# Behavior-Driven Development (BDD) Testing with Apache Spark

**Kevin Mellott**
Technical Team Lead, Data and Analytics

**Zachary Nanfelt**
Software Engineer, Data and Analytics

# Who is
# FIS Global?

- We’re FIS Digital Finance, Mobile Data and Analytics
- One of the **largest global** FinTech companies
- Customers are banks and credit unions
- Ecosystem of products and services **built around core banking**

# Data Wrangling

1. ETL is still a thing
2. The way we do it varies quite a bit
3. When we do it also varies
4. The why we do it, that's easy

# Questions on what we are doing?

Can you prove that the data **transformed** correctly?

Is unit testing **understandable**?

Did we cover all **scenarios**?

Was **acceptance criteria** met?

Are we able to do all this testing complexity in a reasonable **timeframe?**

# What is BDD?

- An extension of Test Driven Development
- Deliberate shared, ubiquitous language
- Automated acceptance tests written as ***Examples*** that anyone can read
- Living documentation – Documentation others can read about code is updated
- More agile to have good documentation as an output to development than making documentation as input
- Enable more Team Members to Participate in the development process

# Core Problem of Data Transformation

- It is **really hard** to prove data transformed correctly in a **normal pipeline aka *Batch-Oriented***
- The **traditional** way has been to push data through the system and then **query it out**
- **Apache Spark** can accelerate not only the **speed you transform**, but the speed in which you can **validate** transformations
  - We can switch from Batch Oriented to Streaming

# Spark is our favorite hammer



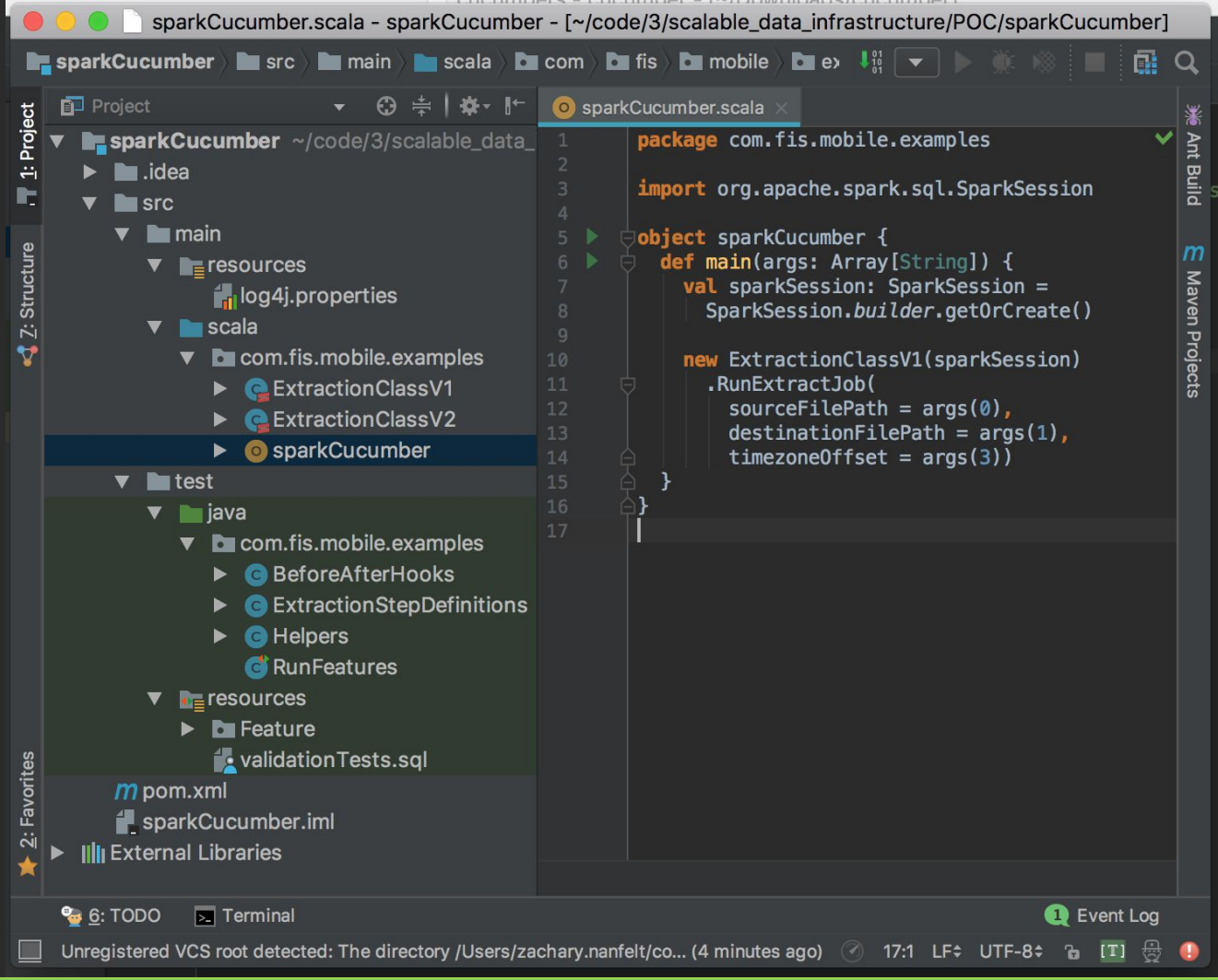
=

Beautiful Baby

# Super Widget Scenario

- Our app servers log everything in **Epoch Time (Unix)** from mobile app clients **all over the world**
- Users seem incapable of computing this mentally and want it to appear in their own **timezone**
- *Crazy*, but some of these guys are **remote** *and* in **different timezones**

# Boilerplate Code



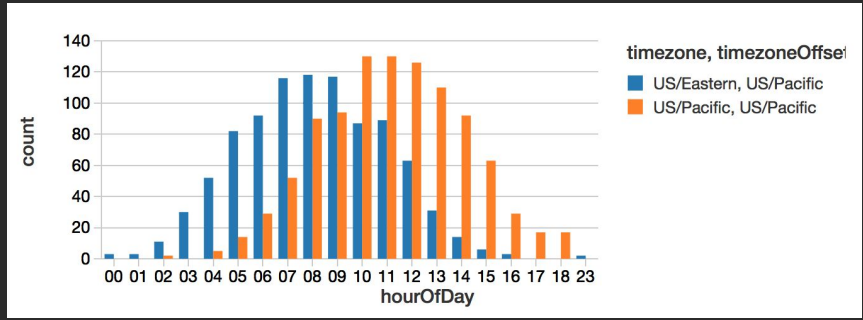
# Extraction Code

```scala
package com.fis.mobile.examples

import ...

class ExtractionClassV1(sparkSession: SparkSession) {
  val TIMESTAMP_FORMAT = "yyyy-MM-dd HH:mm:ss"

  def RunExtractJob(sourceFilePath: String, destinationFilePath: String, timezoneOffset: String): Unit = {
    val sourceDataFrame: DataFrame = GetJsonDataFrame(sourceFilePath)
    val extractedDataFrame: DataFrame = ExtractDataFrame(sourceDataFrame, timezoneOffset)
    SaveJsonDataFrame(extractedDataFrame, destinationFilePath)
  }

  def GetExtractedJsonDataFrame(filePath: String, timezoneOffset: String): DataFrame = {
    ExtractDataFrame(GetJsonDataFrame(filePath), timezoneOffset)
  }

  private def GetJsonDataFrame(filePath: String): DataFrame = {
    sparkSession.read.json(filePath)
  }

  private def ExtractDataFrame(dataFrame: DataFrame, timezoneOffset: String): DataFrame = {
    import sparkSession.implicits._

    dataFrame
      .withColumn("timezoneOffset", lit(timezoneOffset))
      .withColumn("timestampGmt", from_unixtime($"unixTimestamp"))
      .withColumn("timestampLtz",
        date_format(from_utc_timestamp(from_unixtime($"unixTimestamp"), timezoneOffset), TIMESTAMP_FORMAT))
  }

  private def SaveJsonDataFrame(dataFrame: DataFrame, filePath: String): Unit = {
    dataFrame.write.json(filePath)
  }
}
```

# SQL Validation Test Code

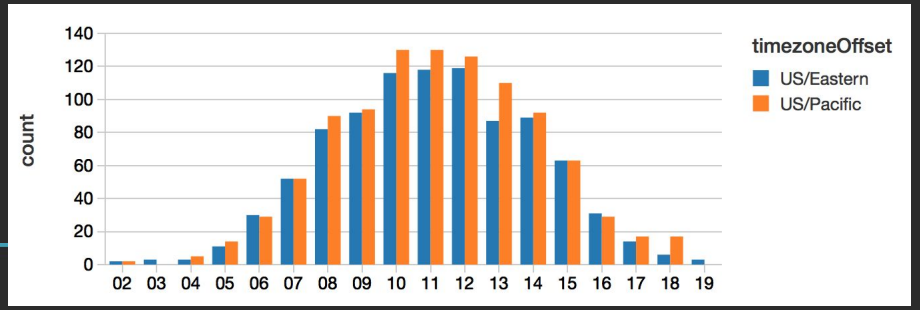
```
SELECT  TIMEZONE_OFFSET,
    TIMESTAMP_GMT,
    TIMESTAMP_LTZ
FROM
    APPSTORE_REVIEWS
WHERE
    TIMEZONE_OFFSET <> 0
LIMIT 10;
```

# Cucumber Test




```
@Extraction @TempFileCleanup @ApacheSpark
Feature: Json Logs Extract Process V1

  Background: general system setup
    Given the system is in UTC time

  @V1
  Scenario: Basic extraction of Epoch time into readable local time zones specified by person doing extraction
    Given there is a file "srcFolder/example.json" with the following lines:
      | {"logId":1, "unixTimestamp":1459482142, "timezone":"US/Pacific"} |
      | {"logId":2, "unixTimestamp":1459482142, "timezone":"US/Eastern"} |
    When the method RunExtractJobV1 gets called with
      | SourceFolder      | srcFolder/* |
      | DestinationFolder | dstFolder   |
      | TimezoneOffset    | US/Pacific  |
    Then there will be a "_SUCCESS" file in the "dstFolder" folder
    And the folder "dstFolder" will have json files with exactly the following DataFrame rows:
      |logId|unixTimestamp|timestampLtz       |timezoneOffset|
      |1    |1459482142   |2016-03-31 20:42:22|US/Pacific    |
      |2    |1459482142   |2016-03-31 20:42:22|US/Pacific    |
```

# Cucumber Test Version 2




```
@Extraction @TempFileCleanup @ApacheSpark @V2
Feature: Json Logs Extract Process V2

  Background: general system setup
    Given the system is in UTC time

  Scenario: Basic extraction of Epoch time into readable local time zones of the devices
    Given there is a file "srcFolder2/example.json" with the following lines:
      | {"logId":1, "unixTimestamp":1459482142, "timezone":"US/Pacific"} |
      | {"logId":2, "unixTimestamp":1459482142, "timezone":"US/Eastern"} |
    When the method RunExtractJobV2 gets called with
      | SourceFolder      | srcFolder2/* |
      | DestinationFolder | dstFolder2   |
    Then there will be a "_SUCCESS" file in the "dstFolder2" folder
    And the folder "dstFolder2" will have json files with exactly the following DataFrame rows:
      |logId|unixTimestamp|timestampLtz       |timezoneOffset|
      |1    |1459482142   |2016-03-31 20:42:22|US/Pacific    |
      |2    |1459482142   |2016-03-31 23:42:22|US/Eastern    |

```

# Why this is so great

- Collaboration and Participation
- Thinking naturally begets better scenarios
- We are able to unify
  - –Use Cases
    - •We are using ETL...
  - –All Projects

# Given a BDD Presentation
# When it is late in the day
# And FIS is giving the talk
# Then get Excited!

- We define Features and Scenarios
  *Expressive Scenarios*
- Given/When/Then
  *Gherkin doesn't care how you use them*
  *They just help with readability.*

# Wait, there's more!

Step Definitions

- Step Definitions tell the *how* to do
  The Feature file said *what* to do

- This the boundary of the programmer's Domain and the business domain.

- It's not all snake oil, really...

# Cucumber Step Definition Code

```
1   package com.fis.mobile.examples;
2
3   import ...
17
18  public class ExtractionStepDefinitions {
19      @Given("^the system is in UTC time$")
20      public void theSystemIsInGMTTime() throws Throwable {
21          TimeZone.setDefault(TimeZone.getTimeZone("UTC"));
22      }
23
24      @Given("^there is a file \"([^\"]*)\" with the following lines:$")
25      public void thereIsAFileWithTheFollowingLines(String propertiesPath, List<String> lines) throws Throwable {
26          File file = new File(Helpers.getTempTestPath(propertiesPath));
27          //noinspection ResultOfMethodCallIgnored
28          file.getParentFile().mkdirs();
29          PrintWriter writer = new PrintWriter(file.getAbsolutePath(),  csn: "UTF-8");
30          for (String str : lines) {
31              writer.println(str.trim());
32          }
33          writer.close();
34      }
35
36      @When("^the method (RunExtractJobV1|RunExtractJobV2) gets called with$")
37      public void theMethodRunExtractJobGetsCalledWith(String jobName, Map<String, String> arguments) throws Throwable {
38          if(jobName.compareTo( anotherString: "RunExtractJobV1")==0) {
39              new ExtractionClassV1(Helpers.testSparkSession).RunExtractJob(
40                      Helpers.getTempTestPath(arguments.get("SourceFolder")),
41                      Helpers.getTempTestPath(arguments.get("DestinationFolder")),
42                      arguments.get("TimezoneOffset"));
43          }
44          else if(jobName.compareTo( anotherString: "RunExtractJobV2")==0) {
45              new ExtractionClassV2(Helpers.testSparkSession).RunExtractJob(
46                      Helpers.getTempTestPath(arguments.get("SourceFolder")),
47                      Helpers.getTempTestPath(arguments.get("DestinationFolder")));
48          } else { throw new PendingException(); }
49      }
```

# Cucumber Step Definition Code

```
51      @Then("^there will be a \"([^\"]*)\" file in the \"([^\"]*)\" folder$")
52      public void thereWillBeAFileInTheFolder(final String partialFileName, String destinationFolder) throws Throwable {
53          String[] filesInFolder = new File(Helpers.getTempTestPath(destinationFolder)).list();
54
55          assert filesInFolder != null;
56          Assert.assertTrue(Arrays.asList(filesInFolder).contains(partialFileName));
57      }
58
59      @Then("^the folder \"([^\"]*)\" will have json files with exactly the following DataFrame rows:$")
60      public void theFolderWillHaveJsonFilesWithTheFollowingDataFrameRows(
61              String destinationFolder, List<Map<String,String>> dataTable) throws Throwable {
62          Dataset<Row> actualDF = Helpers.testSparkSession.read().json(Helpers.getTempTestPath(destinationFolder)).cache();
63
64          Assert.assertEquals( message: "Number of rows in DataFrame", dataTable.size(), actualDF.count());
65
66          for(Map<String, String> expectedColumns : dataTable) {
67              Dataset<Row> actualRow = actualDF;
68
69              for (Map.Entry<String, String> expectedCell : expectedColumns.entrySet()) {
70                  actualRow = actualRow.filter(String.format("%s <=> '%s'", expectedCell.getKey(), expectedCell.getValue()));
71              }
72
73              if (actualRow.count() != 1) {
74                  System.out.println("ACTUAL (entire DataFrame):");
75                  actualDF.show( truncate: false);
76
77                  Assert.assertEquals(String.format("EXPECTED ROW: %s",
78                          expectedColumns.toString()),  expected: 1, actualRow.count());
79              }
80          }
81      }
82  }
83
```

# Cucumber Code

```java
package com.fis.mobile.examples;

import ...

@RunWith(Cucumber.class)
@CucumberOptions(
        glue = "com.fis.mobile.examples",
        features = {"src/test/resources/Feature/"}
)
public class RunFeatures {

}

```

```java
package com.fis.mobile.examples;

import ...

public class BeforeAfterHooks {
    @Before("@TempFileCleanup")
    @After("@TempFileCleanup")
    public void CleanupTempFiles() throws IOException, InterruptedException {
        File tempDirectory = new File(Helpers.getTempPath( relativePath: ""));
        FileUtils.deleteDirectory(tempDirectory);
    }

    @Before("@ApacheSpark")
    public void setup() {
        if(Helpers.testSparkSession == null) {
            Helpers.testSparkSession = SparkSession
                    .builder()
                    .master("local")
                    .appName("cucumberSparkAppTestSession")
                    .config("spark.driver.host", "127.0.0.1")
                    .getOrCreate();
        }
    }
}

```

# For these two guys, ETL wasn't hell, it was target practice.


2 Kinds of People in this world…

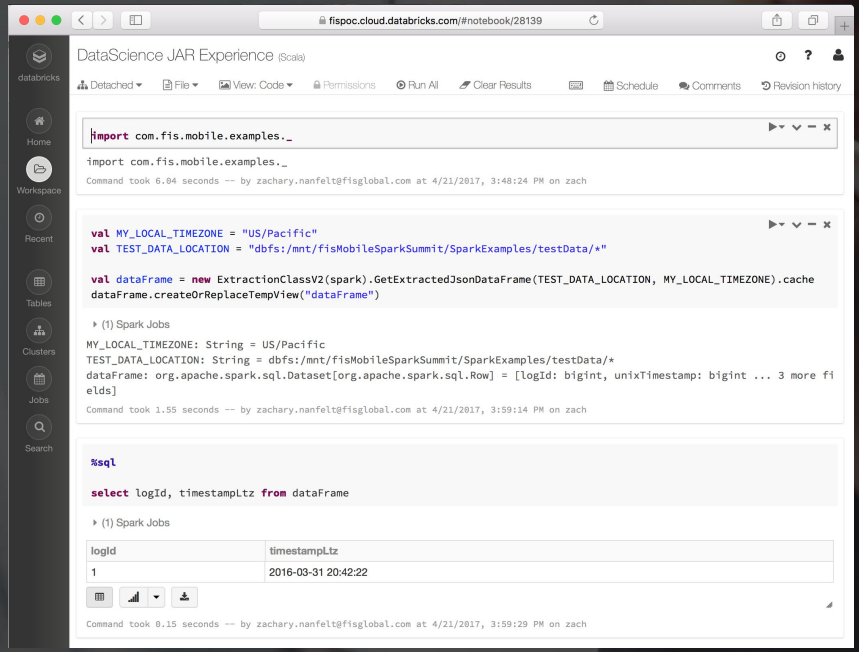
About cucumber

# Enterprise Stuff

- You will notice we are sticking to **Eclipse/IntelliJ**
- Enterprises usually need to prove **Separation of Duties** and **Audit Trails**
- Most Data processing tasks ***should*** have an established process to ensure quality and correctness.
  - All Business have their own Custom Approach to Business Rules
  - Consolidating these transformations ensure quality. Allows QA Checking
- Notebooks:
  - It's really hard to enforce that consistency and correctness in notebooks, except by Compiling libraries.
  - Unifying Business Logic and Common Transformations removes the prep work.

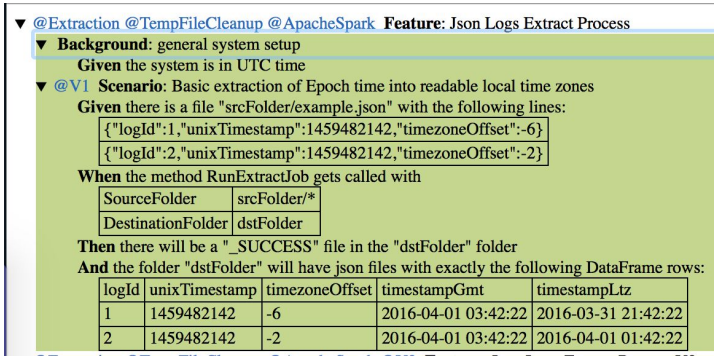
# Code

https://dbc-39f78c99-dfb2.cloud.databricks.com/#notebook/28139

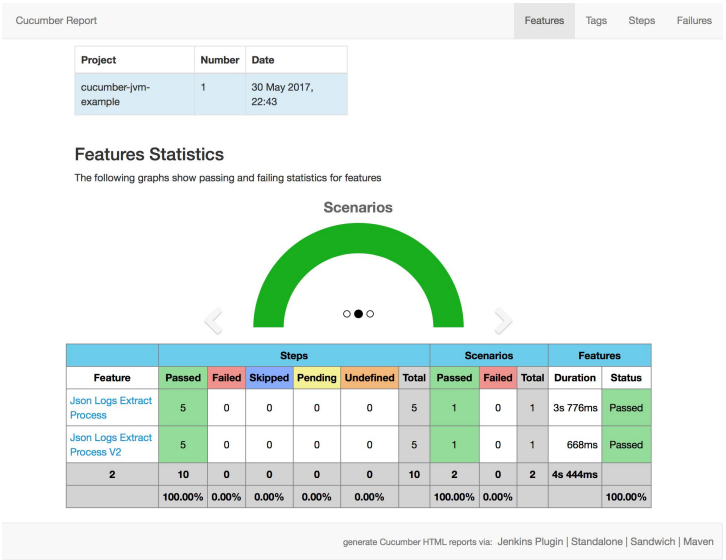


# Tips and Tricks (Pretty Report)

- plugin = {“pretty”, “html:target/cucumber”} isn’t very pretty
- *Use **cucumber-reports***

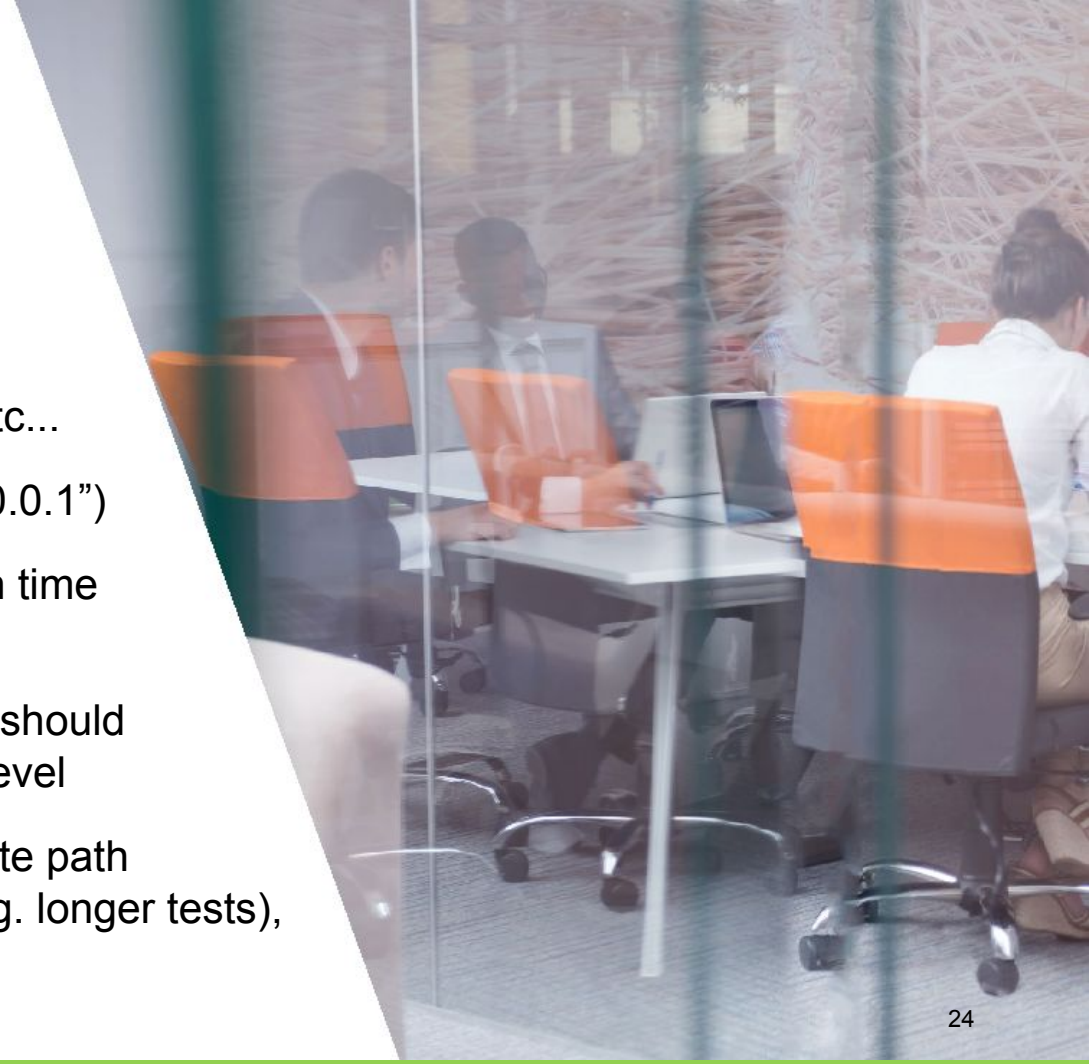



***Verses***

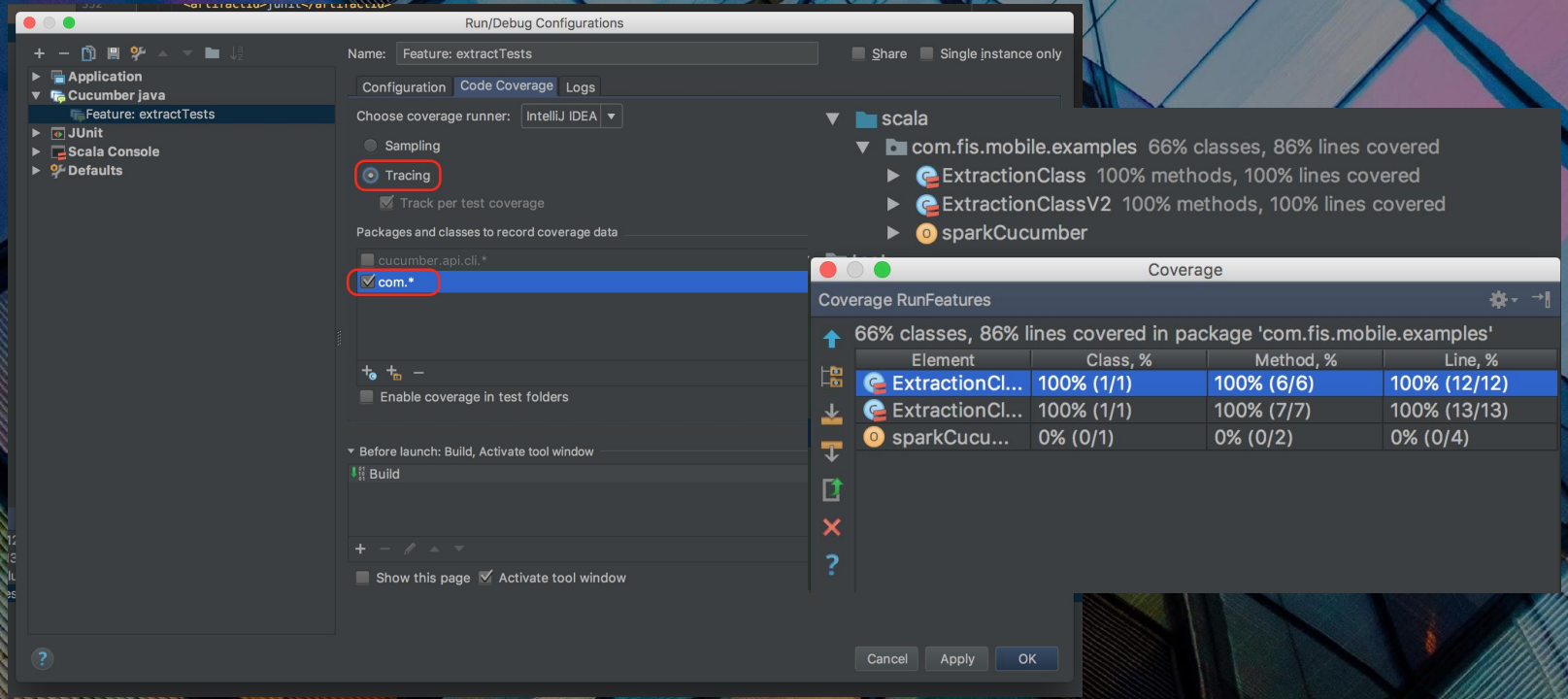


# Tips and Tricks (miscellaneous)

- Java cuke > Scala cuke
  - intelliJ integration, speed, etc...
- .config(“spark.driver.host”, “127.0.0.1”)
  - Saves overall test execution time for each run
- Think hard about whether things should get tested at unit or component level
  - DAG takes longer to compute path on more complex DAGs (e.g. longer tests), but can provide more value



# Tips and Tricks (Code Coverage for Scala Cuke)



# Resources, Resources, Resources

- Cucumber.io
- cucumber-reporting
- Pragmatic Books
  - Cucumber Book
  - Cucumber Recipes
  - Cucumber for Java
- Specification by Example
- Databricks Blog

# Thank you

**Kevin Mellott**
kevin.mellott@fisglobal.com

**Zachary Nanfelt**
zachary.nanfelt@fisglobal.com