COMP5222 Group Project

Behavior-Driven Development

Rails Application with Cucumber

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# What Is Behavior-Driven Development

According to the Wikipedia, behavior-driven development (BDD) is a software development process developed on test-driven development (TDD) in software engineering field. The traditional techniques and principles of TDD and thoughts from domain-driven design and object-oriented analysis and design are combined together. It provides software developers and business analysts with common tools and a common process to cooperate in software development process.

BDD is principally based on the concept that software development should be performed by both business side and technical side. The practice of BDD relies on the use of customized software tools to support this development process. This development environment is not only specifically developed for use in BDD projects, but also it can be used as a specialized form of the tool-chain that supports test-driven development. The central theme of BDD is the tools who automate the testing from specifications written with ubiquitous language.

The most important issues include:

1. The Acceptance Test is not written only by coder, but by the client. (features and scenarios)

2. The Acceptance Test can be written in natural language, but not in programming languages.

3. The definition of the product is consistent with the code, testable and reliable through the whole life cycle of the product.

## Definition of BDD

Behavior-driven development was inspired by the problems encountered by developers practice test-driven development.

* Where to start the whole development process
* What should be tested and what should not to be tested
* How much tests should be include in one test iteration
* What to call the tests
* How to understand why a test fails

The main problem the BDD concerns is the mechanism of unit testing and acceptance testing to solve above problem.

The main results are:

* The unit test name should be sentences starting with the word “should”
* The unit test should be written in order of business value
* Acceptance tests should be written using the standard agile framework of a User story: "As a [role] I want [feature] so that [benefit]"
* Acceptance criteria should be written in terms of scenarios and implemented as classes: Given [initial context], when [event occurs], then [ensure some outcomes]

Based on above principles, the first BDD framework, JBehave, was developed by Dan North in 2003. Then it was ported to Ruby as a story-level BDD framework called RBehave which was integrated into the RSpec project. The story runner of RSpec was later replaced by Cucumber which is developed by Aslak Hellesøy. Cucumber was first developed to be merged into RSpec as a next generation story-runny module, but eventually it found its own reason to live.

## Agile testing, the philosophy behind BDD

1. human

2. less is more

3. fast iteration

4. testable

5. refactor

Agile Development is an approach to software development that attempts to reduce the cost of change, and so deliver software that meets business needs in a more predictable, timely manner.

It encompasses a variety of approaches and methods, but all share common features and are grounded in principles of the AgileManifesto.

Agile development practitioners believe that planning too far ahead is doomed to failure, because, however good we are, we are not prescient and we will make mistakes. They further believe that many TraditionalDevelopment processes are based on such predictions and that this is a fundamental reason why so many software projects fail.

Agile processes accept that mistakes will happen, that people will change their minds, misunderstand things and generally behave like human beings.

Instead of mitigating risk by trying to anticipate problems, agile projects are designed to avoid the increase in the CostOfChange completely. By accepting that change will happen and relying on several techniques to reduce the impact of late changes, agile processes alter the CostOfChange curve.

There are several techniques used on agile projects to effect this reduction in the cost of change. Instead of taking a qualitative approach to development, agile projects try as much as possible to take a quantitative approach.

Estimates for this week are based on what was accomplished last week.

Progress is measured by how much software is actually working.

The usefulness of the software produced is measured by users using it and reporting back if it meets, or fails to meet, their needs.

These are pragmatic, measurable things. Of course, there remain times when guesses must be made based on experience. Agile projects attempt to reduce the impact of getting those guesses wrong by not extrapolating too far ahead, typically only one or two weeks ahead.

Agile projects are characterized by the following:

IterativeDevelopment

SmallTeams

ContinuousIntegration

MinimalDocumentation

No BigDesignUpFront

IterativePlanning

The first Extreme Programming project was started March 6, 1996. Extreme Programming is one of several popular Agile Processes. It has already been proven to be very successful at many companies of all different sizes and industries world wide.

Extreme Programming is successful because it stresses customer satisfaction. Instead of delivering everything you could possibly want on some date far in the future this process delivers the software you need as you need it. Extreme Programming empowers your developers to confidently respond to changing customer requirements, even late in the life cycle.

Extreme Programming emphasizes teamwork. Managers, customers, and developers are all equal partners in a collaborative team. Extreme Programming implements a simple, yet effective environment enabling teams to become highly productive. The team self-organizes around the problem to solve it as efficiently as possible.

Extreme Programming improves a software project in five essential ways; communication, simplicity, feedback, respect, and courage. Extreme Programmers constantly communicate with their customers and fellow programmers. They keep their design simple and clean. They get feedback by testing their software starting on day one. They deliver the system to the customers as early as possible and implement changes as suggested. Every small success deepens their respect for the unique contributions of each and every team member. With this foundation Extreme Programmers are able to courageously respond to changing requirements and technology.

The most surprising aspect of Extreme Programming is its simple rules. Extreme Programming is a lot like a jig saw puzzle. There are many small pieces. Individually the pieces make no sense, but when combined together a complete picture can be seen. The rules may seem awkward and perhaps even naive at first, but are based on sound values and principles.

Our rules set expectations between team members but are not the end goal themselves. You will come to realize these rules define an environment that promotes team collaboration and empowerment, that is your goal. Once achieved productive teamwork will continue even as rules are changed to fit your company's specific needs.

This flow chart shows how Extreme Programming's rules work together. Customers enjoy being partners in the software process, developers actively contribute regardless of experience level, and managers concentrate on communication and relationships. Unproductive activities have been trimmed to reduce costs and frustration of everyone involved.

Take a guided tour of Extreme Programming by following the trail of littlebuttons, starting here.

## The concept of behavior-driven development

1. the outer and inner circles

2. cucumber and rspec

Behaviour-Driven Development (BDD) is an evolution in the thinking behind TestDrivenDevelopment and AcceptanceTestDrivenPlanning.

It brings together strands from TestDrivenDevelopment and DomainDrivenDesign into an integrated whole, making the relationship between these two powerful approaches to software development more evident.

It aims to help focus development on the delivery of prioritised, verifiable business value by providing a common vocabulary (also referred to as a UbiquitousLanguage) that spans the divide between Business and Technology.

It presents a framework of activity based on three core principles:

Business and Technology should refer to the same system in the same way - ItsAllBehaviour

Any system should have an identified, verifiable value to the business - WheresTheBusinessValue

Up-front analysis, design and planning all have a diminishing return - EnoughIsEnough

BDD relies on the use of a very specific (and small) vocabulary to minimise miscommunication and to ensure that everyone – the business, developers, testers, analysts and managers – are not only on the same page but using the same words.

For people familiar with the concept of DomainDrivenDesign, you could consider BDD to be a UbiquitousLanguage for software development.

It must be stressed that BDD is a rephrasing of existing good practice, it is not a radically new departure. Its aim is to bring together existing, well-established techniques under a common banner and with a consistent and unambiguous terminology. BDD is very much focused on “Getting the words right” and this focus is intended to produce a vocabulary that is accurate, accessible, descriptive and consistent.

In fact “Getting the words right” was the starting point for the development of BDD, and is still very much at its core, but the power of getting the words right has led to some insights and extrapolations that have helped us to better understand our approach and to extend it.

## Steps and processes of BDD

The main tool of Rails-oriented BDD is RSpec. It is a testing tool for the Ruby programming language. The BDD is its main field. The object of it is to make Test-Driven Development a productive and enjoyable experience.

According to the [rspec.info](http://rspec.info/), the main features are

* A rich command line program (the rspec command)
* Textual descriptions of examples and groups (rspec-core)
* Flexible and customizable reporting
* Extensible expectation language (rspec-expectations)
* Built-in mocking/stubbing framework (rspec-mocks)

1. client spec

2. begin iter

3. write feature

4. falling the feature

5. pass the feature

6. refactor the code

7. end iter

Principles of BDD

At its core, Behavior-driven development is a specialized version of test-driven development which focuses on behavioral specification of software units.

Test-driven development is a software development methodology which essentially states that for each unit of software, a software developer must:

define a test set for the unit first;

then implement the unit;

finally verify that the implementation of the unit makes the tests succeed.

This definition is rather non-specific in that it allows tests in terms of high-level software requirements, low-level technical details or anything in between. The original developer of BDD (Dan North) came up with the notion of BDD because he was dissatisfied with the lack of any specification within TDD of what should be tested and how.[9] One way of looking at BDD therefore, is that it is a continued development of TDD which makes more specific choices than TDD.

Behavior-driven development specifies that tests of any unit of software should be specified in terms of the desired behavior of the unit.[2][3][9] Borrowing from agile software development the "desired behavior" in this case consists of the requirements set by the business — that is, the desired behavior that has business value for whatever entity commissioned the software unit under construction.[2][9] Within BDD practice, this is referred to as BDD being an "outside-in" activity.[10]

[edit]Behavioral specifications

Following this fundamental choice, a second choice made by BDD relates to how the desired behavior should be specified. In this area BDD chooses to use a semi-formal format for behavioral specification which is borrowed from user story specifications from the field of object-oriented analysis and design. BDD specifies that business analysts and developers should collaborate in this area and should specify behavior in terms of user stories, which are each explicitly written down in a dedicated document.[9][10] Each user story should, in some way, follow the following structure[2][10]:

Title

The story should have a clear, explicit title.

Narrative

A short, introductory section that specifies

who (which business or project role) is the driver or primary stakeholder of the story (the actor who derives business benefit from the story)

which effect the stakeholder wants the story to have

what business value the stakeholder will derive from this effect

Acceptance criteria or scenarios

a description of each specific case of the narrative. Such a scenario has the following structure:

It starts by specifying the initial condition that is assumed to be true at the beginning of the scenario. This may consist of a single clause, or several.

It then states which event triggers the start of the scenario.

Finally, it states the expected outcome, in one or more clauses.

BDD does not have any formal requirements for exactly how these user stories must be written down, but it does insist that each team using BDD come up with a simple, standardized format for writing down the user stories which includes the elements listed above.[2][10] However, in 2007 Dan North suggested a template for a textual format which has found wide following in different BDD software tools.[10] A very brief example of this format might look like this:

Story: Returns go to stock

In order to keep track of stock

As a store owner

I want to add items back to stock when they're returned

Scenario 1: Refunded items should be returned to stock

Given a customer previously bought a black sweater from me

And I currently have three black sweaters left in stock

When he returns the sweater for a refund

Then I should have four black sweaters in stock

Scenario 2: Replaced items should be returned to stock

Given that a customer buys a blue garment

And I have two blue garments in stock

And three black garments in stock.

When he returns the garment for a replacement in black,

Then I should have three blue garments in stock

And two black garments in stock

The scenarios are ideally phrased declaratively rather than imperatively - in the business language, with no reference to elements of the UI through which the interactions take place.[11]

This format is sometimes (incorrectly) referred to as the Gherkin language, which is very close to the syntax shown above. Gherkin is however specific to the Cucumber software tool.[12]

[edit]Specification as a ubiquitous language

Behavior-driven development borrows the concept of the ubiquitous language from domain driven design.[2][3] A ubiquitous language is a (semi-)formal language that is shared by all members of a software development team — both software developers and non-technical personnel.[13] The language in question is both used and developed by all team members as a common means of discussing the domain of the software in question.[13] In this way BDD becomes a vehicle for communication between all the different roles in a software project.[2][5]

BDD uses the specification of desired behavior as a ubiquitous language for the project team members. This is the reason that BDD insists on a semi-formal language for behavioral specification: some formality is a requirement for being a ubiquitous language.[2] In addition, having such a ubiquitous language creates a domain model of specifications, so that specifications may be reasoned about formally.[14] This model is also the basis for the different BDD-supporting software tools that are available.

The example given above establishes a user story for a software system under development. This user story identifies a stakeholder, a business effect and a business value. It also describes several scenarios, each with a precondition, trigger and expected outcome. Each of these parts is exactly identified by the more formal part of the language (the term Given might be considered a keyword, for example) and may therefore be processed in some way by a tool that understands the formal parts of the ubiquitous language.

[edit]Specialized tooling support

Much like test-driven design practice, behavior-driven development assumes the use of specialized support tooling in a project. And much like BDD is a more specific version of TDD, the tooling for BDD is similar to that for TDD but makes more demands on the developer than basic TDD tooling.

[edit]Tooling principles

In principle a BDD support tool is a testing framework for software, much like the tools that support TDD. However, where TDD tools tend to be quite free-format in what is allowed for specifying tests, BDD tools are linked to the definition of the ubiquitous language discussed earlier.

As discussed, the ubiquitous language allows business analysts to write down behavioral requirements in a way that will also be understood by developers. The principle of BDD support tooling is to make these same requirements documents directly executable as a collection of tests. The exact implementation of this varies per tool, but agile practice has come up with the following general process:

The tooling reads a specification document.

The tooling directly understands completely formal parts of the ubiquitous language (such as the Given keyword in the example above). Based on this, the tool breaks each scenario up into meaningful clauses.

Each individual clause in a scenario is transformed into some sort of parameter for a test for the user story. This part requires project-specific work by the software developers.

The framework then executes the test for each scenario, with the parameters from that scenario.

Dan North has developed a number of frameworks that support BDD (including JBehave and RBehave), whose operation is based on the template that he suggested for recording user stories.[2] These tools use a textual description for use cases and several other tools (such as CBehave) have followed suit. However, this format is not required and so there are other tools that use other formats as well. For example Fitnesse (which is built around decision tables), has also been used to roll out BDD.[15]

[edit]Tooling examples

There are several different examples of BDD software tools in use in projects today, for different platforms and programming languages.

Possibly the most well-known is JBehave, which was developed by Dan North. The following is an example taken from that project[16]:

Consider an implementation of the Game of Life. A domain expert (or business analyst) might want to specify what should happen when someone is setting up a starting configuration of the game grid. To do this, he might want to give an example of a number of steps taken by a person who is toggling cells. Skipping over the narrative part, he might do this by writing up the following scenario into a plain text document (which is the type of input document that JBehave reads):

Given a 5 by 5 game

When I toggle the cell at (2, 3)

Then the grid should look like

.....

.....

.....

..X..

.....

When I toggle the cell at (2, 4)

Then the grid should look like

.....

.....

.....

..XX.

.....

When I toggle the cell at (2, 3)

Then the grid should look like

.....

.....

.....

...X.

.....

The bold print is not actually part of the input; it is included here to show which words are recognized as formal language. JBehave recognizes the terms Given (as a precondition which defines the start of a scenario), When (as an event trigger) and Then (as a postcondition which must be verified as the outcome of the action that follows the trigger). Based on this, JBehave is capable of reading the text file containing the scenario and parsing it into clauses (a set-up clause and then three event triggers with verifiable conditions). JBehave then takes these clauses and passes them on to code that is capable of setting a test, responding to the event triggers and verifying the outcome. This code must be written by the developers in the project team (in Java, because that is the platform JBehave is based on). In this case, the code might look like this:

private Game game;

private StringRenderer renderer;

@Given("a $width by $height game")

public void theGameIsRunning(int width, int height) {

game = new Game(width, height);

renderer = new StringRenderer();

game.setObserver(renderer);

}

@When("I toggle the cell at ($column, $row)")

public void iToggleTheCellAt(int column, int row) {

game.toggleCellAt(column, row);

}

@Then("the grid should look like $grid")

public void theGridShouldLookLike(String grid) {

assertThat(renderer.asString(), equalTo(grid));

}

The code has a method for every type of clause in a scenario. JBehave will identify which method goes with which clause through the use of annotations and will call each method in order while running through the scenario. The text in each clause in the scenario is expected to match the template text given in the code for that clause (for example, a Given in a scenario is expected to be followed by a clause of the form "a X by Y game"). JBehave supports the matching of actual clauses to templates and has built-in support for picking terms out of the template and passing them to methods in the test code as parameters. The test code provides an implementation for each clause type in a scenario which interacts with the code that is being tested and performs an actual test based on the scenario. In this case:

The theGameIsRunning method reacts to a Given clause by setting up the initial game grid.

The iToggleTheCellAt method reacts to a When clause by firing off the toggle event described in the clause.

The theGridShouldLookLike method reacts to a Then clause by comparing the actual state of the game grid to the expected state from the scenario.

The primary function of this code is to be a bridge between a text file with a story and the actual code being tested. Note that the test code has access to the code being tested (in this case an instance of Game) and is very simple in nature (has to be, otherwise a developer would end up having to write tests for his tests).

Finally, in order to run the tests, JBehave requires some plumbing code that identifies the text files which contain scenarios and which inject dependencies (like instances of Game) into the test code. This plumbing code is not illustrated here, since it is a technical requirement of JBehave and does not relate directly to the principle of BDD-style testing.

[edit]Story versus Specification

A separate subcategory of behavior-driven development is formed by tools that use specifications as an input language rather than user stories. An example of this style is the RSpec tool that was also developed by Dan North. Specification tools don't use user stories as an input format for test scenarios but rather use functional specifications for units that are being tested. These specification often have a more technical nature than user stories and are usually less convenient for communication with business personnel than are user stories.[2][17] An example of a specification for a stack might look like this:

Specification: Stack

When a new stack is created

Then it is empty

When an element is added to the stack

Then that element is at the top of the stack

When a stack has N elements

And element E is on top of the stack

Then a pop operation returns E

And the new size of the stack is N-1

Such a specification may exactly specify the behavior of the component being tested, but is less meaningful to a business user. As a result, specification-based testing is seen in BDD practice as a complement to story-based testing and operates at a lower level. Specification testing is often seen as a replacement for free-format unit testing.[17]

Specification testing tools like RSpec and JDave are somewhat different in nature than tools like JBehave. Since they are seen as alternatives to basic unit testing tools like JUnit, these tools tend to favor forgoing the separation of story and testing code and prefer embedding the specification directly in the test code instead. For example, an RSpec test for a hashtable might look like this[18]:

describe Hash do

before do

@hash = Hash.new({:hello => 'world'})

end

it "should return a blank instance" do

Hash.new.should == {}

end

it "should hash the correct information in a key" do

@hash[:hello].should == 'world'

end

end

This example shows a specification in readable language embedded in executable code. In this case a choice of the tool is to formalize the specification language into the language of the test code by adding methods named it and should. Also there is the concept of a specification precondition – the before section establishes the preconditions that the specification is based on.

**BDD process**

The BDD process looks like this:

A SubjectMatterExpert (typically a business user) works with a BusinessAnalyst to identify a business requirement. This is expressed as a story using the following template:

As a Role

I request a Feature

To gain a Benefit

The speaker, who holds the Role, is the person who will gain the Benefit from the requested Feature.

This can also be paraphrased variously as ...

I want to achieve a specific Goal, and as a Role I should be able to accomplish this by performing Functionality.

A Role invokes Feature to cause a Benefit

## BDD software in different languages

See references from here [http://behaviordrivendevelopment.wikispaces.com/MoreTools](http://behaviordrivendevelopment.wikispaces.com/MoreTools).

+ ASSpec - ActionScript 3

+ Aero - PHP 5

+ Aubergine - .NET

+ BDoc - Extracting documentation from unit tests, supporting behavior driven development

+ BDD in Python - is core module doctest

+ Bumblebee - Extract documentation from JUnit tests with support for adding text, code-snippets, screenshots and more. Puts focus on the end-user.

+ beanSpec - Java

+ Behat - PHP implementation of the Gherkin Domain-specific language

+ Cedar - Objective C

+ CppSpec - C++

+ cfSpec - ColdFusion

+ CSpec - C

+ dSpec - Delphi

+ Concordion - a Java automated testing tool for BDD that uses plain English to describe behaviors.

+ Cucumber - Plain text + Ruby. Works against Java, .NET, Ruby, Flex or any web application via Watir or Selenium.

+ easyb - Groovy/Java

+ EasySpec - Groovy, usable in Java. Developer also working on Perception a tool for doing Context/Specification reporting for many different tools.

+ EXTasy - Behavior-driven framework for ExtJS interfaces. Written in python.

+ FitNesse - Java, .NET, C++, Delphi, Python, Ruby, Smalltalk, Perl. Now supports BDD directly with plain text tables and scenarios.

+ Freshen - Python - clone of the Cucumber BDD framework

+ GivWenZen - Java and FitNesse

+ GivWenZen for Flex and ActionScript3 - Flex cousin of Java GivWenZen

+ GSpec - Groovy

+ Igloo - C++

+ Instinct - Java

+ Jasmine - JavaScript - framework-independent BDD with easy CI integration

+ JavaStubs - Java - BDD framework supporting partial-mocking/method stubbing

+ JBee - Java

+ JBehave - Java - The first BDD framework, now at version 3.x

+ JDave - Java

+ JFXtras Test - JavaFX

+ JSpec - JavaScript - BDD framework independent, async support, multiple reporters (terminal, dom, server, console, etc.), Rhino support, over 50 matchers and much more

+ JSSpec - JavaScript

+ Kiwi - RSpec like BDD library for iOS

+ Lettuce - a Cucumber-like BDD tool for Python

+ Morelia viridis - Cucumber clone for Python

+ MSpec - .NET

+ NBehave - .NET

+ NSpec - .NET

+ NUnit - A TDD framework in .NET which can be used for BDD examples and scenarios

+ ObjectiveMatchy - iPhone - A Matcher System for iPhone development.

+ Pyccuracy - Behavior-driven framework in Python.

+ Pyhistorian - General purpose BDD Story Runner in Python (internal DSL, not plain-text)

+ PyCukes - Cucumber-like BDD tool built on top of Pyhistorian

+ Robot Framework - Generic keyword-driven test automation framework for acceptance level testing and acceptance test-driven development (ATDD) written in Python

+ RSpec - Ruby

+ Spock - Spock is a testing and specification framework for Java and Groovy

+ SSpec - SSpec is the BDD framework for Smalltalk (multiple dialects) created by Dave Astels

+ SpecFlow - SpecFlow is inspired by Cucumber and the community around it. Binding business requirements to .NET code

+ screw-unit - JavaScript

+ ScalaTest - Scala

+ specs - Scala

+ spec-cpp - C++

+ Spectacular - Open source BDD and ATDD tool incorporating several types of tests in a single document and introduces Executable Use Cases

+ Specter - Another implementation of BDD framework in .NET with focus on specification readability

+ StoryQ - .NET 3.5, can be integrated with NUnit to provide both specification readability and testing

+ TickSpec - Gherkin based framework supporting F# and C#

+ tspec - Groovy/Java (Thai syntax)

+ Tumbler - Java. Integrated with JUnit

+ Twist - Commercial Eclipse-based tool for creating executable specifications

+ Vows - JavaScript

+ XSpec - XPath, XSLT and XQuery

# Cucumber - A Ruby Based BDD Software

The former tool of cucumber is the rspec story runner.

Cucumber lets software development teams describe how software should behave in plain text. The text is written in a business-readable domain-specific language and serves as documentation, automated tests and development-aid - all rolled into one format.

Cucumber works with Ruby, Java, .NET, Flex or web applications written in any language. It has been translated to over 40 spoken languages.

Cucumber also supports more succinct tests in tables - similar to what FIT does. Dig around in the examples and documentation to learn more about Cucumber tables.

Background and Credits

Cucumber is Aslak Hellesøy’s rewrite of RSpec’s “Story runner”, which was originally written by Dan North. (Which again was a rewrite of his first implementation - RBehave. RBehave was his Ruby port of JBehave). Early versions of the RSpec “Story Runner” required that stories be written in Ruby. Seeing how much this sucked David Chelimsky added plain text support with contributions from half a dozen other people.

In April 2008, Aslak Hellesøy started the Cucumber project to address the internal design flaws and usability problems of the RSpec Story Runner (Yes - Cucumber also has warts on the inside). Joseph Wilk and Ben Mabey joined as regular contributors when Cucumber was just a little Gherkin. Matt Wynne joined the Cucumber team in September 2009 after. Mike Sassak and Gregory Hnatiuk joined in October 2009 after their great work on a faster parser for Cucumber. In addition to the core team over over 160 250 developers have contributed patches, bugfixes, tears and joy.

Cucumber's plain text DSL (Gherkin) somehow came out from the Agile community, mostly based on distillations made by Dan North, Chris Matts, Liz Keogh, David Chelimsky and dozens of people on the RSpec and Cucumber mailing lists. And me.

Cucumber is a tool that executes plain-text functional descriptions as automated tests. The language that Cucumber understands is called Gherkin. Here is an example:

Feature: Search courses

In order to ensure better utilization of courses

Potential students should be able to search for courses

Scenario: Search by topic

Given there are 240 courses which do not have the topic "biology"

And there are 2 courses A001, B205 that each have "biology" as one of the topics

When I search for "biology"

Then I should see the following courses:

| Course code |

| A001 |

| B205 |

While Cucumber can be thought of as a “testing” tool, the intent of the tool is to support BDD. This means that the “tests” (plain text feature descriptions with scenarios) are typically written before anything else and verified by business analysts, domain experts, etc. non technical stakeholders. The production code is then written outside-in, to make the stories pass.

Cucumber itself is written in Ruby, but it can be used to “test” code written in Ruby or other languages including but not limited to Java, C# and Python. Cucumber only requires minimal use of Ruby programming and Ruby is easy, so don’t be afraid even if the code you’re developing in is not Ruby.

## Specification based acceptance testing

The acceptance testing is performed by cucumber.

The acceptance report should be structured like this.

Application

has\_many Features

Feature

has\_a comment

has\_many Scenarios

Scenario

Given …

When …

Then …

Developing with Cucumber and BDD

Once you have set up Cucumber in your project you can get down to action.

When you decide you want to add a new feature or fix a bug, start by writing a new feature or scenario that describes how the feature should work. Don’t write any code (yet).

Now run the features again. The one you wrote should have yellow, pending steps – or failing, red ones. (If you don’t get that you’re doing something wrong, or the feature is already implemented).

This is when you start writing code. Start by writing a couple of lines of code to address the failure you got from Cucumber. Run cucumber again. Repeat and rinse until you’re happy with your feature. When you get down to nitty gritty details, drop down one abstraction level and use RSpec, or any Ruby testing framework, to write some specs/tests for your classes. Write the specs first! If you follow this process you have a good guard against brittle, unmaintainable, undocumented code that nobody understands. (Yes, features and specs are documentation too).

If you think this sounds annoying, try it out anyway. You’ll end up writing better, lesser coupled (and less) code this way. Trust me. Work outside-in (the outside being the feature, the inside being the low level code). Do it the BDD way.

Business value and MMF

You should discuss the “In order to” part of the feature and pop the why stack max 5 times (ask why recursively) until you end up with one of the following business values:

Protect revenue

Increase revenue

Manage cost

Increase brand value

Make the product remarkable

Provide more value to your customers

If you’re about to implement a feature that doesn’t support one of those values, chances are you’re about to implement a non-valuable feature. Consider tossing it altogether or pushing it down in your backlog. Focus on implementing the MMFs (Minimum Marketable Features) that will yield the most value.

Outcomes and bottom-up scenarios

The value provided by a system is what you can get out of it – not what you put into it (Chris Matts said that). Just like the value is expressed at the top of a feature (In order to…), the value should be in the steps of a scenarios too, more precisely in the Then steps.

When you’re writing a new scenario, I recommend you start with the formulation of the desired outcome. Write the Then steps first. Then write the When step to discover the action/operation and finally write the Given steps that need to be in place in order for the When/Then to make sense.

Read more about Given-When-Then and Gherkin in general.

## Features and scenarios

Structure of scenarios

Every .feature file conventionally consists of a single feature. A line starting with the keyword Feature followed by free indented text starts a feature. A feature usually contains a list of scenarios. You can write whatever you want up until the first scenario, which starts with the word Scenario (or localized equivalent; Gherkin is localized for dozens of languages) on a new line. You can use tagging to group features and scenarios together independent of your file and directory structure.

Every scenario consists of a list of steps, which must start with one of the keywords Given, When, Then, But or And. Cucumber treats them all the same, but you shouldn’t. Here is an example:

Feature: Serve coffee

In order to earn money

Customers should be able to

buy coffee at all times

Scenario: Buy last coffee

Given there are 1 coffees left in the machine

And I have deposited 1$

When I press the coffee button

Then I should be served a coffee

In addition to a scenario, a feature may contain a background, scenario outline and examples. Respective keywords (in English) and places to read more about them are listed below. You can get a list of localized keywords with cucumber --i18n [LANG].

keyword localized more info, see

name ‘English’

native ‘English’

encoding ‘UTF-8’

feature ‘Feature’ Feature Introduction

background ‘Background’ Background

scenario ‘Scenario’ Feature Introduction

scenario\_outline ‘Scenario Outline’ Scenario outlines

examples ‘Examples’ / ‘Scenarios’ Scenario outlines

given ‘Given’ Given-When-Then

when ‘When’ Given-When-Then

then ‘Then’ Given-When-Then

but ‘But’ Given-When-Then

Step definitions

For each step Cucumber will look for a matching step definition. A step definition is written in Ruby. Each step definition consists of a keyword, a string or regular expression, and a block. Example:

# features/step\_definitions/coffee\_steps.rb

Then "I should be served coffee" do

@machine.dispensed\_drink.should == "coffee"

end

Step definitions can also take parameters if you use regular expressions:

# features/step\_definitions/coffee\_steps.rb

Given /there are (\d+) coffees left in the machine/ do |n|

@machine = Machine.new(n.to\_i)

end

This step definition uses a regular expression with one match group – (\d+). (It matches any sequence of digits). Therefore, it matches the first line of the scenario. The value of each matched group gets yielded to the block as a string. You must take care to have the same number of regular expression groups and block arguments. Since block arguments are always strings, you have to do any type conversions inside the block, or use Step Argument Transforms.

When Cucumber prints the results of the running features it will underline all step arguments so that it’s easier to see what part of a step was actually recognised as an argument. It will also print the path and line of the matching step definition. This makes it easy to go from a feature file to any step definition.

Take a look at Step Definitions and the examples directory to see more.

## Gherkin, a language describing the specification

Gherkin is the language that Cucumber understands. It is a Business Readable, Domain Specific Language that lets you describe software’s behaviour without detailing how that behaviour is implemented.

Gherkin serves two purposes – documentation and automated tests. The third is a bonus feature – when it yells in red it’s talking to you, telling you what code you should write.

Gherkin’s grammar is defined in the Treetop grammar that is part of the Cucumber codebase. The grammar exists in different flavours for many spoken languages (37 at the time of writing), so that your team can use the keywords in your own language.

There are a few conventions.

Single Gherkin source file contains a description of a single feature.

Source files have .feature extension.

Gherkin Syntax

Like Python and YAML, Gherkin is a line-oriented language that uses indentation to define structure. Line endings terminate statements (eg, steps). Either spaces or tabs may be used for indentation (but spaces are more portable). Most lines start with a keyword.

Comment lines are allowed anywhere in the file. They begin with zero or more spaces, followed by a hash sign (#) and some amount of text.

Parser divides the input into features, scenarios and steps. When you run the feature the trailing portion (after the keyword) of each step is matched to a Ruby code block called Step Definitions.

A Gherkin source file usually looks like this

1: Feature: Some terse yet descriptive text of what is desired

2: In order to realize a named business value

3: As an explicit system actor

4: I want to gain some beneficial outcome which furthers the goal

5:

6: Scenario: Some determinable business situation

7: Given some precondition

8: And some other precondition

9: When some action by the actor

10: And some other action

11: And yet another action

12: Then some testable outcome is achieved

13: And something else we can check happens too

14:

15: Scenario: A different situation

16: ...

First line starts the feature. Lines 2-4 are unparsed text, which is expected to describe the business value of this feature. Line 6 starts a scenario. Lines 7-13 are the steps for the scenario. Line 15 starts next scenario and so on.

**Given When Then**

Cucumber scenarios consist of steps, also known as Givens, Whens and Thens.

Cucumber doesn’t technically distinguish between these three kind of steps. However, we strongly recommend that you do! These words have been carefully selected for their purpose, and you should know what the purpose is to get into the BDD mindset.

Robert C. Martin has written a great post about BDD’s Given-When-Then concept where he thinks of them as a finite state machine.

Given

The purpose of givens is to put the system in a known state before the user (or external system) starts interacting with the system (in the When steps). Avoid talking about user interaction in givens. If you had worked with usecases, you would call this preconditions.

Examples:

Create records (model instances) / set up the database state.

It’s ok to call into the layer “inside” the UI layer here (in Rails: talk to the models).

Log in a user (An exception to the no-interaction recommendation. Things that “happened earlier” are ok).

And for all the Rails users out there – we recommend using a Given with a multiline table argument to set up records instead of fixtures. This way you can read the scenario and make sense out of it without having to look elsewhere (at the fixtures).

When

The purpose of When steps is to describe the key action the user performs (or, using Robert C. Martin’s metaphor, the state transition).

Examples:

Interact with a web page (Webrat/Watir/Selenium interaction etc should mostly go into When steps).

Interact with some other user interface element.

Developing a library? Kicking off some kind of action that has an observable effect somewhere else.

Then

The purpose of Then steps is to observe outcomes. The observations should be related to the business value/benefit in your feature description. The observations should also be on some kind of output – that is something that comes out of the system (report, user interface, message) and not something that is deeply buried inside it (that has no business value).

Examples:

Verify that something related to the Given+When is (or is not) in the output

Check that some external system has received the expected message (was an email with specific content sent?)

While it might be tempting to implement Then steps to just look in the database – resist the temptation. You should only verify outcome that is observable for the user (or external system) and databases usually are not.

And, But

If you have several givens, whens or thens you can write

Scenario: Multiple Givens

Given one thing

Given another thing

Given yet another thing

When I open my eyes

Then I see something

Then I don't see something else

Or you can make it read more fluently by writing

Scenario: Multiple Givens

Given one thing

And another thing

And yet another thing

When I open my eyes

Then I see something

But I don't see something else

To Cucumber steps beginning with And or But are exactly the same kind of steps as all the others.

**Step definition**

Step definitions are defined in ruby files under features/step\_definitions/\*\_steps.rb. Here is a simple example:

Given /^I have (\d+) cucumbers in my belly$/ do |cukes|

# Some Ruby code here

end

A step definition is analogous to a method definition / function definition in any kind of OO/procedural programming language. Step definitions can take 0 or more arguments, identified by groups in the Regexp (and an equal number of arguments to the Proc).

Some people are uncomfortable with Regular Expressions. It’s also possible to define Step Definitions using strings and $variables like this:

Given "I have $n cucumbers in my belly" do |cukes|

# Some Ruby code here

end

In this case the String gets compiled to a Regular Expression behind the scenes: /^I have (.\*) cucumbers in my belly$/.

Then there are Steps. Steps are declared in your features/\*.feature files. Here is an example:

Given I have 93 cucumbers in my belly

A step is analogous to a method or function invocation. In this example, you’re “calling” the step definition above with one argument – the string “93”. Cucumber matches the Step against the Step Definition’s Regexp and takes all of the captures from that match and passes them to the Proc.

Step Definitions start with a preposition or an adverb (Given, When, Then, And, But), and can be expressed in any of Cucumber’s supported Spoken languages. All Step definitions are loaded (and defined) before Cucumber starts to execute the plain text.

When Cucumber executes the plain text, it will for each step look for a registered Step Definition with a matching Regexp. If it finds one it will execute its Proc, passing all groups from the Regexp match as arguments to the Proc.

The preposition/adverb has no significance when Cucumber is registering or looking for Step Definitions.

Also check out Multiline Step Arguments for more info on how to pass entire tables or bigger strings to your step definitions.

Successful steps

When Cucumber finds a matching Step Definition it will execute it. If the block in the step definition doesn’t raise an Exception, the step is marked as successful (green). What you return from a Step Definition has no significance what so ever.

Undefined steps

When Cucumber can’t find a matching Step Definition the step gets marked as yellow, and all subsequent steps in the scenario are skipped. If you use --strict this will cause Cucumber to exit with 1.

Pending steps

When a Step Definition’s Proc invokes the #pending method, the step is marked as yellow (as with undefined ones), reminding you that you have work to do. If you use --strict this will cause Cucumber to exit with 1.

Failed steps

When a Step Definition’s Proc is executed and raises an error, the step is marked as red. What you return from a Step Definition has no significance what so ever. Returning nil or false will not cause a step definition to fail.

Skipped steps

Steps that follow undefined, pending or failed steps are never executed (even if there is a matching Step Definition), and are marked cyan.

String steps

Steps can be defined using strings rather than regular expressions. Instead of writing

Given /^I have (.\*) cucumbers in my belly$/ do |cukes|

You could write

Given “I have $count cucumbers in my belly” do |cukes|

Note that a word preceded by a $ sign is taken to be a placeholder, and will be converted to match .\*. The text matched by the wildcard becomes an argument to the block, and the word that appeared in the step definition is disregarded.

Ambiguous steps

Consider these step definitions:

Given /Three (.\*) mice/ do |disability|

end

Given /Three blind (.\*)/ do |animal|

end

And a plain text step:

Given Three blind mice

Cucumber can’t make a decision about what Step Definition to execute, and wil raise a Cucumber::Ambiguous error telling you to fix the ambiguity.

Guess mode

Running the plain text step will match the Regexp of both step definitions and raise Cucumber::Ambiguous. However,

if you run Cucumber with --guess, it will guess that you were aiming for the step definition with 2 match groups.

There is ranking logic that gets invoked when the option is turned on:

The longest Regexp with 0 capture groups always wins.

The Regexp with the most capture groups wins (when there are none with 0 groups)

If there are 2+ Regexen with the same number of capture groups, the one with the shortest overall captured string length wins

If there are still 2+ options then an Ambiguous error is raised

So if you try --guess with the mice above, Cucumber will pick /Three blind (.\*)/, because “mice” is shorter than “blind”.

Consider guess mode a workaround. We still recommend you try to have unambiguous regular expressions. When you have a lot of step definitions you quickly lose track of the situations where cucumber will apply guessing logic, and that can lead to some surprises.

Redundant Step Definitions

In Cucumber you’re not allowed to use a regexp more than once in a Step Definition (even across files, even with different code inside the Proc), so the following would cause a Cucumber::Redundant error:

Given /Three (.\*) mice/ do |disability|

# some code

end

Given /Three (.\*) mice/ do |disability|

# some other code

end

**Scenario Outline**

Copying and pasting scenarios to use different values quickly becomes tedious and repetitive:

Scenario: eat 5 out of 12

Given there are 12 cucumbers

When I eat 5 cucumbers

Then I should have 7 cucumbers

Scenario: eat 5 out of 20

Given there are 20 cucumbers

When I eat 5 cucumbers

Then I should have 15 cucumbers

Scenario outlines allow us to more concisely express these examples through the use of a template with placeholders, using Scenario Outline, Examples with tables and < > delimited parameters:

Scenario Outline: eating

Given there are <start> cucumbers

When I eat <eat> cucumbers

Then I should have <left> cucumbers

Examples:

| start | eat | left |

| 12 | 5 | 7 |

| 20 | 5 | 15 |

The Scenario Outline steps provide a template which is never directly run. A Scenario Outline is run once for each row in the Examples section beneath it (not counting the first row).

The way this works is via placeholders. Placeholders must be contained within < > in the Scenario Outline's steps. For example:

Given <I'm a placeholder and I'm ok>

The placeholders indicate that when the Examples row is run they should be substituted with real values from the Examples table. If a placeholder name is the same as a column title in the Examples table then this is the value that will replace it.

You can also use placeholders in Multiline Step Arguments.

IMPORTANT: Your step definitions will never have to match a placeholder. They will need to match the values that will replace the placeholder

So when running the first row of our example:

Examples:

| start | eat | left |

| 12 | 5 | 7 |

The scenario that is actually run is:

Scenario: controlling order

Given there are 12 cucumbers # <start> replaced with 12

When I eat 5 cucumbers # <eat> replaced with 5

Then I should have 7 cucumbers # <left> replaced with 7

## Organizing and tagging of features

# An Example Project Using Cucumber

In recent years, the cloud computing is emerging as a main trend of current information industry. Though there are many new cloud service provider, a huge number of old fashioned applications still can not be used in cloud. The aim of this project is to migrate a simple image processing application into cloud. With this project, old fashioned image processing application is empowered with new cloud based flexibility.

## Requirements of a cloud based image processing website

The major requirements are listed below.

1. upload an image to this website, and view the uploaded image
2. process this image and preview the result image
3. download the result image

## The first prototype, image uploading and showing

## The second iteration, core image processing

## The third iteration, security and style issue

## The fourth iteration, refactoring

# Defects And Pitfalls of BDD

## How to write great features

## How to organize features

## BDD using different languages