoryConsumption(memInfos[0]);
  }

  Database getDatabase() {
     return SDK.getDatabase();
  }
}
```

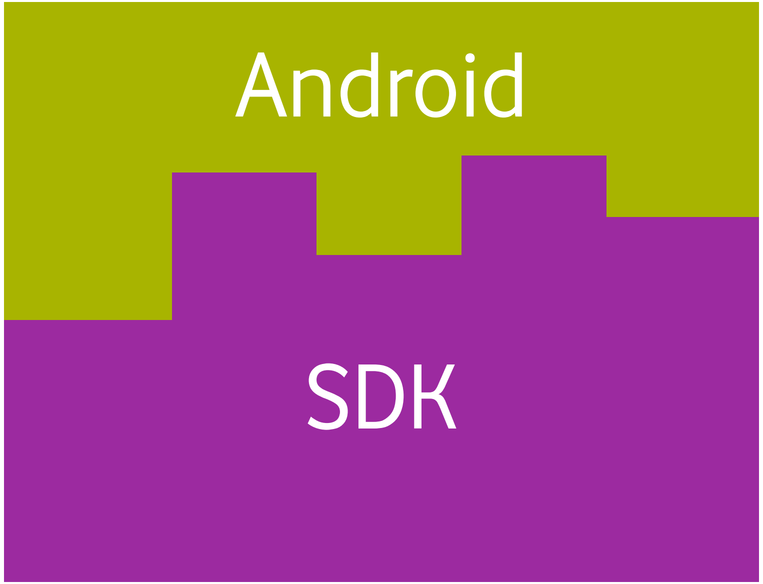
Lazy-init in getter
→ override in special test class

```
public class TestMemoryLogger {

  @Override
  Database getDatabase() {
     return new FakeDatabase();
  }

}
```

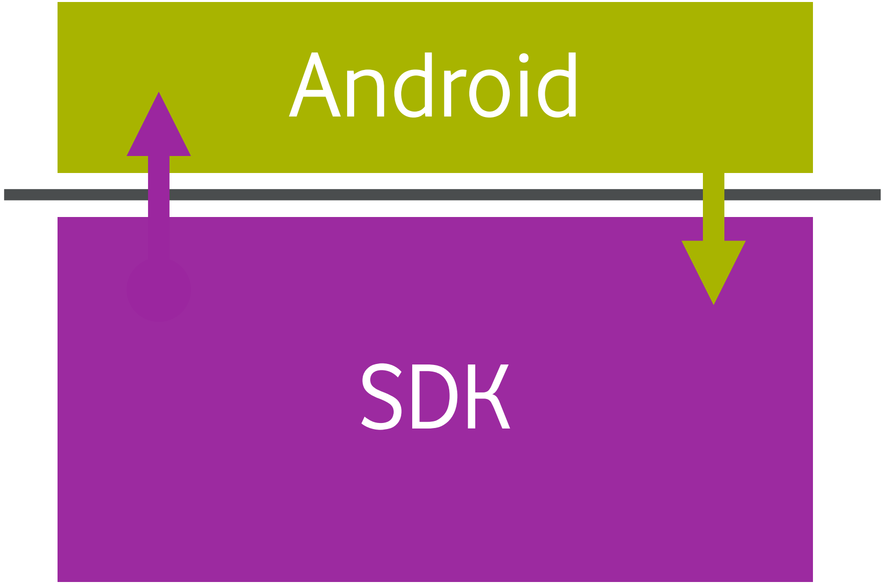
```
public class MemoryLogger {

  private Database database;

  public MemoryLogger() {
  }

  public void logCurrentMemoryConsumption() {
     IActivityManager activityManager = AndroidRuntime.getActivityManager();

     int pid = Process.myPid();

     MemoryInfo[] memInfos = activityManager.getProcessMemoryInfo(new int[] {pid});

     dataBase.updateMemoryConsumption(memInfos[0]);
  }

  static void setDatabase(Database database) {
     this.database = database;
  }
}
```

Static setter
→ call and replace in test class

Revising our architecture



Revising our architecture



jUnit can help us

```
public class MemoryLoggerTest {

  @ClassRule
  public static EnvironmentRule environmentRule = new EnvironmentRule();

  @Test
  public void myFirstTest() {
      ...
  }

}
```

jUnit can help us

```
public class MemoryLoggerTest {

   @ClassRule
   public static EnvironmentRule environmentRule = new EnvironmentRule();

   @Test
   public void myFirstTest() {
       ..
   }

}
```

```
public interface TestRule {

   public Statement apply(Statement base, Description description)

}
```

```java
public class EnvironmentRule implements TestRule {

  public Statement apply(Statement base, Description description) {
      return new Statement() {
          @Override
          public void evaluate() throws Throwable {
              before();
              try {
                  base.evaluate();
              } finally {
                  after();
              }
          }
      };
  }




}
```

```java
public class EnvironmentRule implements TestRule {

  public Statement apply(Statement base, Description description) {
      return new Statement() {
          @Override
          public void evaluate() throws Throwable {
              before();
              try {
                  base.evaluate();
              } finally {
                  after();
              }
          }
      };
  }



}
```

```
public class EnvironmentRule implements TestRule {

  public Statement apply(Statement base, Description description) {
      return new Statement() {
          @Override
          public void evaluate() throws Throwable {
              before();
              try {
                  base.evaluate();
              } finally {
                  after();
              }
          }
      };
  }

  protected void before() throws Throwable {
      // setup the environment here
  }

  protected void after() {
      // tear down so we do not leak state into other tests
  }
}
```

Revising our architecture

- Use constructor injection
- Introduce abstractions
- Always depend on abstraction and not on implementation

Revise static calls

```
public class MemoryLogger {

  public void logCurrentMemoryConsumption() {
      ...
     FileUtils.writeToFile(memInfos[0].toString(), "memory.log");
  }
}

public class FileUtils {

  public static void writeToFile(String filename, String fileContents) {
    FileOutputStream outputStream;
    try {
        outputStream = someContext().openFileOutput(filename, Context.MODE_PRIVATE);
        outputStream.write(fileContents.getBytes());
        outputStream.close();
    } catch (Exception e) {
        ...
    }
  }
}
```

```java
public class FileUtils {

  public static void writeToFile(String filename, String fileContents) {
    FileOutputStream outputStream;
    try {
        outputStream = someContext().openFileOutput(filename, Context.MODE_PRIVATE);
        outputStream.write(fileContents.getBytes());
        outputStream.close();
    } catch (Exception e) {
        ...
    }
  }
}
```

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    try {
        outputStream = someContext().openFileOutput(filename, Context.MODE_PRIVATE);
        outputStream.write(fileContents.getBytes());
        outputStream.close();
    } catch (Exception e) {
        ...
    }
  }
}

class FileUtilsImpl {

  public void writeToFile(String filename, String fileContents) {

  }
}
```

```
public class FileUtils {

  public static void writeToFile(String filename, String fileContents) {

  }
}

class FileUtilsImpl {

  public void writeToFile(String filename, String fileContents) {
    FileOutputStream outputStream;
    try {
        outputStream = someContext().openFileOutput(filename, Context.MODE_PRIVATE);
        outputStream.write(fileContents.getBytes());
        outputStream.close();
    } catch (Exception e) {
        ...
    }
  }
}
```

```
public class FileUtils {

  static FileUtilsImpl IMPL = new FileUtilsImpl()

  public static void writeToFile(String filename, String fileContents) {
    IMPL.writeToFile(filename, fileContents);
  }
}

public class FileUtilsImpl {

  public void writeToFile(String filename, String fileContents) {
      ...
  }
}
```

Replace in test with InMemoryFileUtilsImpl() e.g. via static setter of field access

Restructuring code

```
public class Activity {

    public void setRequestedOrientation(@ActivityInfo.ScreenOrientation int requestedOrientation) {
        if (mParent == null) {
            try {
                ActivityManagerNative.getDefault().setRequestedOrientation(mToken, requestedOrientation);
            } catch (RemoteException e) {
                // Empty
            }
        } else {
            mParent.setRequestedOrientation(requestedOrientation);
        }
    }

    @ActivityInfo.ScreenOrientation
    public int getRequestedOrientation() {
        if (mParent == null) {
            try {
                return ActivityManagerNative.getDefault().getRequestedOrientation(mToken);
            } catch (RemoteException e) {
                // Empty
            }
        } else {
            return mParent.getRequestedOrientation();
        }
        return ActivityInfo.SCREEN_ORIENTATION_UNSPECIFIED;
    }

    public int getTaskId() {
        try {
            return ActivityManagerNative.getDefault().getTaskForActivity(mToken, false);
        } catch (RemoteException e) {
            return -1;
        }
    }

    public boolean isTaskRoot() {
        try {
            return ActivityManagerNative.getDefault().getTaskForActivity(mToken, true) >= 0;
        } catch (RemoteException e) {
            return false;
        }
    }

    public boolean moveTaskToBack(boolean nonRoot) {
        try {
            return ActivityManagerNative.getDefault().moveActivityTaskToBack(mToken, nonRoot);
        } catch (RemoteException e) {
            // Empty
        }
        return false;
    }

    @NonNull
    public String getLocalClassName() {
        final String pkg = getPackageName();
        final String cls = mComponent.getClassName();
        int packageLen = pkg.length();
        if (!cls.startsWith(pkg) || cls.length() <= packageLen || cls.charAt(packageLen) != '.') {
            return cls;
        }
        return cls.substring(packageLen + 1);
    }
    public ComponentName getComponentName() {
        return mComponent;
    }

    public SharedPreferences getPreferences(int mode) {
        return getSharedPreferences(getLocalClassName(), mode);
    }

    private void ensureSearchManager() {
        if (mSearchManager != null) {
            return;
        }

        mSearchManager = new SearchManager(this, null);
    }

    @Override
    public Object getSystemService(@ServiceName @NonNull String name) {
        if (getBaseContext() == null) {
            throw new IllegalStateException("System services not available to Activities before onCreate()");
        }

        if (WINDOW_SERVICE.equals(name)) {
            return mWindowManager;
        } else if (SEARCH_SERVICE.equals(name)) {
            ensureSearchManager();
            return mSearchManager;
        }
        return super.getSystemService(name);
    }

    public void setTitle(CharSequence title) {
        mTitle = title;
        onTitleChanged(title, mTitleColor);

        if (mParent != null) {
            mParent.onChildTitleChanged(this, title);
        }
    }

    public void setTitle(int titleId) {
        setTitle(getText(titleId));
    }

    @Deprecated
    public void setTitleColor(int textColor) {
        mTitleColor = textColor;
        onTitleChanged(mTitle, textColor);
    }

    public final CharSequence getTitle() {
        return mTitle;
    }

    public final int getTitleColor() {
        return mTitleColor;
    }

    protected void onTitleChanged(CharSequence title, int color) {
        if (mTitleReady) {
            final Window win = getWindow();
            if (win != null) {
                win.setTitle(title);
                if (color != 0) {
                    win.setTitleColor(color);
```

```
protected void onTitleChanged(CharSequence title, int color) {
    if (mTitleReady) {
        final Window win = getWindow();
        if (win != null) {
            win.setTitle(title);
            if (color != 0) {
                win.setTitleColor(color);
            }
        }
        if (mActionBar != null) {
            mActionBar.setWindowTitle(title);
        }
    }
}

public boolean dispatchPopulateAccessibilityEvent(AccessibilityEvent event) {
    event.setClassName(getClass().getName());
    event.setPackageName(getPackageName());

    LayoutParams params = getWindow().getAttributes();
    boolean isFullScreen = (params.width == LayoutParams.MATCH_PARENT) &&
        (params.height == LayoutParams.MATCH_PARENT);
    event.setFullScreen(isFullScreen);

    CharSequence title = getTitle();
    if (!TextUtils.isEmpty(title)) {
       event.getText().add(title);
    }

    return true;
}

@Override
protected void onApplyThemeResource(Resources.Theme theme, int resid,
        boolean first) {
    if (mParent == null) {
        super.onApplyThemeResource(theme, resid, first);
    } else {
        try {
            theme.setTo(mParent.getTheme());
        } catch (Exception e) {
            // Empty
        }
        theme.applyStyle(resid, false);
    }

    // Get the primary color and update the TaskDescription for this activity
    if (theme != null) {
        TypedArray a = theme.obtainStyledAttributes(com.android.internal.R.styleable.Theme);
        int colorPrimary = a.getColor(com.android.internal.R.styleable.Theme_colorPrimary, 0);
        a.recycle();
        if (colorPrimary != 0) {
            ActivityManager.TaskDescription v = new ActivityManager.TaskDescription(null, null,
                    colorPrimary);
            setTaskDescription(v);
        }
    }
}
```

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protected void onTitleChanged(CharSequence title, int color) {
    if (mTitleReady) {
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        if (win != null) {
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            mActionBar.setWindowTitle(title);
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    boolean isFullScreen = (params.width == LayoutParams.MATCH_PARENT) &&
        (params.height == LayoutParams.MATCH_PARENT);
    event.setFullScreen(isFullScreen);

    CharSequence title = getTitle();
    if (!TextUtils.isEmpty(title)) {
       event.getText().add(title);
    }

    return true;
}

@Override
protected void onApplyThemeResource(Resources.Theme theme, int resid,
        boolean first) {
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        super.onApplyThemeResource(theme, resid, first);
    } else {
        try {
            theme.setTo(mParent.getTheme());
        } catch (Exception e) {
            // Empty
        }
        theme.applyStyle(resid, false);
    }

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    if (theme != null) {
        TypedArray a = theme.obtainStyledAttributes(com.android.internal.R.styleable.Theme);
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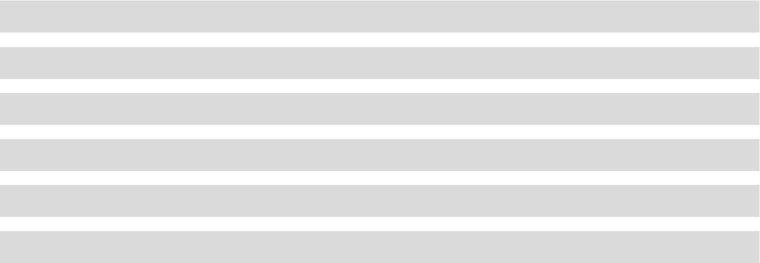
        a.recycle();
        if (colorPrimary != 0) {
            ActivityManager.TaskDescription v = new ActivityManager.TaskDescription(null, null,
                    colorPrimary);
            setTaskDescription(v);
        }
    }
}
```

Bullet method

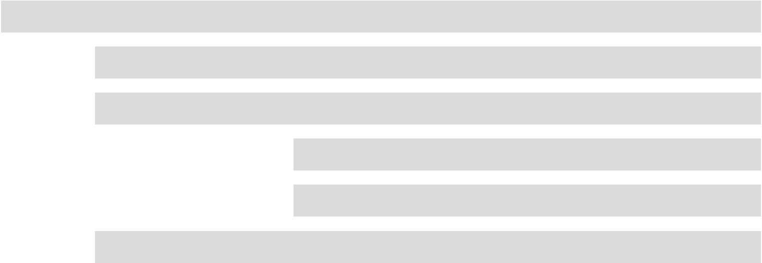
```
@Override
protected void onApplyThemeResource(Resources.Theme theme, int resid,
        boolean first) {
    if (mParent == null) {
        super.onApplyThemeResource(theme, resid, first);
    } else {
        try {
            theme.setTo(mParent.getTheme());
        } catch (Exception e) {
            // Empty
        }
        theme.applyStyle(resid, false);
    }

    // Get the primary color and update the TaskDescription for this activity
    if (theme != null) {
        TypedArray a = theme.obtainStyledAttributes(com.android.internal.R.styleable.Theme);
        int colorPrimary = a.getColor(com.android.internal.R.styleable.Theme_colorPrimary, 0);
        a.recycle();
        if (colorPrimary != 0) {
            ActivityManager.TaskDescription v = new ActivityManager.TaskDescription(null, null,
                    colorPrimary);
            setTaskDescription(v);
        }
    }
}
```

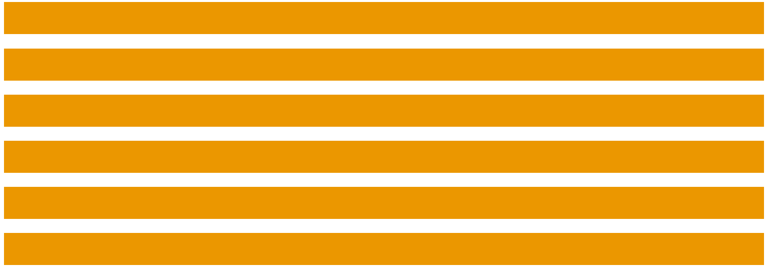
Bullet method



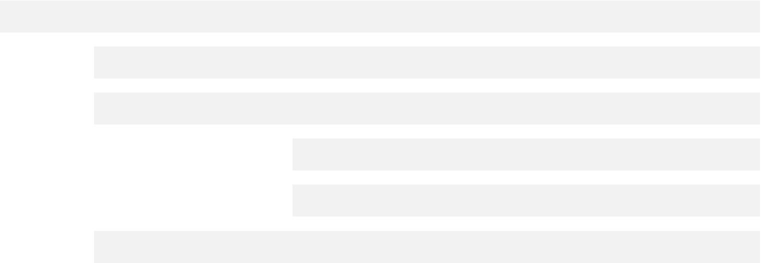
Nested method



Bullet method



Nested method



```
public String buildHtmlPage(int id) {
  PageContent content = database.getContent(id);
  StringBuilder sb = new StringBuilder();
  sb.append("<!DOCTYPE>");
  sb.append("<html>");
  sb.append("<head>")
   .append("<meta content=\"text/html; chartset=UTF-8\" />")
   .append("<title>").append(content.getTitle()). append("</title>")
   .append("</head>");
  sb.append("<body>")
   .append("<h1>")append(content.getHeading()).append("</h1>")
   .append("<section>").append(content.getText()).append("</section>")
  sb.append("<footer>").append(content.getCopyright()).append("</footer>");
  sb.append("</body>");
  sb.append("</html>");
  return sb.toString();
}
```

```
public String buildHtmlPage(int id) {
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    sb.append("<body>")
     .append("<h1>")append(content.getHeading()).append("</h1>")
     .append("<section>").append(content.getText()).append("</section>")
    sb.append("<footer>").append(content.getCopyright()).append("</footer>");
    sb.append("</body>");
    sb.append("</html>");
    return sb.toString();
}
```

```
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}
```

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     .append("<section>").append(content.getText()).append("</section>")
    sb.append("<footer>").append(content.getCopyright()).append("</footer>");
    sb.append("</body>");
    sb.append("</html>");
    return sb.toString();
}
```

```
public String buildHtmlPage(PageContent content) {

   StringBuilder sb = new StringBuilder();
   appendDoctype(sb);
   sb.append("<html>");
   sb.append("<head>")
    .append("<meta content=\"text/html; chartset=UTF-8\" />")
    .append("<title>").append(content.getTitle()). append("</title")
    .append("</head>");
   sb.append("<body>")
    .append("<h1>")append(content.getHeading()).append("</h1>")
    .append("<section>").append(content.getText()).append("</section>")
   sb.append("<footer>").append(content.getCopyright()).append("</footer>");
   sb.append("</body>");
   sb.append("</html>");
   return sb.toString();
}
```

```
public String buildHtmlPage(PageContent content) {

   StringBuilder sb = new StringBuilder();
   appendDoctype(sb);
   startHtml(sb);
   sb.append("<head>")
    .append("<meta content=\"text/html; chartset=UTF-8\" />")
    .append("<title>").append(content.getTitle()). append("</title")
    .append("</head>");
   sb.append("<body>")
    .append("<h1>")append(content.getHeading()).append("</h1>")
    .append("<section>").append(content.getText()).append("</section>")
   sb.append("<footer>").append(content.getCopyright()).append("</footer>");
   sb.append("</body>");
   sb.append("</html>");
   return sb.toString();
}
```

```
public String buildHtmlPage(PageContent content) {

  StringBuilder sb = new StringBuilder();
  appendDoctype(sb);
  startHtml(sb);
  appendHead(sb, content);

  sb.append("<body>")
   .append("<h1>")append(content.getHeading()).append("</h1>")
   .append("<section>").append(content.getText()).append("</section>")
  sb.append("<footer>").append(content.getCopyright()).append("</footer>");
  sb.append("</body>");
  sb.append("</html>");
  return sb.toString();
}
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TESTABLE

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TESTABLE

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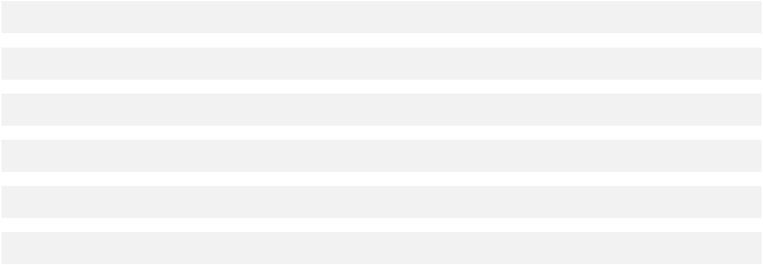
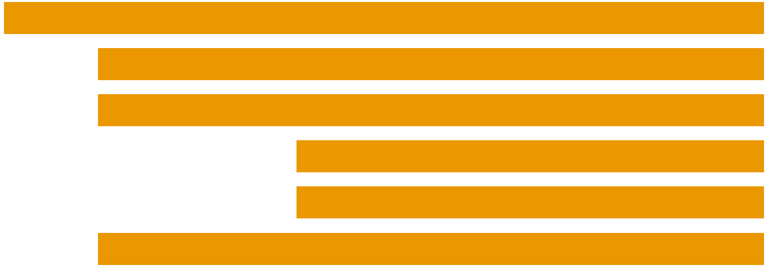
Bullet method



Nested method



```
public void package(Parcel parcel) {
 if (parcel.shouldPackage() && parcel.getState() != PACKAGED) {
   int w = parcel.getWidth()
   int h = parcel.getHeight();
   int surface = w*h;
   Color color = parcel.getPreferredPackagingColor();
   Package package = new Package(w, h, color);
   package.wrap(parcel);

   Taper taper = Taper.getInstance();
   if (parcel.mustTape() && taper.canTape(package)) {
     taper.tape(package);
   } else {
     throw new InsufficientTapeException();
   }
   dispatcher.dispatch(package);
 }
}
```

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public void package(Parcel parcel) {
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      } else {
          throw new InsufficientTapeException();
      }
      dispatcher.dispatch(package);
  }
}
```

```
public void package(Parcel parcel) {
  if (shouldPackage(parcel)) {
      Package package = packageParcel(parcel);

      Taper taper = Taper.getInstance();
      if (parcel.mustTape() && taper.canTape(package)) {
          taper.tape(package);
      } else {
          throw new InsufficientTapeException();
      }
      dispatcher.dispatch(package);
  }
}
```

```
public void package(Parcel parcel) {
 if (shouldPackage(parcel)) {
   Package package = packageParcel(parcel);

   Taper taper = Taper.getInstance();
   if (parcel.mustTape() && taper.canTape(package)) {
     taper.tape(package);
   } else {
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   }
   dispatcher.dispatch(package);
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```
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      }
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```java
public void package(Parcel parcel) {
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          tapePackage(package);
      } else {
          throw new InsufficientTapeException();
      }
      dispatcher.dispatch(package);
  }
}
```

TESTABLE

TESTABLE

Moving to testable code

- Focused interfaces for test calls
- Focus on main purpose of class

FOCUS!

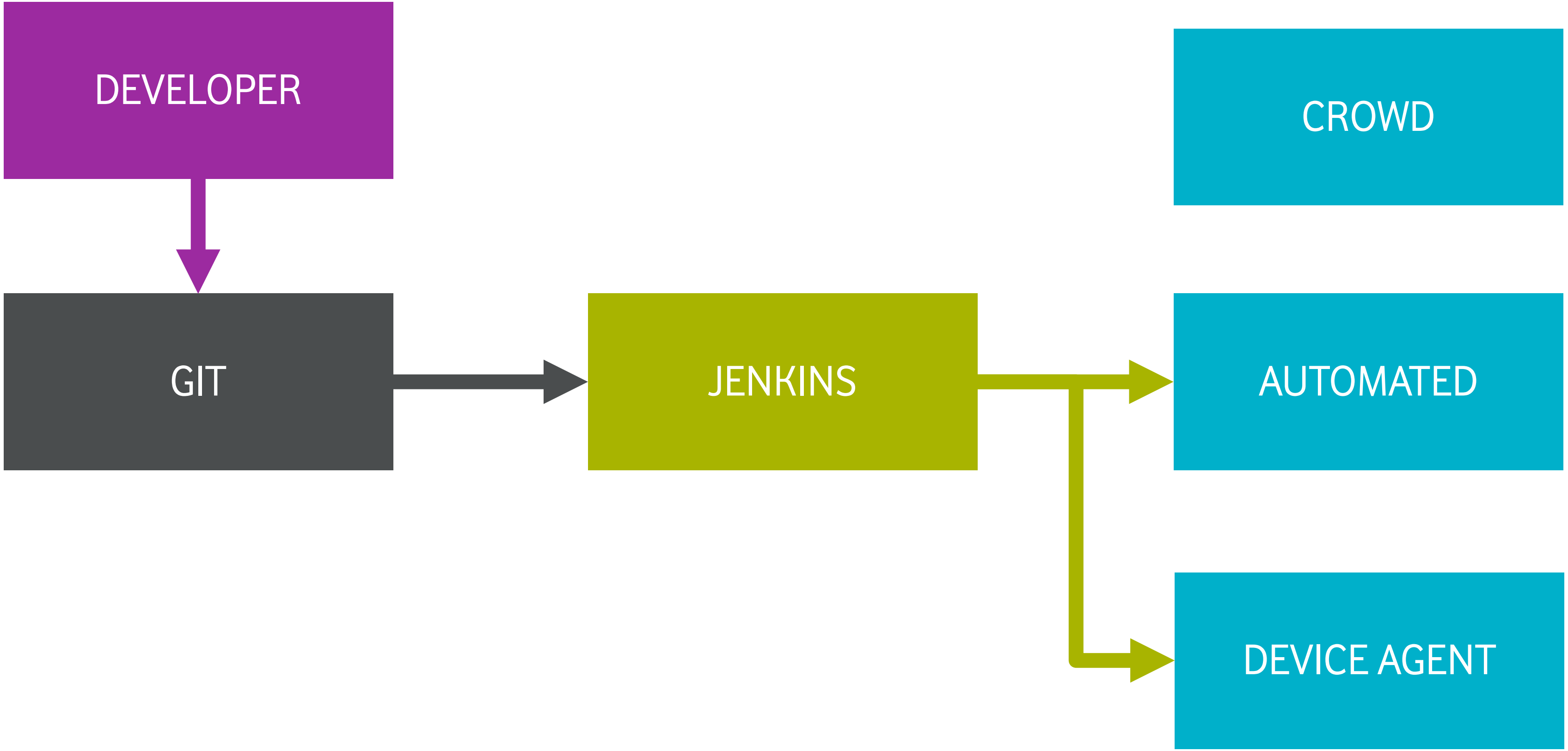
"Programming is the art of doing one thing at a time."

Michael C. Feathers - Working effectively with legacy code

Auxiliaries

- Get to know the code before doing changes
- Use Test-driven development
- Use Pull-Requests, review them yourself, eventually reject and simplify

Test automation



DEVELOPER

GIT

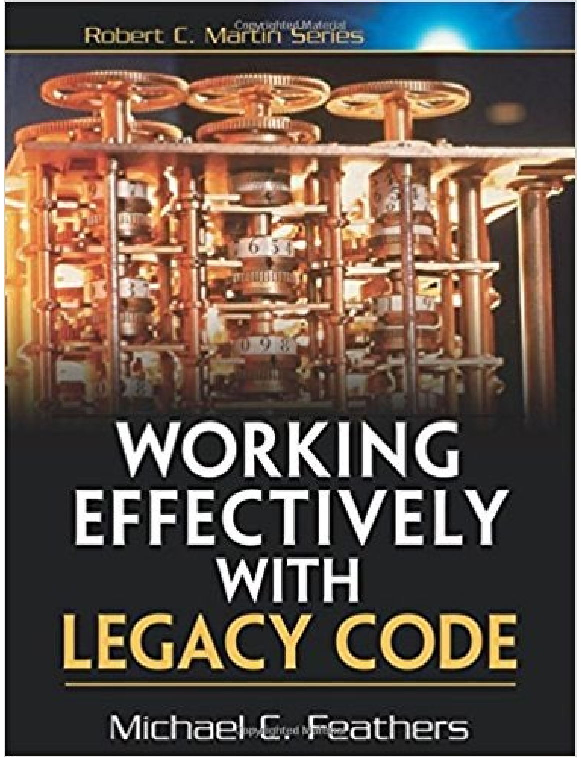
JENKINS

CROWD

AUTOMATED

DEVICE AGENT

Summary



Robert C. Martin Series

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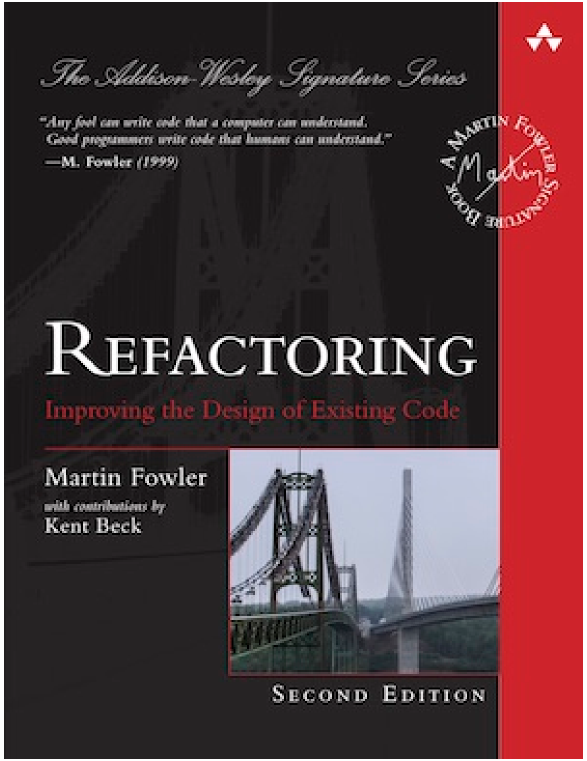
WORKING EFFECTIVELY WITH LEGACY CODE

Michael C. Feathers



The Addison-Wesley Signature Series

"Any fool can write code that a computer can understand. Good programmers write code that humans can understand."
—M. Fowler (1999)

A Martin Fowler Signature Book

REFACTORING

Improving the Design of Existing Code

Martin Fowler
with contributions by
Kent Beck

SECOND EDITION

Thank you!

Anton Augsburg

@ungesehn