

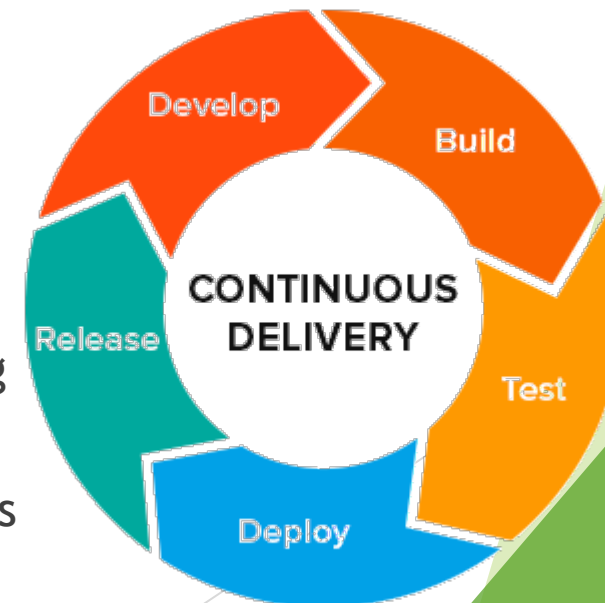
# TDD Lecture Supplement: Behavior-Driven Development (BDD)

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# Agile Software Development:

## Quick adaptation to changing requirements

- ▶ Agile: A development process amenable to frequent changes in requirements
  - ▶ Stresses adapting to user needs quickly vs. negotiating a contract
  - ▶ Stresses efficient communication vs. comprehensive specification
  - ▶ Stresses iterative design vs. rigid plan
- ▶ Some Agile practices:
  - ▶ Continuous Delivery (CD):  
Frequent delivery of software for user feedback
  - ▶ Test Driven Development (TDD):  
Allows continuous delivery through continuous testing
  - ▶ Behavior Driven Development (BDD):  
A type of TDD better suited for adapting to user needs



# TDD Strength: Coding is driven by requirements

- ▶ Requirements drives → Testing drives → Development
  - ▶ Test cases are written based on the requirements
  - ▶ Code is written to fulfill the test cases
- ▶ End result:
  1. Ensures all code adheres to requirements at all times 😊
  2. Ensures all coding effort is focused on fulfilling requirements 😊
- ▶ What's not to like?
- ▶ What if requirements need to change often (at every iteration of CD cycle)?

## TDD Weak Link 1:

# Maintaining requirements can become a burden

### ► A typical Software Requirements Specification (SRS):

The rent-a-cat system shall list all cats when command “1” is given such that an empty string is returned when no cats are available, and a full listing of cats is returned when there are cats available.

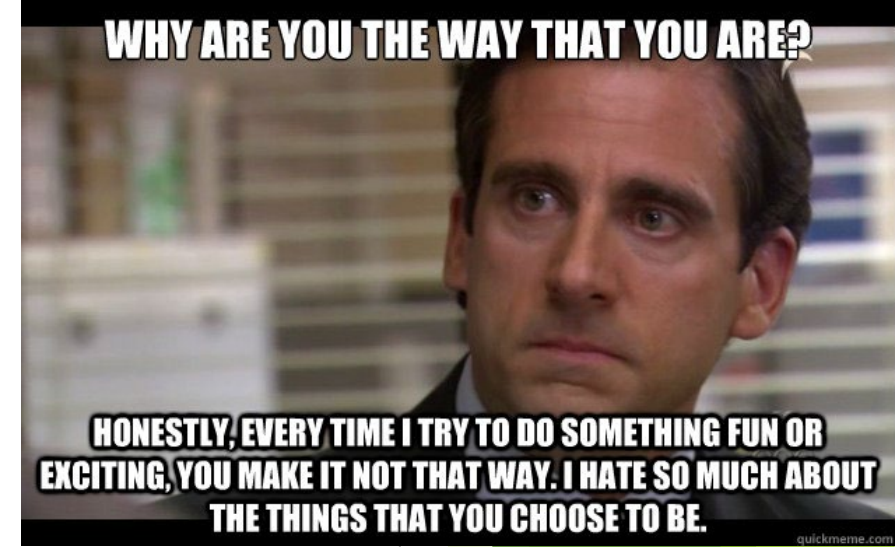
Each line in a listing of cats shall consist of the string “ID” followed by one space (ASCII code 32) followed by the numerical ID of the cat followed by the string “.” followed by the name of the cat followed by a UNIX-style newline ‘\n’ (ASCII code 10).

A cat name shall consist of alpha-numeric characters and spaces (ASCII code 32).

→ Why is it so long? If I’m an end-user, I’m not going to read this. ☹

→ Even if I did read this, I am not going to understand it. ☹

# SRS, Why are you like this?



- ▶ SRS is not meant to be read by the end-user:
  1. Meant for **lawyers** : SRS is a **contract** (why it sounds like legalese)
  2. Meant for **developers** : SRS is a **specification** (why it is so technical)
- ▶ Painstakingly compiled by requirement analysts after interviewing users



But what if requirements must change often (as part of the CD cycle)?

- ▶ Now SRS becomes a **burden**:
  1. End-user must pore through SRS in order to give feedback
  2. Hundreds of pages of SRS documents must be maintained throughout
- ▶ SRS should be a tool for **communication** with user, not litigation!

## TDD Weak Link 2:

### Maintaining test cases can become a burden

- ▶ If requirements change often, since Requirements → Tests → Code,
  - ▶ Testing infrastructure needs to change often as well
- ▶ TDD means a lot of time is spent maintaining testing infrastructure
  - ▶ Time that would not be spent had we not done TDD
  - ▶ Maintaining testing infrastructure can feel like extra baggage
  - ▶ Testing should improve productivity, not decrease it!

# Behavior-Driven Development (BDD): Behavior is Requirement *and* Test in one

- ▶ Introduced by Dan North in 2006 issue of “Better Software magazine”
  - ▶ <https://dannorth.net/introducing-bdd/>
- ▶ Paradigms laid down by Dan North in above article:
  - ▶ Software is **described in terms of behaviors** not code-centric specifications
  - ▶ **Behaviors are in a “ubiquitous language”** --- in other words plain English
  - ▶ **Behaviors are “executable”** --- behaviors are directly testable on the code (Given as a set of testable what-if scenarios that describe the requirement)
    - ▶ Can we automatically execute “plain English” behaviors on today’s computers?



# A Code-Centric Specification: Something that only coders understand

The rent-a-cat system shall list all cats when command “1” is given such that an empty string is returned when no cats are available, and a full listing of cats is returned when there are cats available.

Each line in a listing of cats shall consist of the string “ID” followed by one space (ASCII code 32) followed by the numerical ID of the cat followed by the string “.” followed by the name of the cat followed by a UNIX-style newline ‘\n’ (ASCII code 10).

A cat name shall consist of alpha-numeric characters and spaces (ASCII code 32).



# A Behavior Driven Specification: Something that users can understand

Rule: **When** there are cats, the listing is one line per each cat.

**Scenario:** List available cats with 1 cat

**Given** a cat with ID 1 and name "Jennyanydots"

**When** I list the cats

**Then** the listing is: "ID 1. Jennyanydots\n"

**Scenario:** List available cats with 2 cats

**Given** a cat with ID 1 and name "Jennyanydots"

**And** a cat with ID 2 and name "Old Deuteronomy"

**When** I list the cats

**Then** the listing is: "ID 1. Jennyanydots\nID 2. Old Deuteronomy\n"

# Behavior-Driven Development: Solves existing problems with TDD

1. Maintaining requirements can become a burden  
→ Behaviors are easily shared with and updated by stakeholders
  2. Maintaining test cases can become a burden  
→ Since behaviors *are* the tests, tests are updated with requirements
- ▶ Closer to the Agile philosophy of adapting to user needs
    - ▶ Now stakeholders become active participants in shaping requirements
    - ▶ Now software companies are not as afraid to change requirements
  - ▶ In other aspects, BDD still works like TDD: red-green-refactor loop

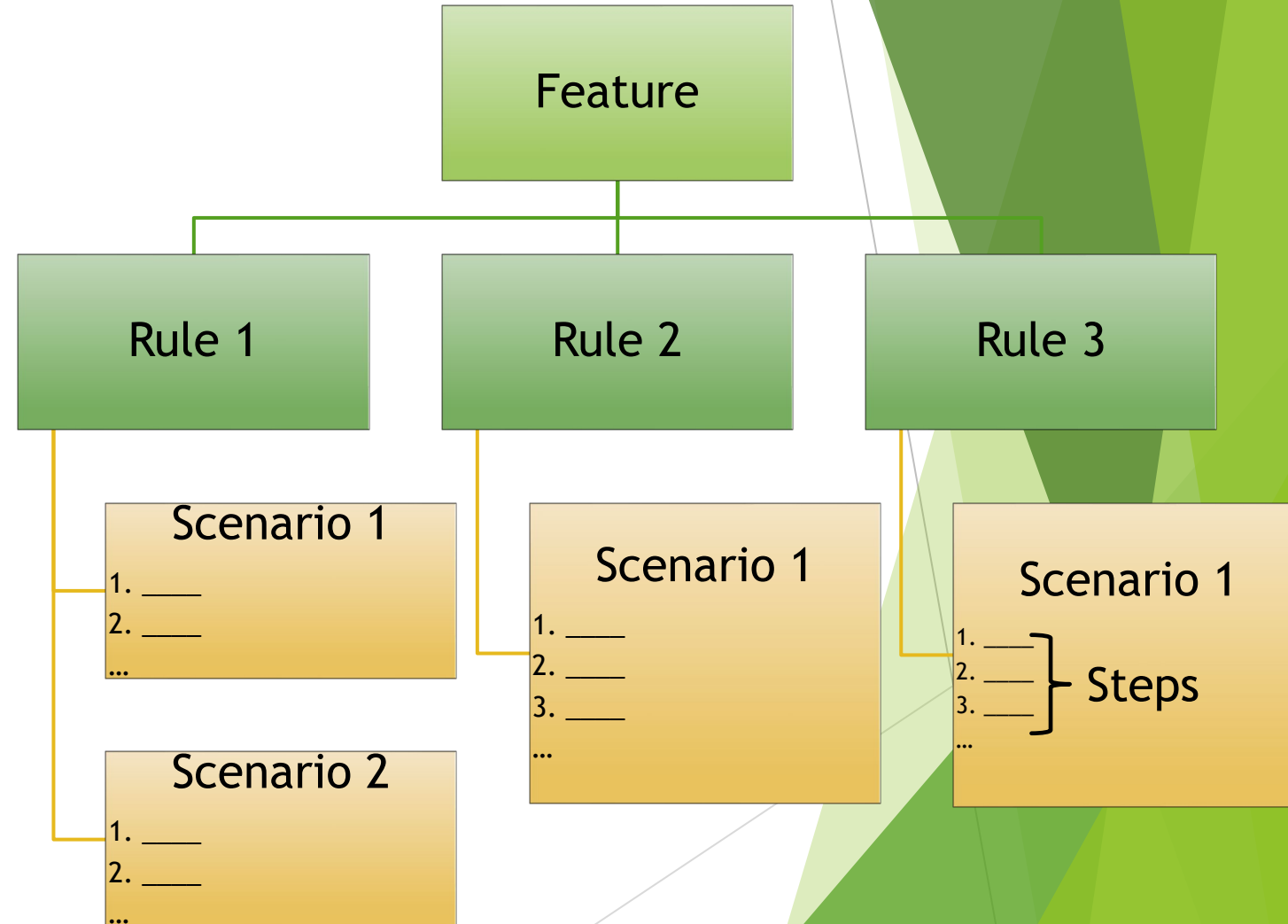
# Dialect for Describing Behaviors: Gherkin or JBehave

- ▶ Dialect for describing behaviors must satisfy two criteria
  1. Must be like plain English so end-users can understand it
  2. Must have some structure so testing behaviors can be automated
- ▶ Two popular Domain Specific Languages (DSLs):
  1. Gherkin : Used with the Cucumber testing framework
  2. JBehave : Used with the JBehave testing framework
- ▶ We will learn Gherkin with Cucumber but JBehave is almost identical
  - ▶ In fact, JBehave framework also has a Gherkin language parser

# Gherkin : Domain Specific Language for describing Behaviors

# Gherkin hierarchy

Feature	A discrete functionality or subsystem (a.k.a <i>user story</i> ).
Rules	One or more business rules that a feature must follow.
Scenario	One or more use cases that demonstrate a rule
Steps	Preconditions, Execution Steps, Postconditions for a scenario



# Feature Syntax

- ▶ **Feature:** <text>
  - ▶ <text> can be any multi-line text that extends until the next keyword
- ▶ <text> is usually a one line description of the feature followed by:
  - As a <role>
  - I want <function>
  - So that <reason / benefit>
  - ▶ <role> : user, administrator, customer service, data analyst, ...
  - ▶ <function> : what functionality the feature provides
  - ▶ <benefit> : what business goals the function serves for the role

# Feature Example

**Feature:** Rent-A-Cat listing

As a user

I want to see a listing of available cats in the rent-a-cat facility

So that I can see what cats are available for rent.

# Another Feature Example

**Feature:** Rent-A-Cat statistics

As a system administrator

I want to see how many days each cat was rented each month

So that I can decide who wins the cat-of-the-month prize.



# Rule Syntax

- ▶ **Rule:** <text>

- ▶ <text> can be any multi-line text that extends until the next keyword
- ▶ Multiple rules can follow the Feature keyword

- ▶ **Examples:**

**Feature:** Rent-A-Cat listing

...

Rule: **When** there are no cats, the listing is an empty string.

Rule: **When** there are cats, the listing is one line per each cat.

# Scenario Syntax

- ▶ **Scenario:** <text>

- ▶ <text> can be any multi-line text that extends until the next keyword
- ▶ Multiple scenarios can follow the Rule keyword

- ▶ **Examples:**

Rule: **When** there are cats, the listing is one line per each cat.

**Scenario:** List available cats with **1** cat

...

**Scenario:** List available cats with **2** cats

...

# Step Syntax

- ▶ One or more steps describe a scenario
  - ▶ **Given** <text>: Describes a precondition
  - ▶ **When** <text>: Describes an execution step
  - ▶ **Then** <text>: Describes a postcondition
- ▶ There can be multiple **Given**, **When**, **Then** steps for a scenario
  - ▶ When there are multiple steps of same type can use **And** keyword
  - ▶ # First precondition  
**Given** <text1>  
# Equivalent to **Given** <text2>  
**And** <text2>

# Step Example

**Scenario:** List available cats with 1 cat

**Given** a rent-a-cat facility

**Given** a cat with ID 1 and name "Jennyanydots"

**When** I list the cats

**Then** the listing is: "ID 1. Jennyanydots\n"

# Background Syntax

- ▶ Each feature can have an optional Background
  - ▶ Same purpose as @Before in JUnit (common preconditions for all scenarios)
- ▶ **Background:** <multiple **Given** steps>
  - ▶ Comes immediately after the **Feature** keyword
- ▶ Example:

**Background:**

**Given** a rent-a-cat facility

**And** a cat with ID 1 and name "Jennyanydots"

**And** a cat with ID 2 and name "Old Deuteronomy"

**And** a cat with ID 3 and name "Mistoffelees"

# How are the steps executed on code?

- ▶ No, the plain English scenarios won't run automatically on code
  - ▶ At least we are not there yet 😊
- ▶ You must implement the steps (in Java)
  - ▶ Cucumber framework will use regular expression matching  
--- to match plain English steps to your Java steps
  - ▶ Same steps are used repeatedly for many scenarios, so not much coding!
  - ▶ If different English words are used for same step, match with regex

# When to use (and not use) BDD

- ▶ Pro: Makes requirements easy to evolve using user feedback
  - ▶ Leading to a product with higher user satisfaction
- ▶ Con: Leaves room for ambiguous requirements
  - ▶ It's basically specification by example
- ▶ Depending on domain/field, may not be a good choice
  - ▶ Good for user-facing functionality
  - ▶ Bad for back-end or safety-critical development