BEHAVIOR-DRIVEN DEVELOPMENT

TEST

PBA SOFTWAREUDVIKLING/
BSC SOFTWARE DEVELOPMENT

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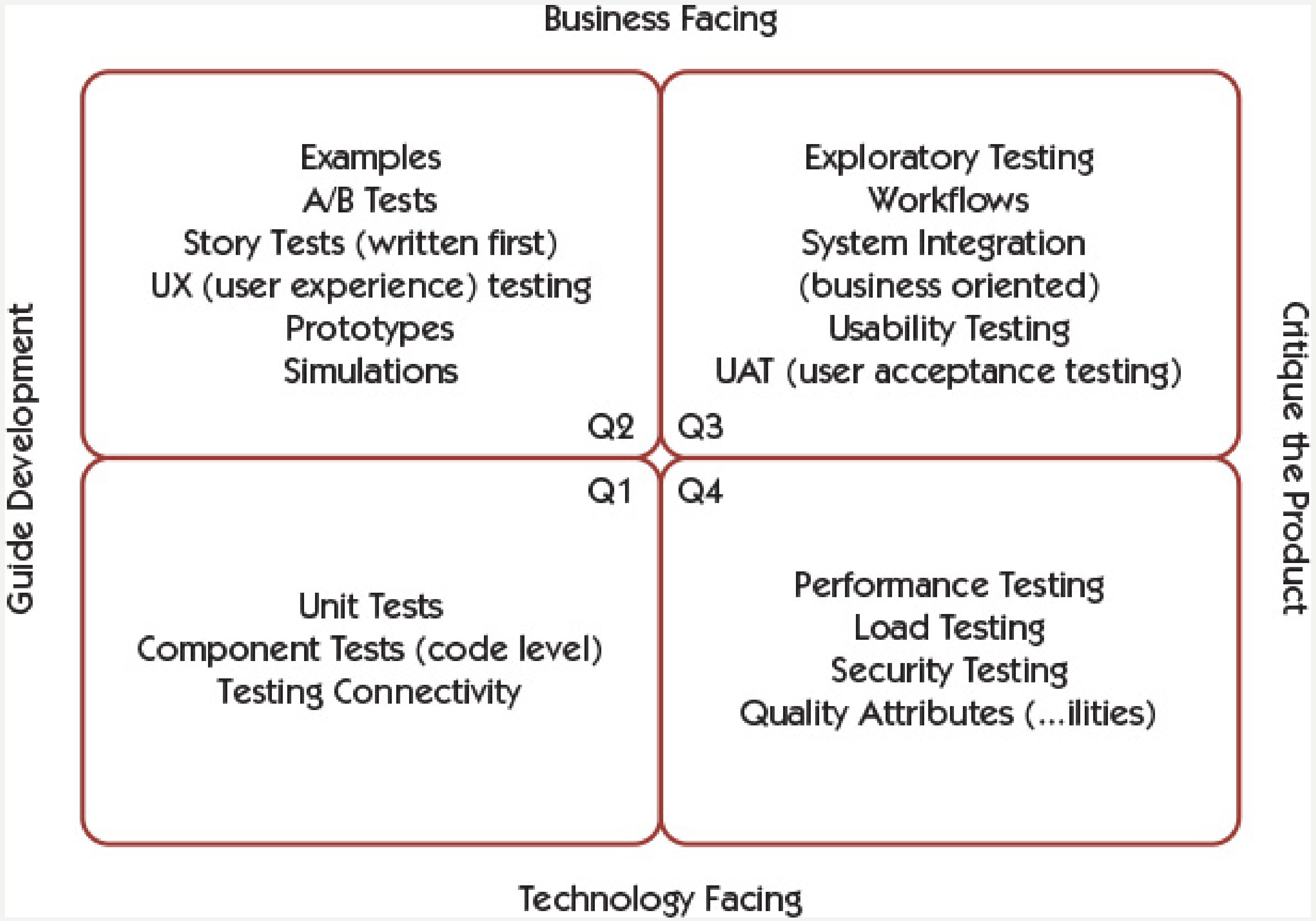
TODAY´S TOPIC

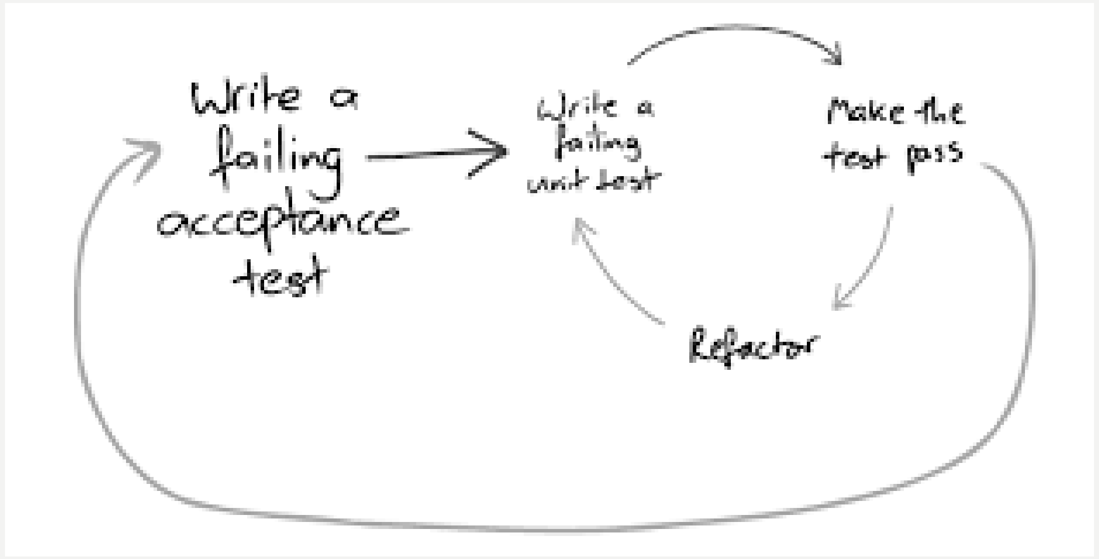
- Develop by examples with Behavior-driven development (BDD)
  - Gherkin & Cucumber
  - Result: Automated functional tests
- Status study point assignments
- Guest lecturer Gitte Ottosen on Agile Testing

BUSINESS FACING TESTS – WE ARE IN Q2 TODAY



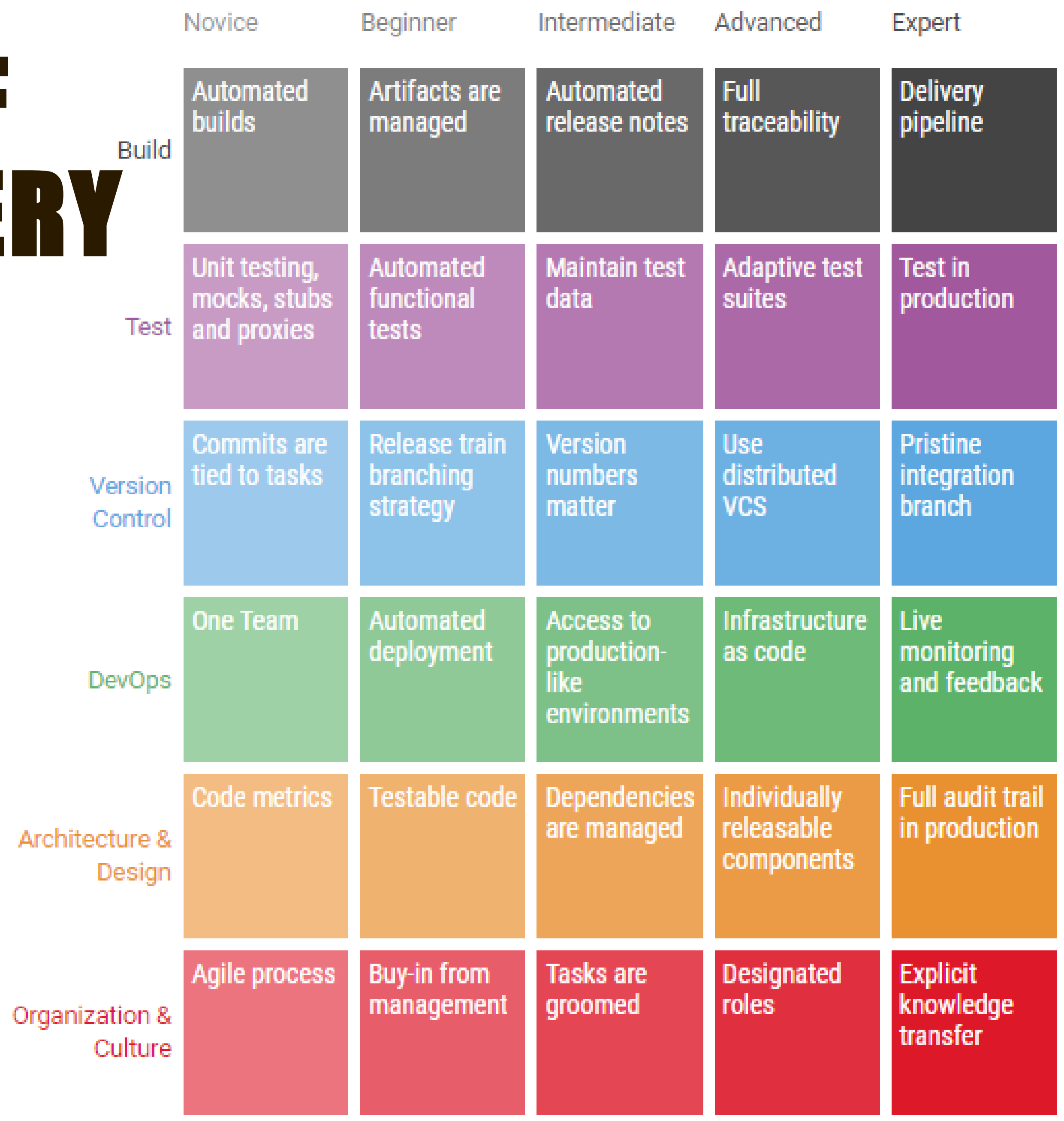
ACCEPTANCE TEST-DRIVEN DEVELOPMENT (ATDD)

- Start each feature with an acceptance test
  - Clarifies WHAT to do with no underlying tech focus



MATURITY MODEL OF CONTINUOUS DELIVERY

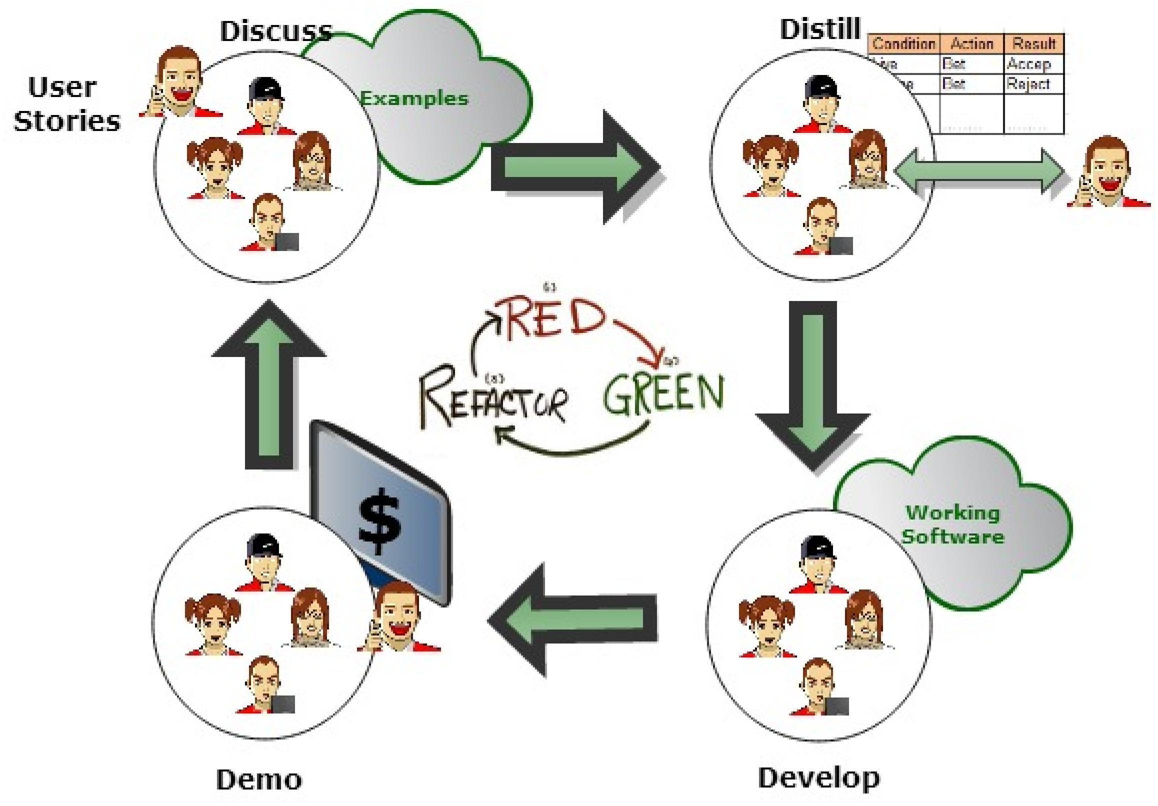
- We want automated functional tests as part of Continuous Delivery pipeline to reduce time spent on regression testing
- If we write acceptance tests early by getting examples of desired and undesired system behavior from the customer, we know the right things to build



	Novice	Beginner	Intermediate	Advanced	Expert
Build	Automated builds	Artifacts are managed	Automated release notes	Full traceability	Delivery pipeline
Test	Unit testing, mocks, stubs and proxies	Automated functional tests	Maintain test data	Adaptive test suites	Test in production
Version Control	Commits are tied to tasks	Release train branching strategy	Version numbers matter	Use distributed VCS	Pristine integration branch
DevOps	One Team	Automated deployment	Access to production-like environments	Infrastructure as code	Live monitoring and feedback
Architecture & Design	Code metrics	Testable code	Dependencies are managed	Individually releasable components	Full audit trail in production
Organization & Culture	Agile process	Buy-in from management	Tasks are groomed	Designated roles	Explicit knowledge transfer

ATDD Cycle

from User Stories to Business value



(Based on ATDD cycle model developed by James Shore with changes suggested by Grigori Melnick, Brian Marick, and Elisabeth Hendrickson.)
The Specification by Example concept is taken from Gojko Adzic.

THE POWER OF USING EXAMPLES

Having conversations

Is more important that **capturing** conversations

Is more important that **automating** conversations

Automation becomes a useful side effect of using that tool

Source: More Agile Testing by Janet Gregory & Lisa Crispin

EXPOSE UNCERTAINTY EARLY

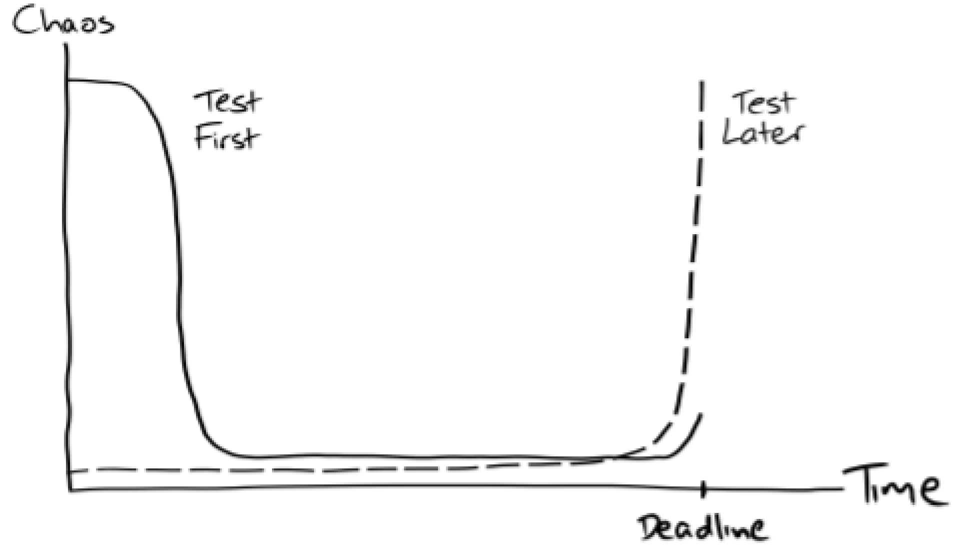
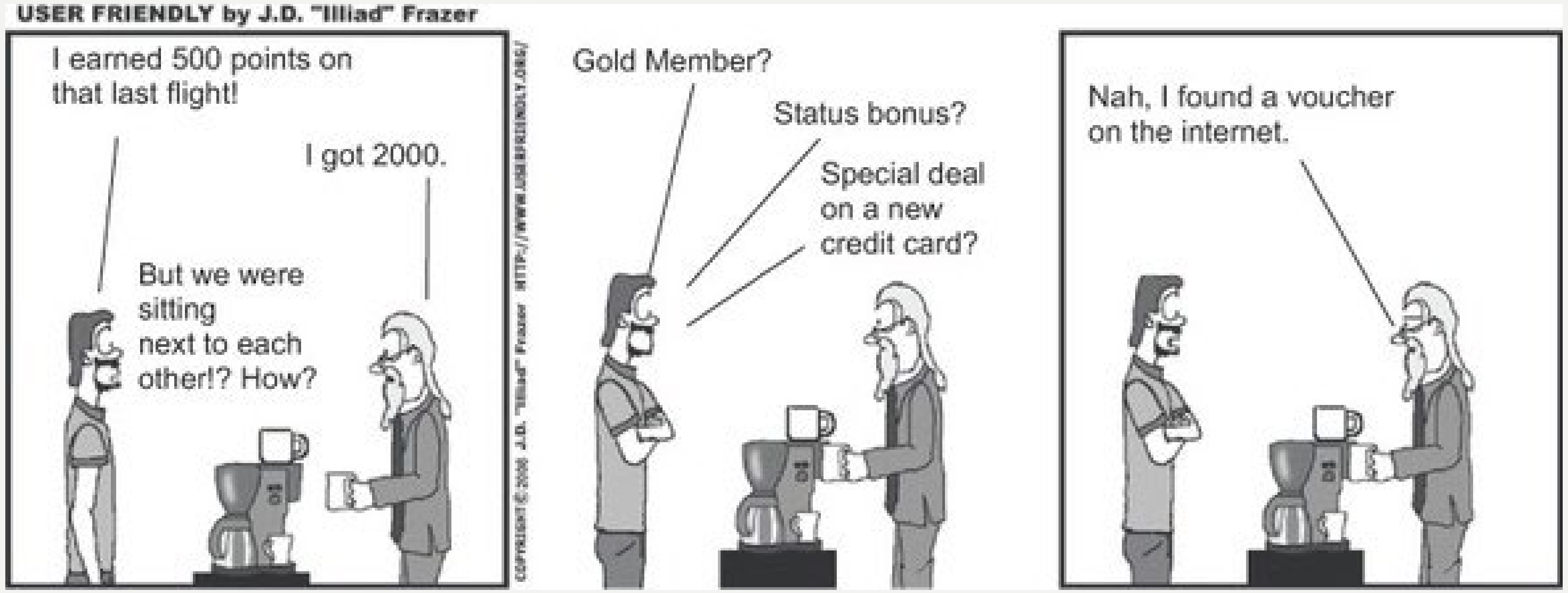


Figure 4.4 *Visible uncertainty in test-first and test-later projects*

BUSINESS REQUIREMENTS

Business requirements are often not as simple as they appear – therefore examples can help:


USER FRIENDLY by J.D. "Illiad" Frazer
I earned 500 points on that last flight!
I got 2000.
But we were sitting next to each other!? How?
COPYRIGHT © 2000 J.D. "Illiad" Frazer HTTP://WWW.USERFRIENDLY.ORG/
Gold Member?
Status bonus?
Special deal on a new credit card?
Nah, I found a voucher on the internet.

BUILD THE RIGHT PRODUCT

Non standard naming for getting examples in agile development:

- Acceptance-test-driven development (ATDD)
- Behavior-driven development (BDD)
- Specification by example (SBE)

- These practices have minor differences between them, but all address the problem of different stakeholders using different vocabularies which in turn result in incorrect interpretations of requirements and discrepancies between code, test and customer expectations

Source: Develop Testing by Tarlinder chapter 2

AUTOMATED ACCEPTANCE TESTS

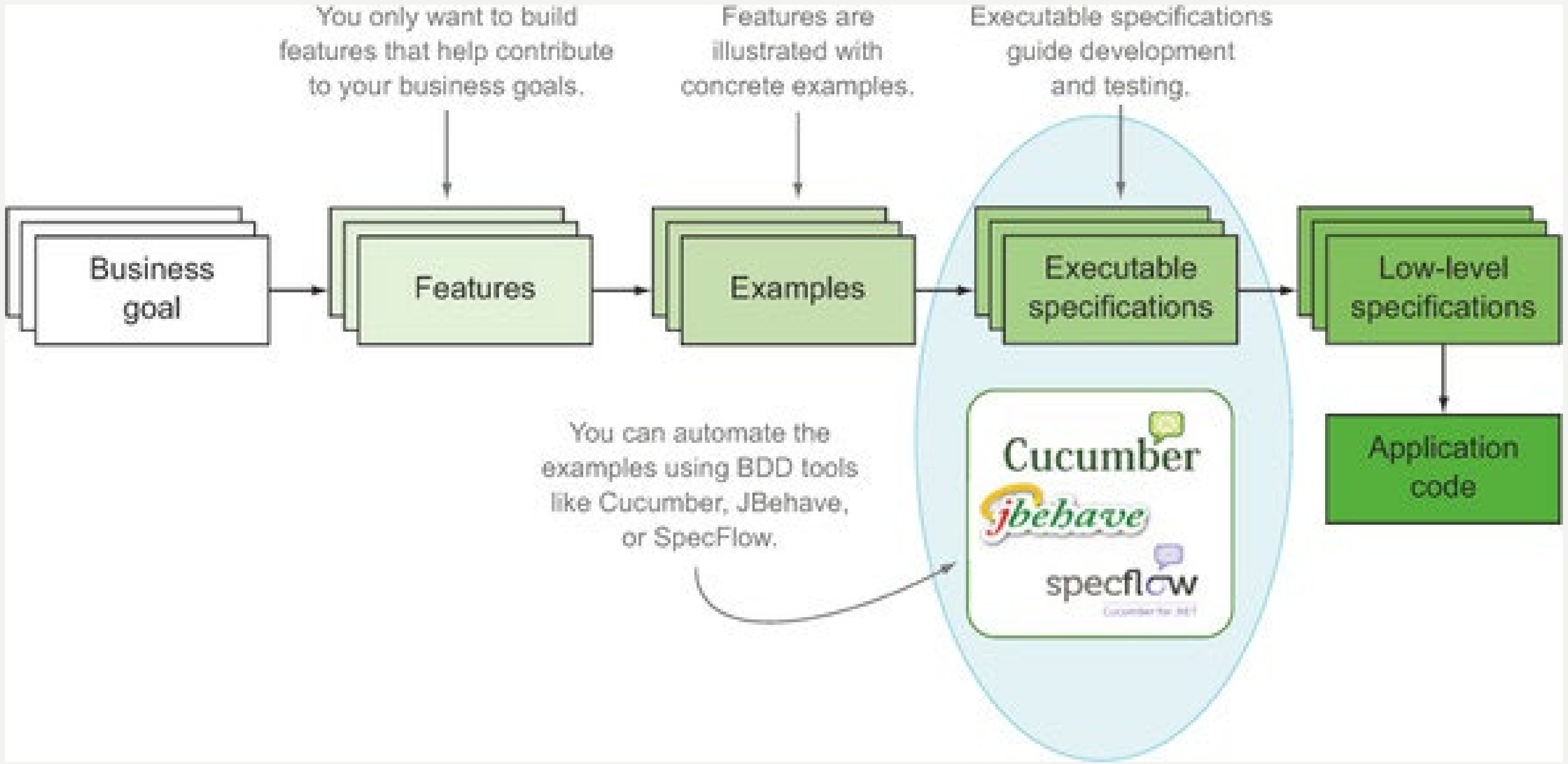
- Examples of desired behavior from conversations with stakeholders are turned into executable tests
- Tools: FitNesse, Cucumber, SpecFlow …

Textual artifact (scenario or table)

-------- bind to ----------

executable code

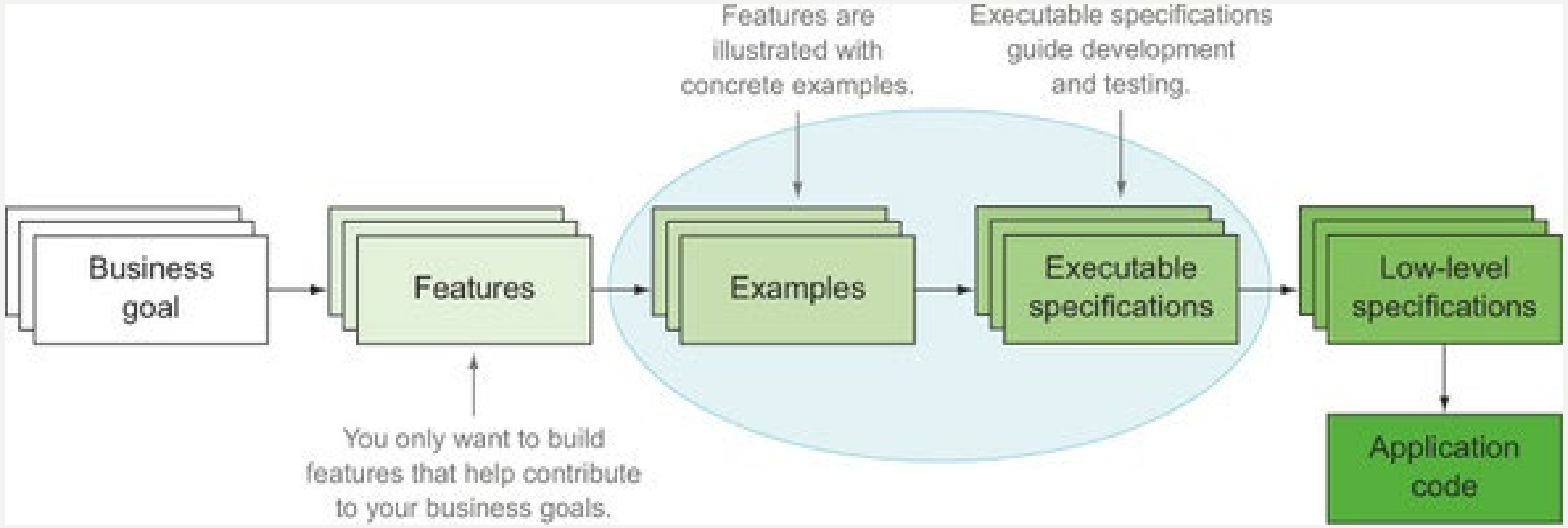
CUCUMBER CAN HELP AUTOMATION


You only want to build features that help contribute to your business goals.
Features are illustrated with concrete examples.
Executable specifications guide development and testing.
Business goal
Features
Examples
Executable specifications
Low-level specifications
Application code
You can automate the examples using BDD tools like Cucumber, JBehave, or SpecFlow.
Cucumber
jbehave
specflow

Source: John Ferguson Smart- BDD in Action chap 7

EXAMPLES WRITTEN IN GHERKIN

- If examples are expressed in a clear and precise way, they can be transformed into executable specifications and living documentation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Executable specifications
Low-level specifications
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You only want to build features that help contribute to your business goals.

Source: John Ferguson Smart- BDD in Action (chap. 5)

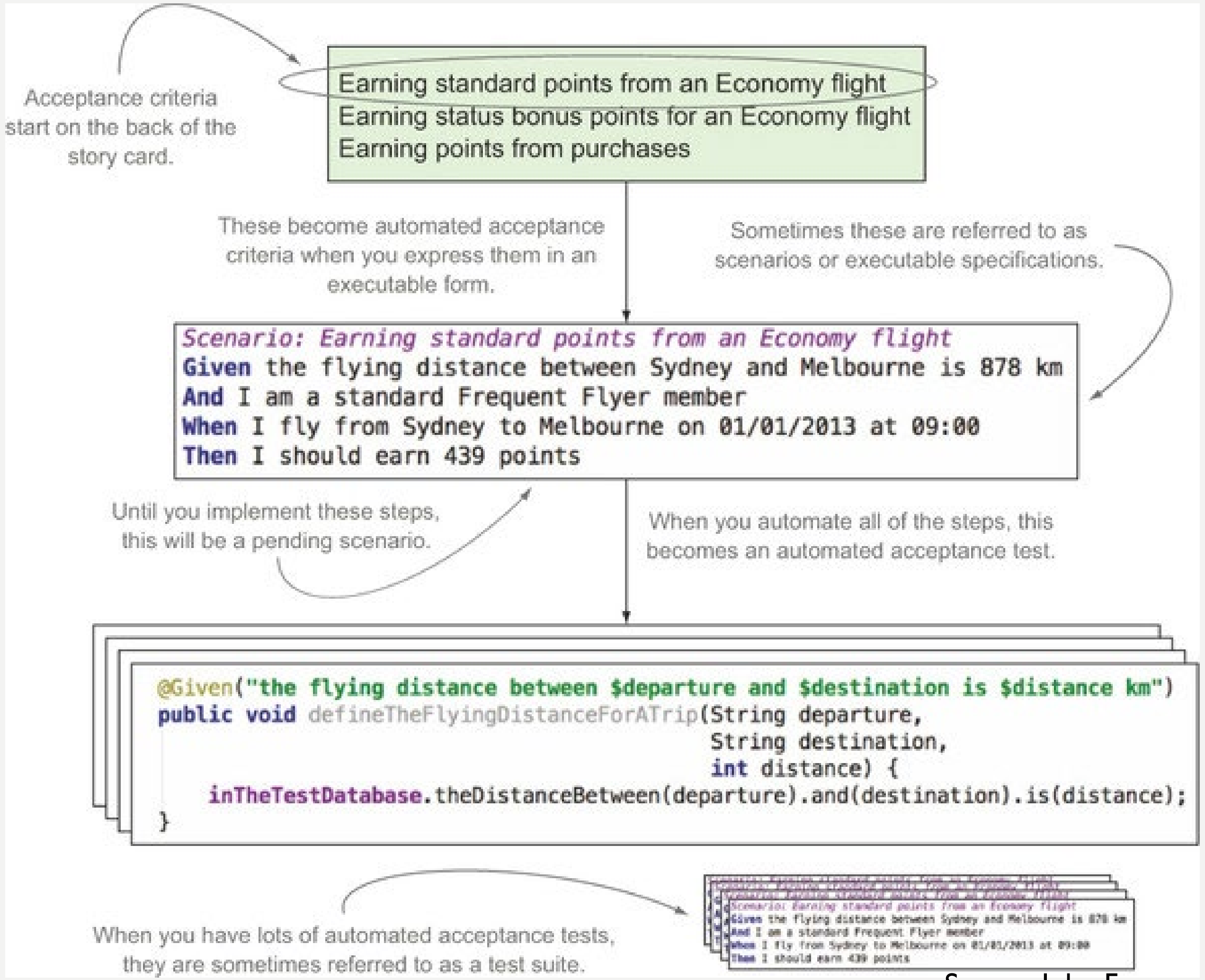
ACCEPTANCE CRITERIA TURNED INTO EXECUTABLE SPECIFICATIONS

BDD at acceptance test level:

Excutable tests written in a

given_when_then

format (Gherkin)



Acceptance criteria start on the back of the story card.

Earning standard points from an Economy flight
Earning status bonus points for an Economy flight
Earning points from purchases

These become automated acceptance criteria when you express them in an executable form.

Sometimes these are referred to as scenarios or executable specifications.

```
Scenario: Earning standard points from an Economy flight
Given the flying distance between Sydney and Melbourne is 878 km
And I am a standard Frequent Flyer member
When I fly from Sydney to Melbourne on 01/01/2013 at 09:00
Then I should earn 439 points
```

Until you implement these steps, this will be a pending scenario.

When you automate all of the steps, this becomes an automated acceptance test.

```java
@Given("the flying distance between $departure and $destination is $distance km")
public void defineTheFlyingDistanceForATrip(String departure,
                                            String destination,
                                            int distance) {
   inTheTestDatabase.theDistanceBetween(departure).and(destination).is(distance);
}
```

When you have lots of automated acceptance tests, they are sometimes referred to as a test suite.

25-03-2019

Source: John Ferguson Smart- BDD in Action

MOST USEFUL DISCUSSION?

What gives you most useful discussion with business stakeholders?

1. "Can you give me a scenario where that happens?" / "Can you give me an example?"

OR

2. "Can you give me acceptance criteria for this?" / "Can you help me work out how to test this?"

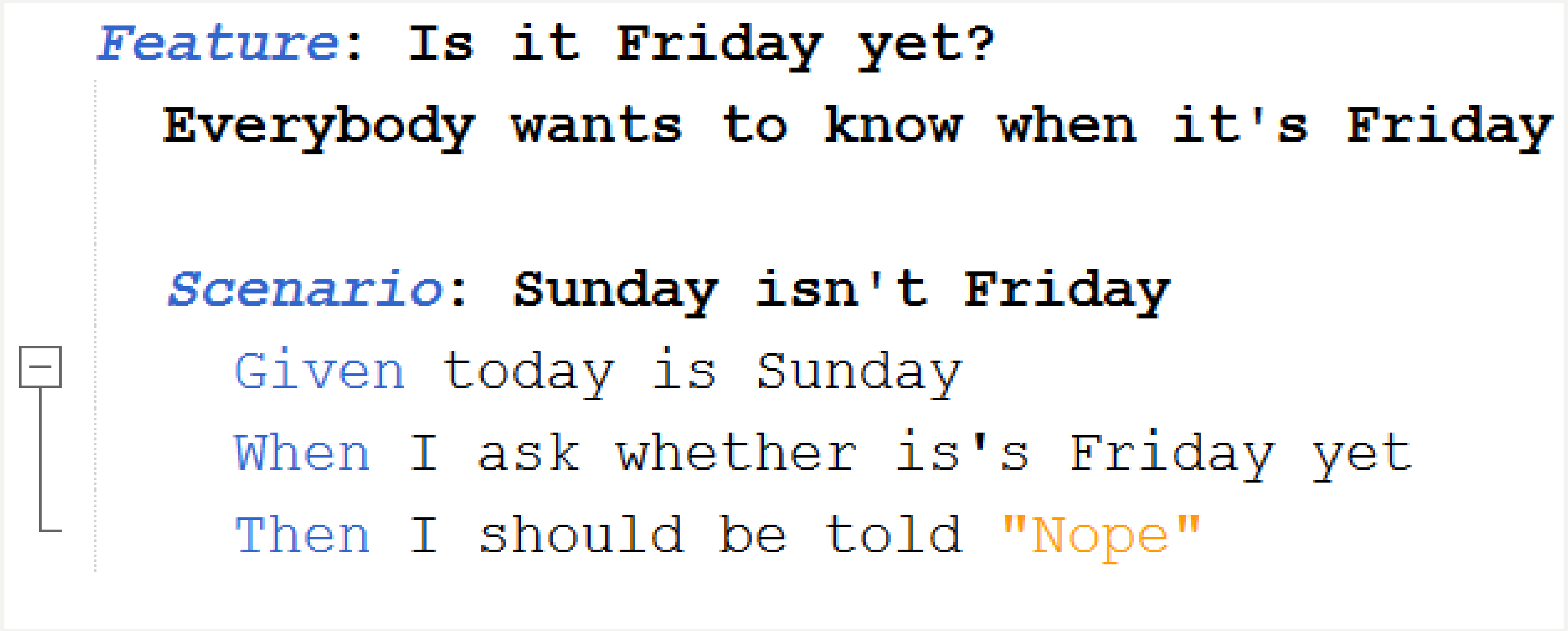
DEMO

Based on https://docs.cucumber.io/guides/10-minute-tutorial/

MAVEN POM.XML

```
<dependencies>
    <dependency>
        <groupId>io.cucumber</groupId>
        <artifactId>cucumber-java</artifactId>
        <version>2.3.1</version>
        <scope>test</scope>
    </dependency>
    <dependency>
        <groupId>io.cucumber</groupId>
        <artifactId>cucumber-junit</artifactId>
        <version>2.3.1</version>
        <scope>test</scope>
    </dependency>
    <dependency>
        <groupId>junit</groupId>
        <artifactId>junit</artifactId>
        <version>4.12</version>
        <scope>test</scope>
    </dependency>
  </dependencies>
```

SCENARIO EXAMPLE

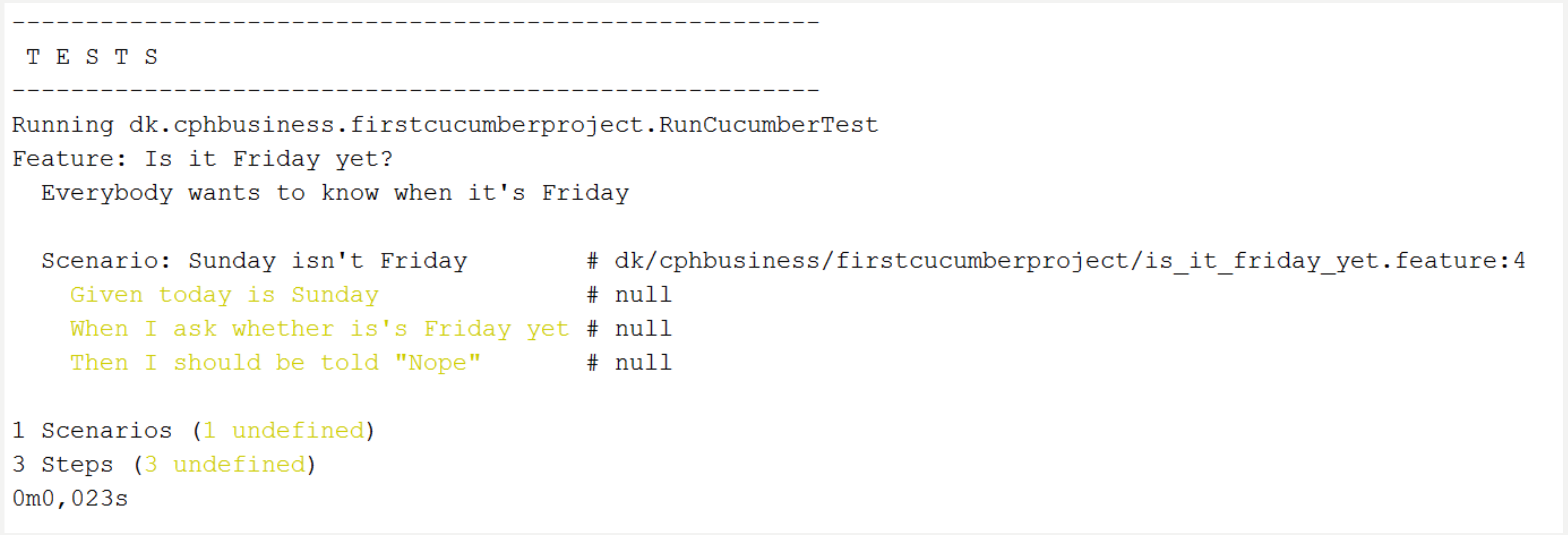


```
Feature: Is it Friday yet?
  Everybody wants to know when it's Friday

  Scenario: Sunday isn't Friday
    Given today is Sunday
    When I ask whether is's Friday yet
    Then I should be told "Nope"
```

DEFINE TEST RUNNER

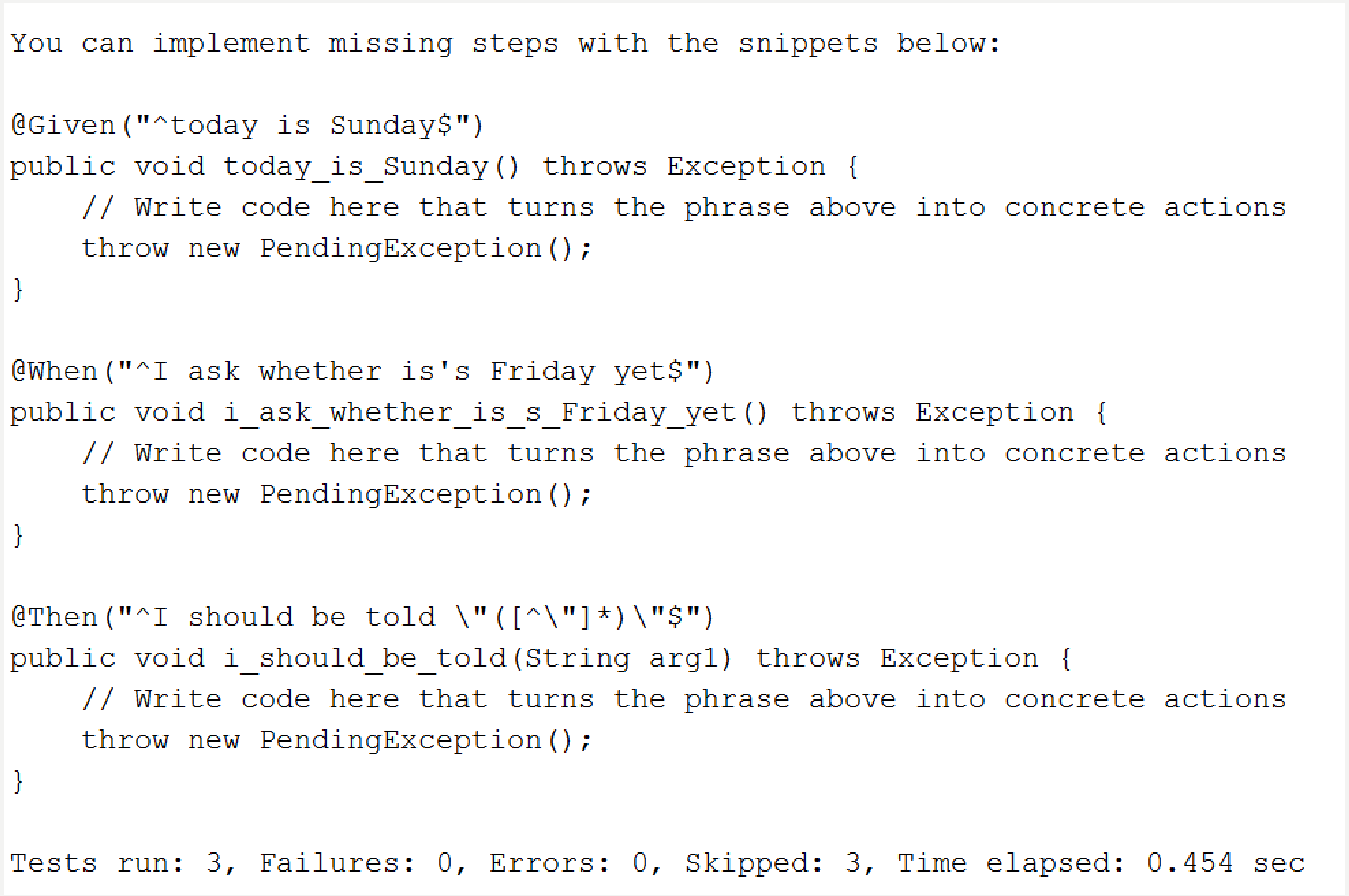
```java
import cucumber.api.CucumberOptions;
import cucumber.api.junit.Cucumber;
import org.junit.runner.RunWith;

@RunWith(Cucumber.class)
@CucumberOptions(plugin = {"pretty"})
public class RunCucumberTest {
}
```

RUN TEST



```
-------------------------------------------------------
 T E S T S
-------------------------------------------------------
Running dk.cphbusiness.firstcucumberproject.RunCucumberTest
Feature: Is it Friday yet?
  Everybody wants to know when it's Friday

  Scenario: Sunday isn't Friday        # dk/cphbusiness/firstcucumberproject/is_it_friday_yet.feature:4
    Given today is Sunday              # null
    When I ask whether is's Friday yet # null
    Then I should be told "Nope"       # null

1 Scenarios (1 undefined)
3 Steps (3 undefined)
0m0,023s
```

LOOK AT TEST OUTPUT



```
You can implement missing steps with the snippets below:

@Given("^today is Sunday$")
public void today_is_Sunday() throws Exception {
    // Write code here that turns the phrase above into concrete actions
    throw new PendingException();
}

@When("^I ask whether is's Friday yet$")
public void i_ask_whether_is_s_Friday_yet() throws Exception {
    // Write code here that turns the phrase above into concrete actions
    throw new PendingException();
}

@Then("^I should be told \"([^\"]*)\"$")
public void i_should_be_told(String arg1) throws Exception {
    // Write code here that turns the phrase above into concrete actions
    throw new PendingException();
}

Tests run: 3, Failures: 0, Errors: 0, Skipped: 3, Time elapsed: 0.454 sec
```

WRITE STEP DEFINITIONS

```
public class Stepdefs {
    private String today;
    private String actualAnswer;

@Given("^today is Sunday$")
    public void today_is_Sunday() {
        this.today = "Sunday";
    }

    @When("^I ask whether it's Friday yet$")
    public void i_ask_whether_is_s_Friday_yet() {
        this.actualAnswer = IsItFriday.isItFriday(today);
    }

    @Then("^I should be told \"([^\"]*)\"$")
    public void i_should_be_told(String expectedAnswer) {
        assertEquals(expectedAnswer, actualAnswer);
    }}
```

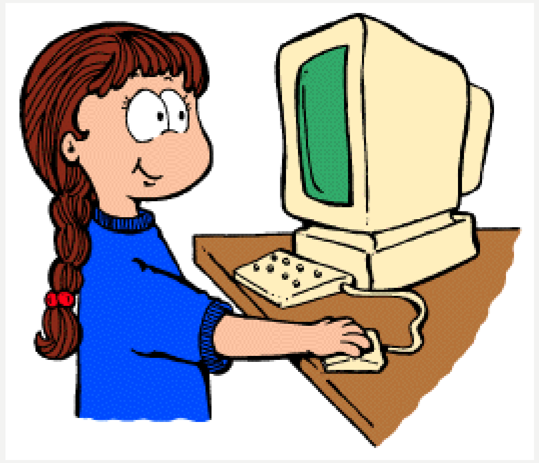
WRITE (SIMPLE!) CODE

```
class IsItFriday {
    static String isItFriday(String today) {
        return "Nope";
    }
}
```

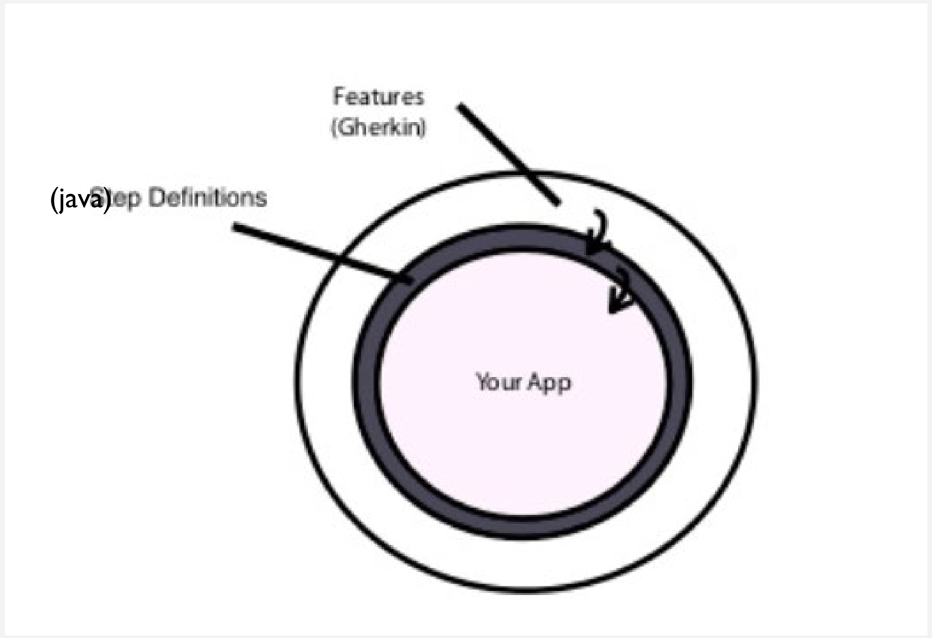
RESOURCES

- Cucumber introduction https://docs.cucumber.io/guides/overview/
- Gherkin syntax https://docs.cucumber.io/gherkin/reference/

YOUR TURN!



- NB: Must be < Java 9
- Soda machine example: https://media.pragprog.com/titles/dhwcr/jvm.pdf



FEATURE FILE

In src/test/resources (text file): SodaMachine.feature

Feature: Soda machine

Scenario: Get soda

Given I have $2 in my account

When I wave my magic ring at the machine

Then I should get a soda

CUCUMBER

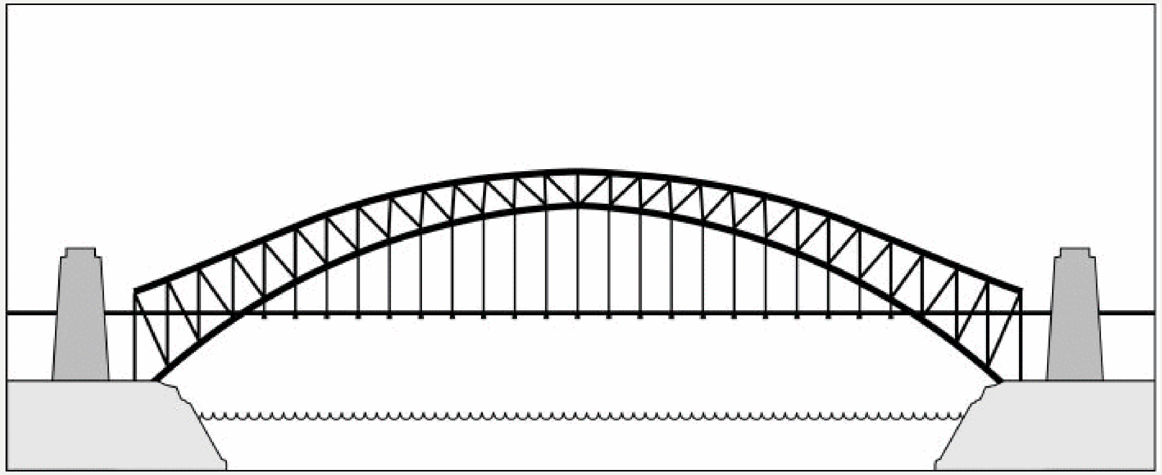
Tool for

Communication

Collaboration

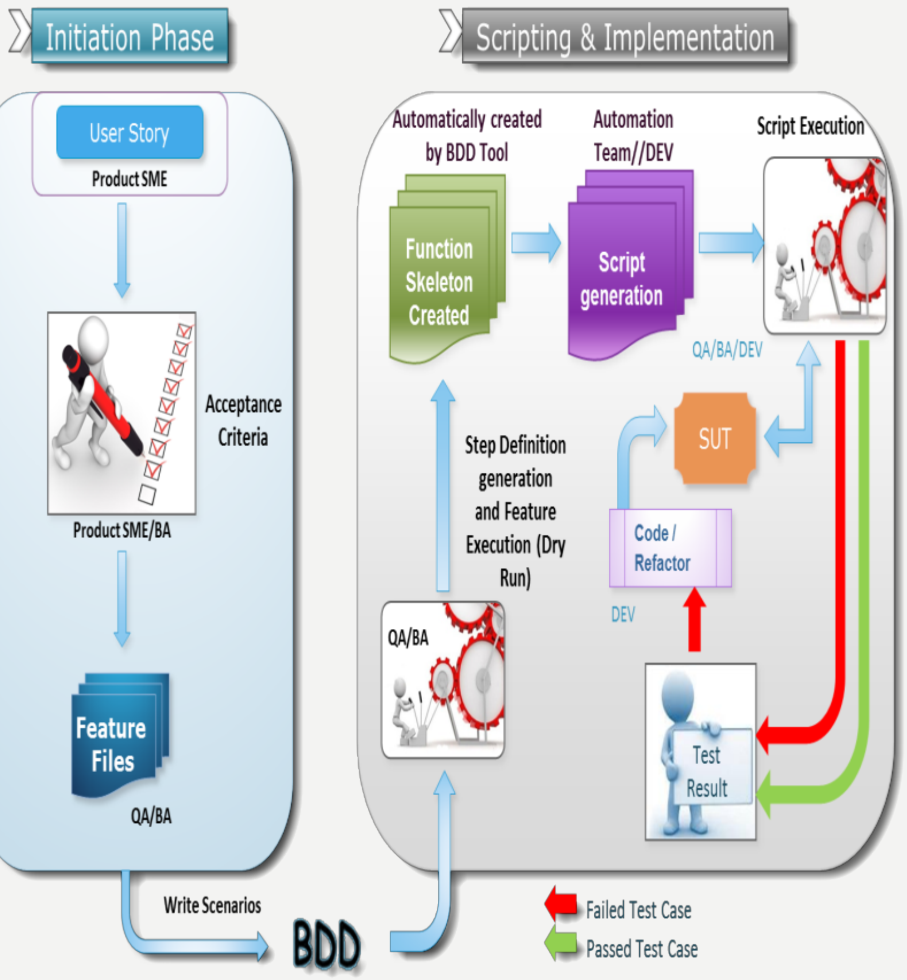
Testing

Non-technical people like BA, PM



Technical people

TEST APPROACH FOR BDD



Source:

http://toolsqa.com/blogs/test-approach-and-comparisons-between-atdd-tdd-and-bdd/

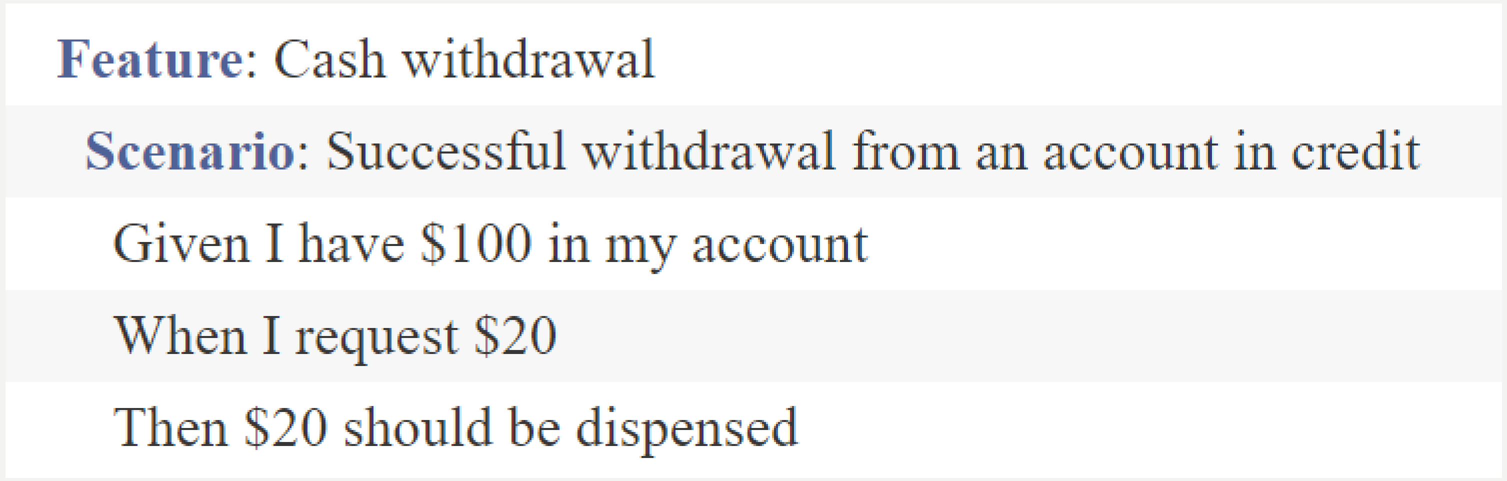
GHERKIN SYNTAX

- Gherkin is Domain-Specific-Language
  - Given (Arrange/Context)
  - When (Act)
  - Then (Assert)

- **Gherkin** steps are expressed in **plain text**.

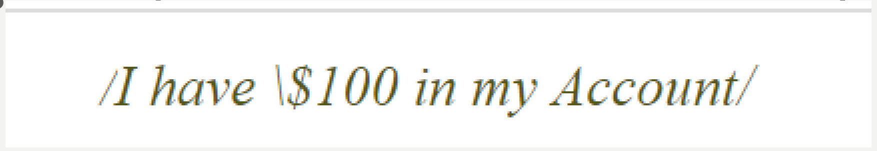
- **Cucumber** scans the text of each step for patterns that it recognizes, which you define using a ***regular expression***

REGULAR EXPRESSION 1



```
Feature: Cash withdrawal
  Scenario: Successful withdrawal from an account in credit
    Given I have $100 in my account
    When I request $20
    Then $20 should be dispensed
```

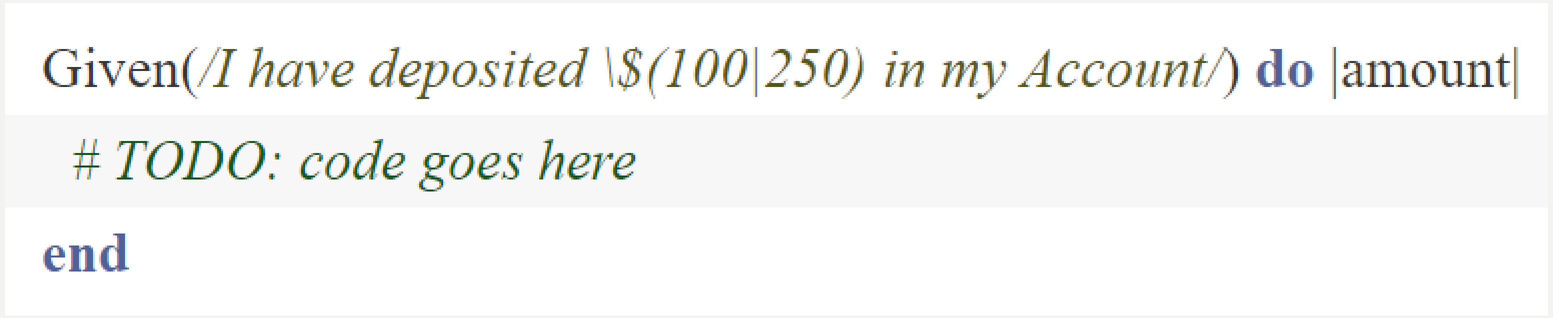
- A simple regular expression that will match this step would look like this



```
/I have \$100 in my Account/
```

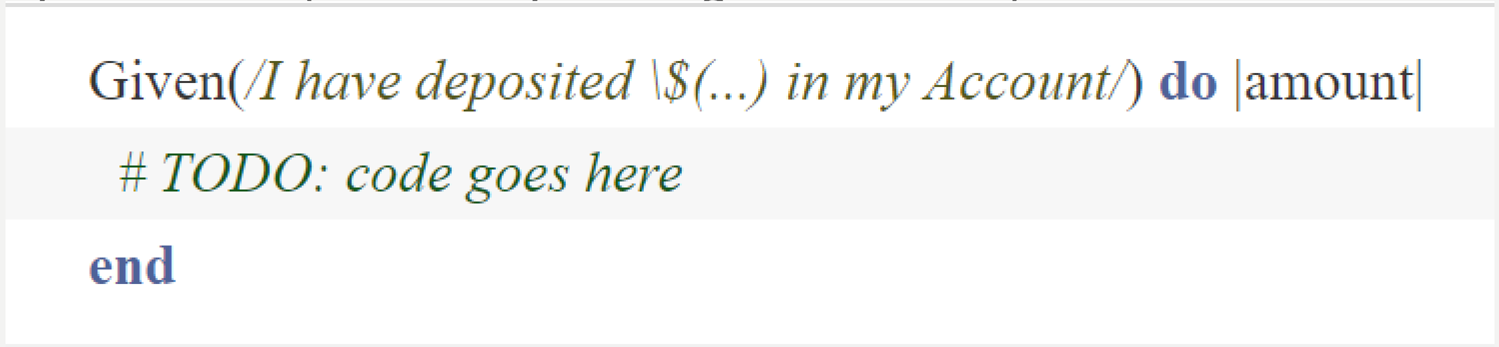
Source: Wynne & Hellesøy: The cucumber book

REGULAR EXPRESSION 2 –THE DOT



```
Given(/I have deposited \$(100|250) in my Account/) do |amount|
  # TODO: code goes here
end
```

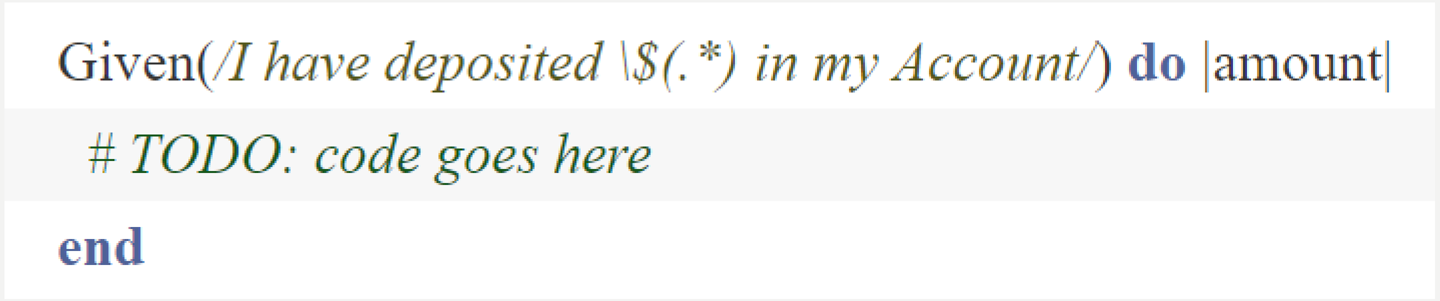
- The dot is a *metacharacter* with magical powers meaning: *match any single character*.
- So, we can try this instead (matchin any three-figure dollar sum):



```
Given(/I have deposited \$(...) in my Account/) do |amount|
  # TODO: code goes here
end
```

REGULAR EXPRESSION 3 – STAR *

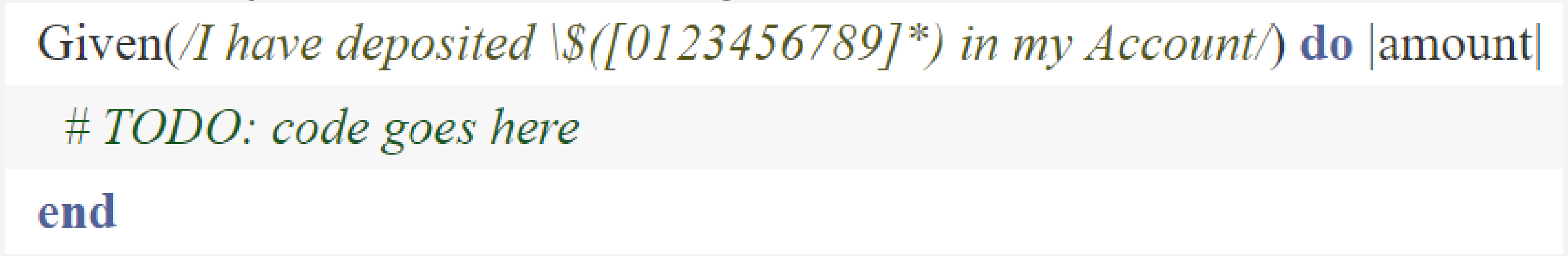
- The star modifier means *any number of times*. So, with .* we're capturing *any character, any number of times*.



```
Given(/I have deposited \$(.*) in my Account/) do |amount|
  # TODO: code goes here
end
```

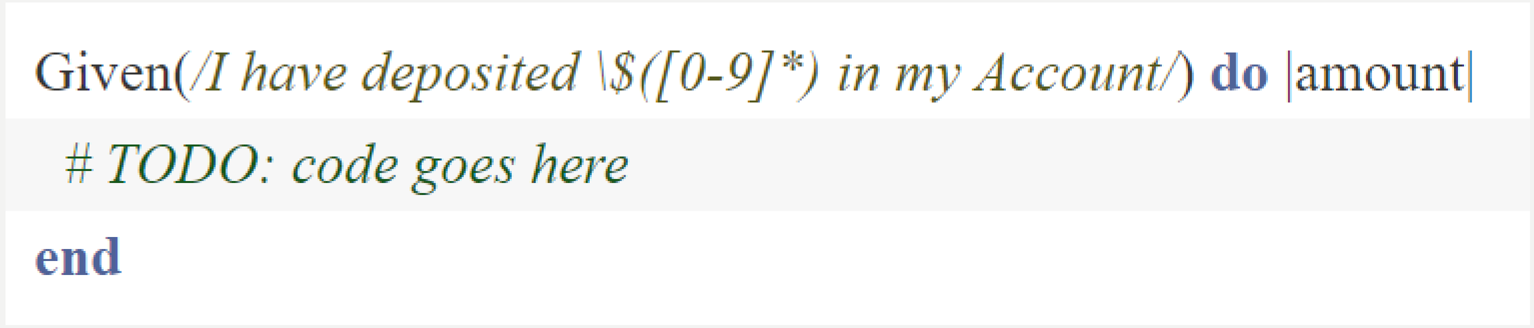
REGULAR EXPRESSION 4 - CHARACTER CLASSES

- Character classes allow you to match one of a range of characters



```
Given(/I have deposited \$([0123456789]*) in my Account/) do |amount|
  # TODO: code goes here
end
```

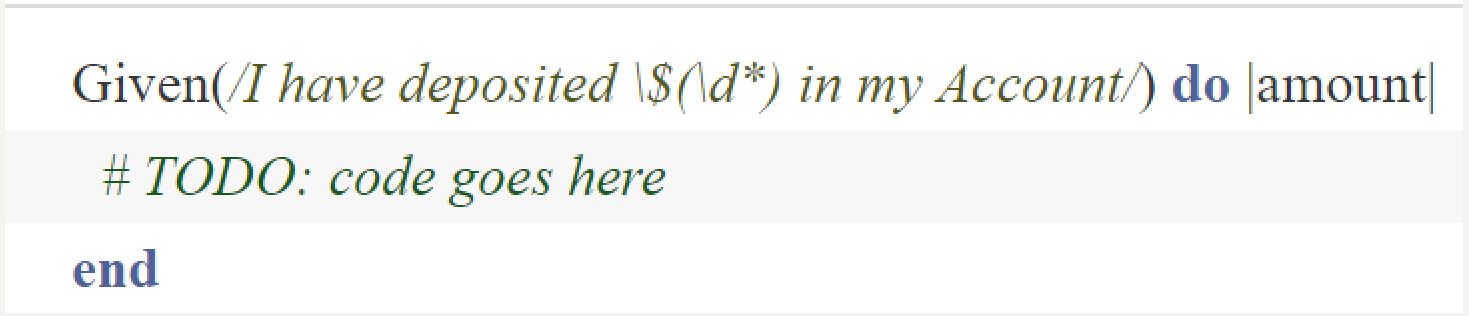
- For a continuous range of characters, you can use a hyphen:



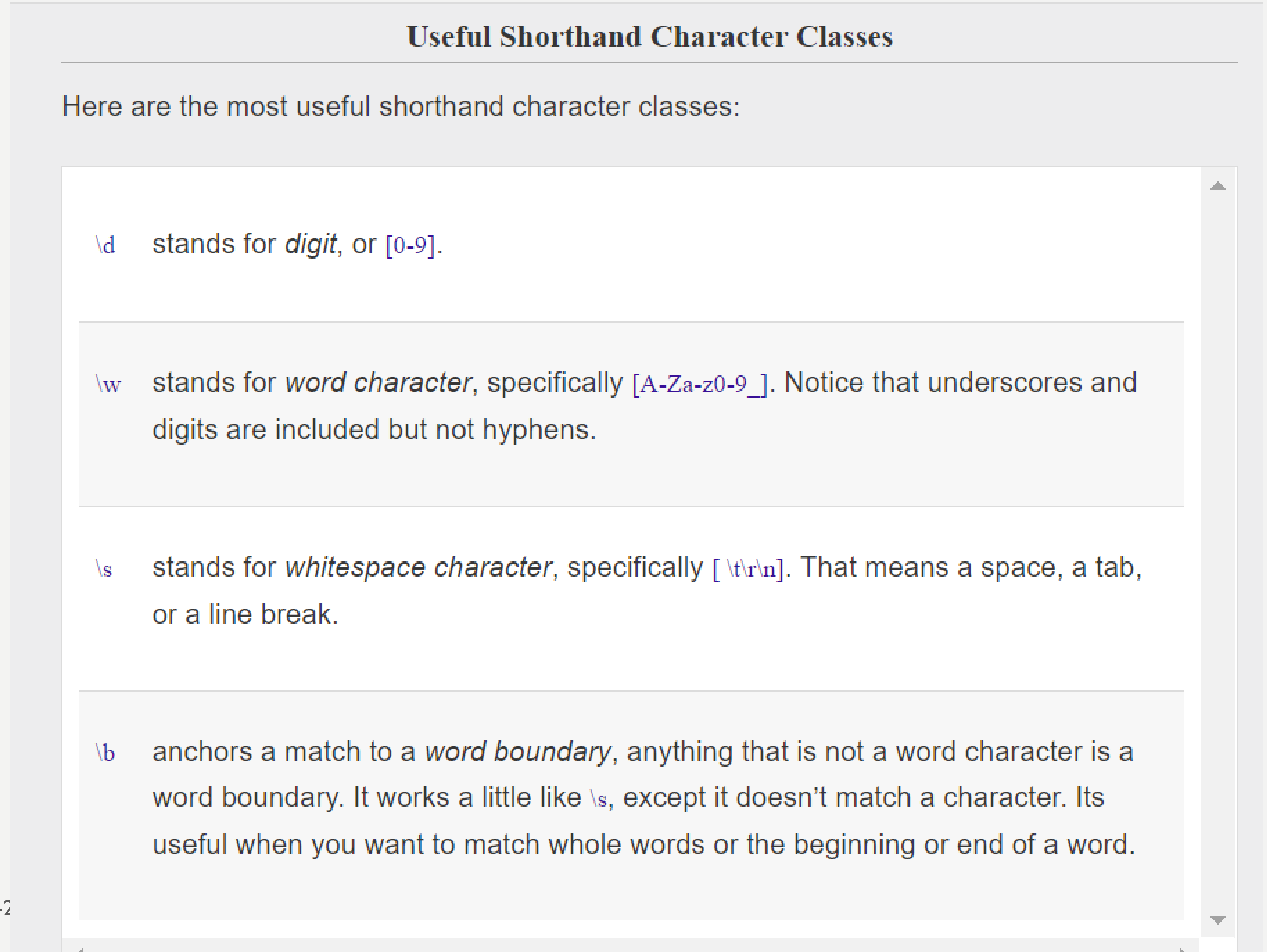
```
Given(/I have deposited \$([0-9]*) in my Account/) do |amount|
  # TODO: code goes here
end
```

REGULAR EXPRESSION 5 – CHARECTER CLASSES SHORTHAND

- For common patterns of characters like [0-9], there are a *shorthand character classes*, e.g. digits:



```
Given(/I have deposited \$(\d*) in my Account/) do |amount|
  # TODO: code goes here
end
```



Useful Shorthand Character Classes

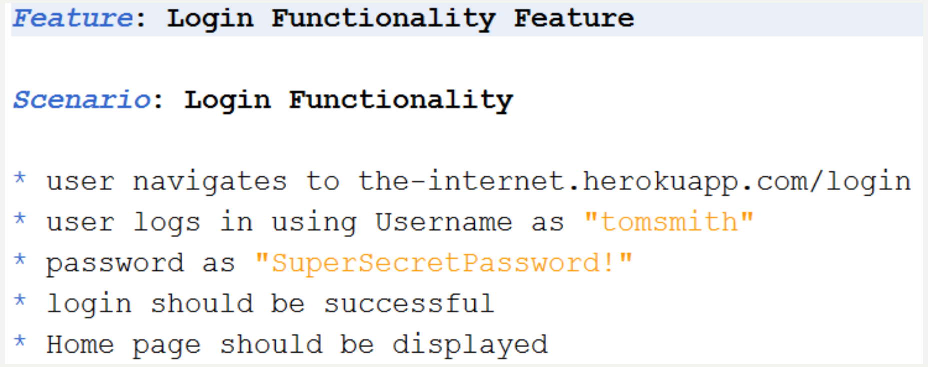
Here are the most useful shorthand character classes:

\d	stands for *digit*, or [0-9].
\w	stands for *word character*, specifically [A-Za-z0-9_]. Notice that underscores and digits are included but not hyphens.
\s	stands for *whitespace character*, specifically [\t\r\n]. That means a space, a tab, or a line break.
\b	anchors a match to a *word boundary*, anything that is not a word character is a word boundary. It works a little like \s, except it doesn't match a character. Its useful when you want to match whole words or the beginning or end of a word.

DEMO – CUCUMBER & SELENIUM

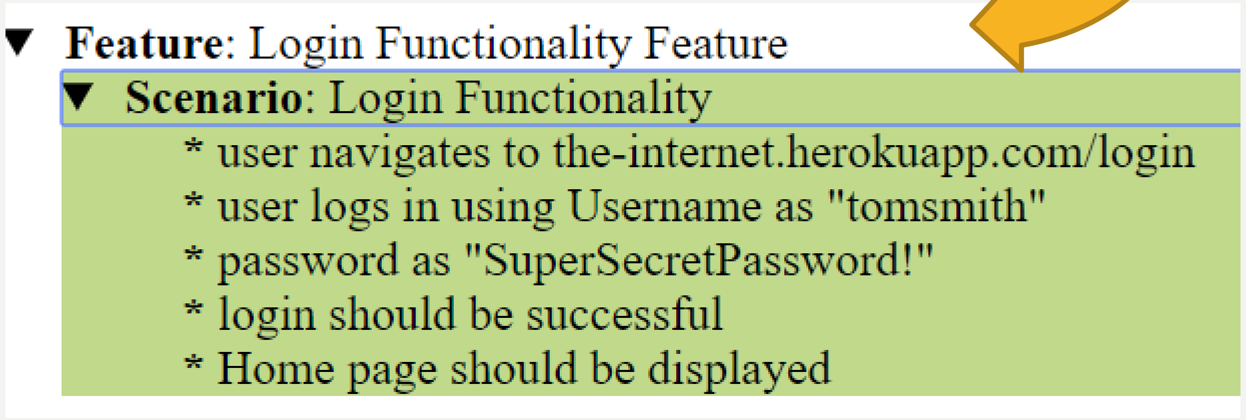
cucumber

HTML REPORT



```
Feature: Login Functionality Feature

Scenario: Login Functionality

* user navigates to the-internet.herokuapp.com/login
* user logs in using Username as "tomsmith"
* password as "SuperSecretPassword!"
* login should be successful
* Home page should be displayed
```

Look at /reports/test-report/index.html



▼ **Feature**: Login Functionality Feature
▼ **Scenario**: Login Functionality
* user navigates to the-internet.herokuapp.com/login
* user logs in using Username as "tomsmith"
* password as "SuperSecretPassword!"
* login should be successful
* Home page should be displayed

```
@RunWith(Cucumber.class)
@CucumberOptions(plugin = {"pretty","html:reports/test-report"})
public class RunCucumberTest {}
```

DATA DRIVEN TESTING

Data tables can used with **Scenario Outline**

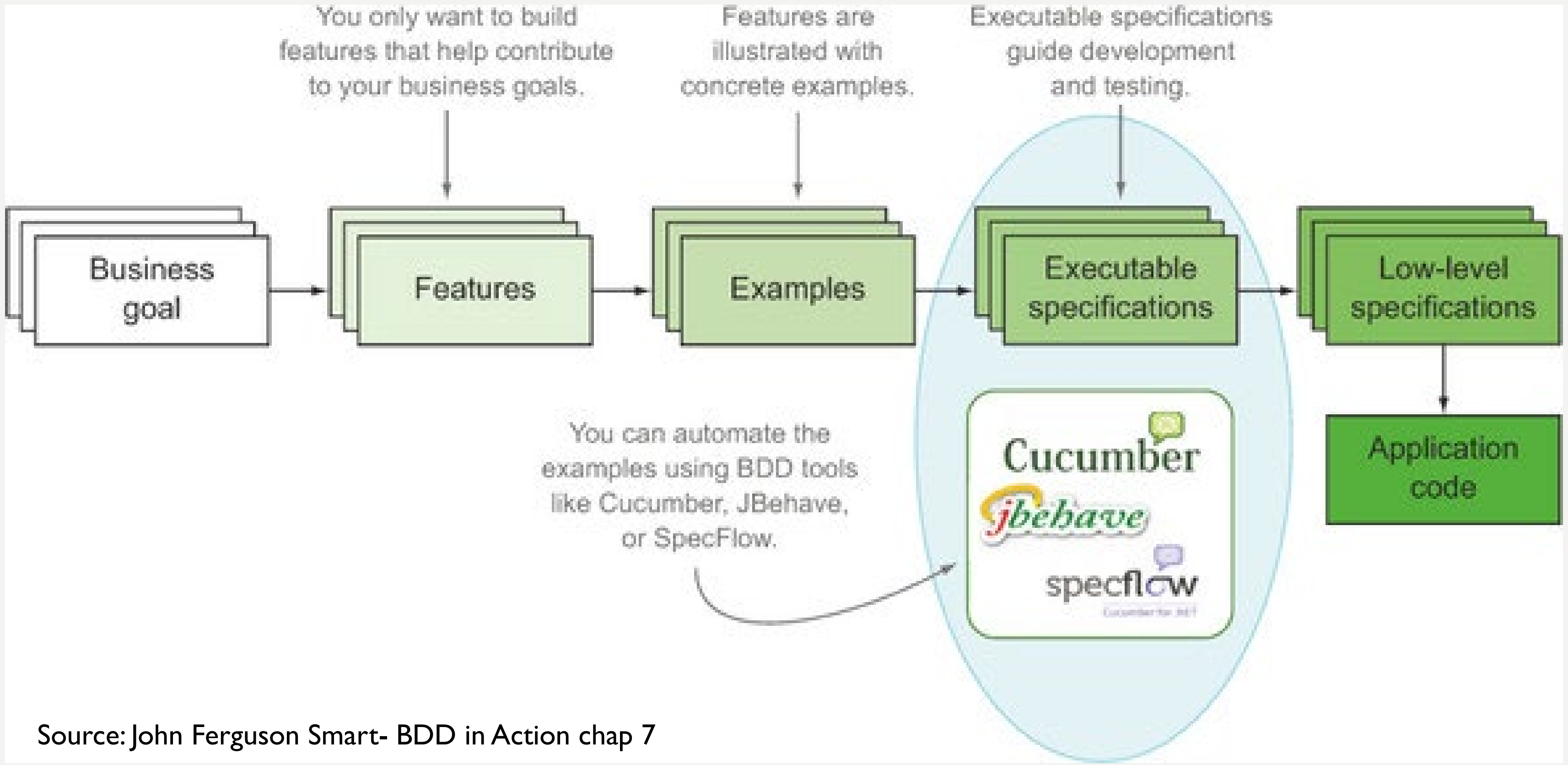
```
Feature: Adding

Scenario Outline: Add by one
Given the input <input>
When the calculator is run
Then the output should be <output>

Examples:
|input | output|
|4     | 5     |
|14    |15     |
```

DEMO DATA TABLE

- CucumberCalculator
- CucumberCalculator2

CUCUMBER OVERVIEW - AGAIN

- Doesn't have to be web application
- Could be REST API, message queues, database etc.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Cucumber
jbehave
specflow

Source: John Ferguson Smart- BDD in Action chap 7

WELL-FORMED USER STORIES

Story:

```
Feature/user story: Shopping Cart
As a Shopper
I want to put items in my shopping cart
Because I want to manage items before I check out
```

Example:

```
Scenario: User adds item to cart
Given I'm a logged-in User
When I go to the Item page
And I click "Add item to cart"
Then the quantity of items in my cart should go up
And my subtotal should increment
And the warehouse inventory should decrement
```

Examples from: https://content.pivotal.io/blog/how-to-write-well-formed-user-stories

ACCEPTANCE CRITERIA VS. SCENARIOS

- A **scenario** is example of system's behavior from users' perspectives
- **Acceptance criteria** are a set of rules which cover aspects of a system's behavior, and from which scenarios can be derived.

A **scenario** (*example*) from pet shop:

```
Given a rabbit called Fluffy who is 1 1/2 months old
When we try to sell Fluffy
Then we should be told Fluffy is too young.
```

Acceptance criteria from pet shop:

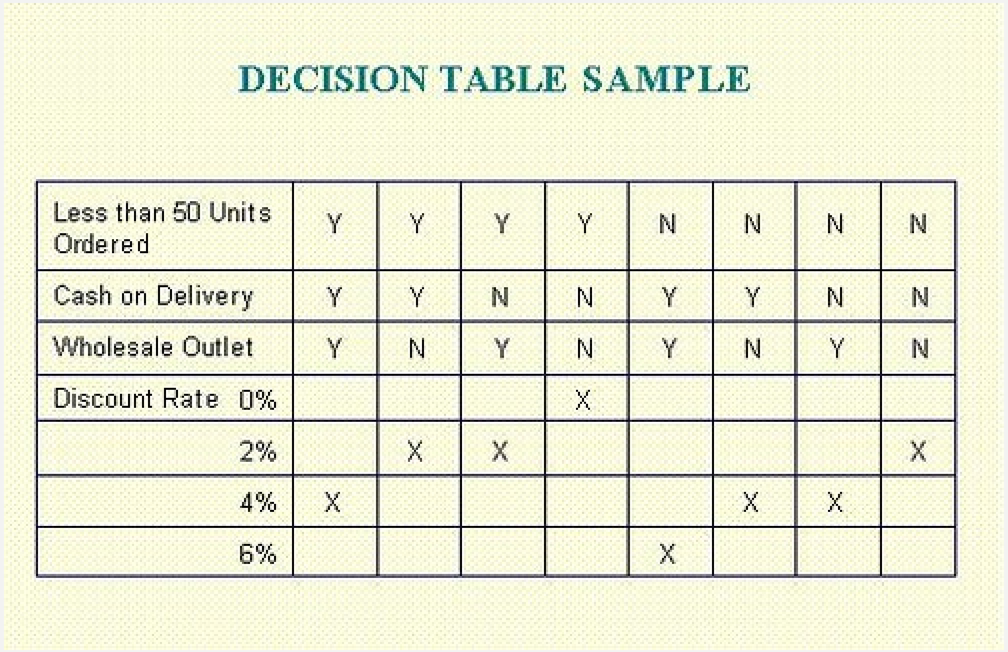
```
Given a baby animal is younger than its recommended selling age
When we try to sell it
Then we should be told it's too young
```

Despite the Given, When, Then forma,t it is a full specification of this aspect of behavior – phrased in scenario form.

Source: https://lizkeogh.com/2011/06/20/acceptance-criteria-vs-scenarios/

STUDY POINT ASSIGNMENT

Company X sells merchandise to wholesale and retail outlets. Wholesale customers receive a two percent discount on all orders. The company also encourages both wholesale and retail customers to pay cash on delivery by offering a two percent discount for this method of payment. Another two percent discount is given on orders of 50 or more units. Each column represents a certain type of order.



DECISION TABLE SAMPLE

Less than 50 Units Ordered	Y	Y	Y	Y	N	N	N	N
Cash on Delivery	Y	Y	N	N	Y	Y	N	N
Wholesale Outlet	Y	N	Y	N	Y	N	Y	N
Discount Rate 0%				X				
2%		X	X					X
4%	X					X	X	
6%					X			

Express the process sale function by example in feature file with Gherkin syntax and write Cucumber step definitions.

Conditions are captured in the decision table.

Implement the process sale and run Cucumber tests.

Make screen dumps of test results.