Behavior-Driven Development (BDD)

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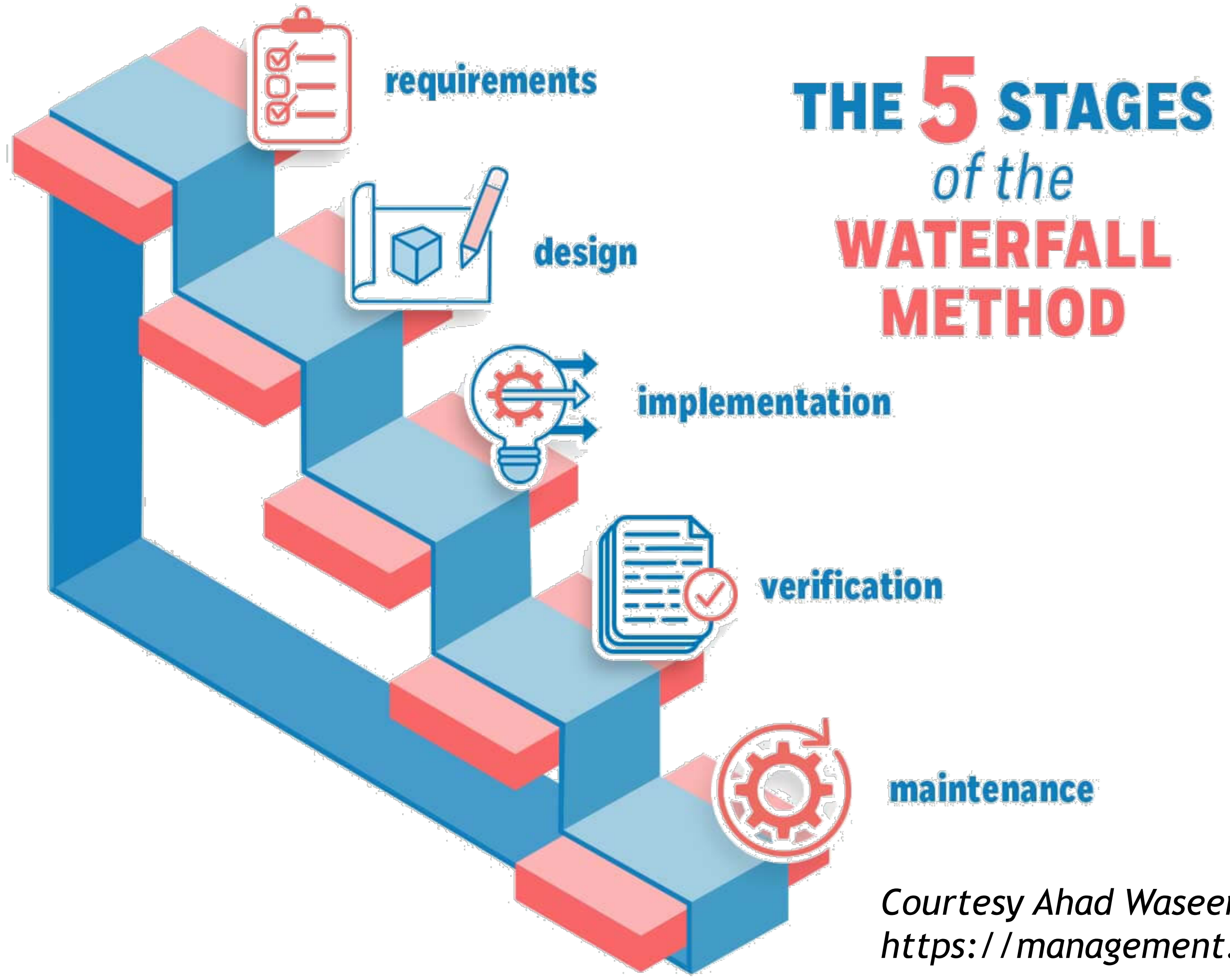
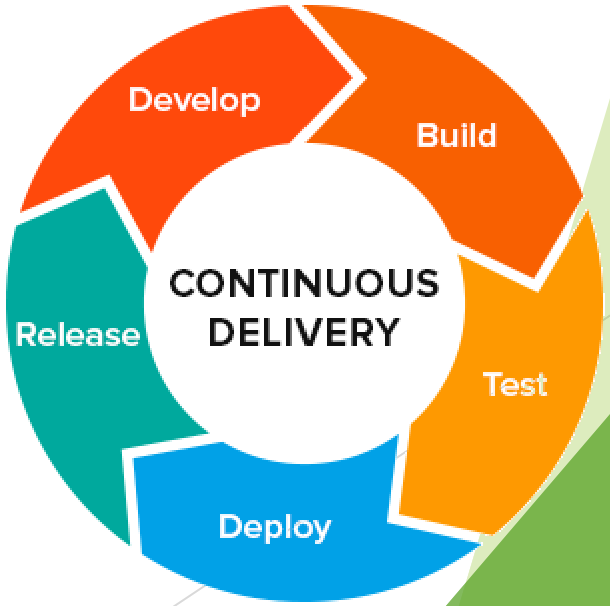
Waterfall Model:
Linear sequential approach do development



Courtesy Ahad Waseem
https://management.org/waterfall-methodology

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.

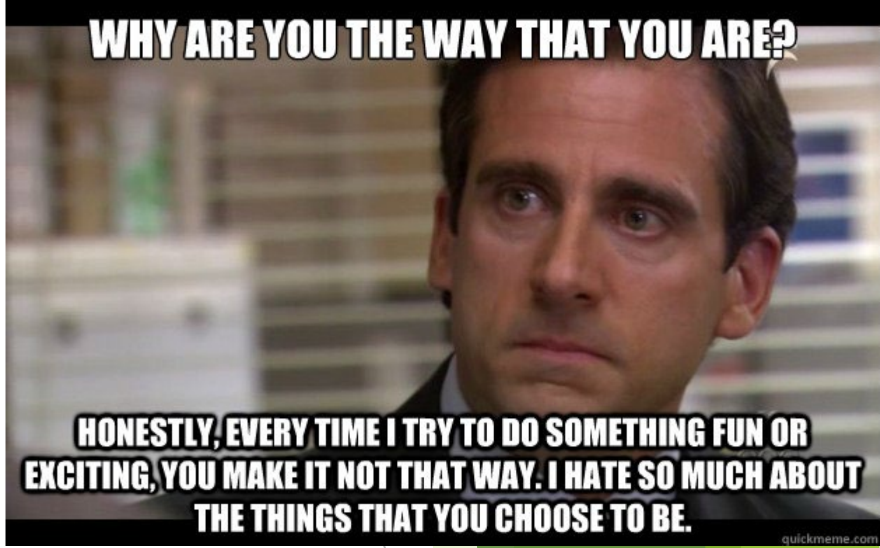
Each line in a listing of cats shall consist of the string “ID” followed by one space (ASCII code 32) followed by the numerical ID of the cat followed by the string “.” followed by the name of the cat followed by a UNIX-style newline ‘\n’ (ASCII code 10).

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?


WHY ARE YOU THE WAY THAT YOU ARE?
HONESTLY, EVERY TIME I TRY TO DO SOMETHING FUN OR EXCITING, YOU MAKE IT NOT THAT WAY. I HATE SO MUCH ABOUT THE THINGS THAT YOU CHOOSE TO BE.
quickmeme.com

- 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 stakeholders

🧐 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: Example usage scenarios of the software
  - Behaviors are in a “ubiquitous language” --- in other words plain English
  - Behaviors are “executable” --- easily tested on the software using automation
- Behaviors are the ultimate “living documentation”
  - Unlike testing code, now even stakeholders can read the documentation

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
  - Understanding and changing requirements becomes much easier
  - Now stakeholders become active participants in shaping requirements

- In other aspects, BDD still works like TDD: red-green-refactor loop

Dialect for Describing Behaviors: Gherkin or JBehave

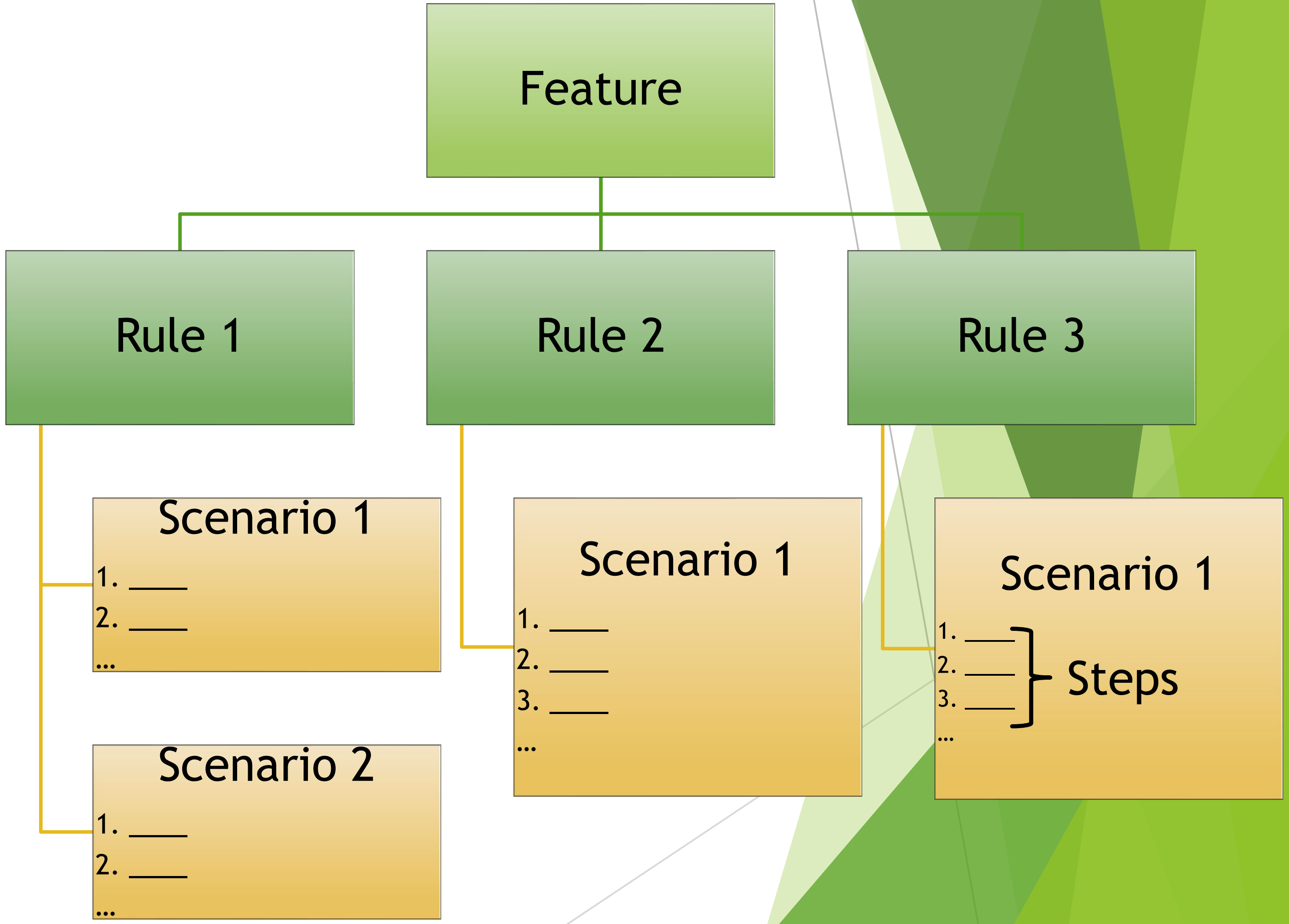
- Dialect for describing behaviors must satisfy two criteria
  1. Must be like plain English so end-users can understand it
  2. Must have some structure so testing behaviors can be automated

- 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.
Rules	Business rules that a feature must follow.
Scenarios	Example 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 a one-line title of the feature followed by a narrative:

  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
- The narrative is called a **user story**.

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
And 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**: <one or more **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?

- The plain English Gherkin steps won’t run automatically ☺
  - Each Gherkin step invokes a Cucumber step written in Java
- Gherkin steps invoke Cucumber steps via **pattern matching**. E.g.:

```
@Given("a cat with ID {int} and name {string}")
public void aCatWithIDAndName(Integer id, String name) {
    cat = new Cat(id, name);
}
```

  - Allows above Cucumber step to match many Gherkin steps. E.g.:

```
Given a cat with ID 1 and name "Jennyanydots”
Given a cat with ID 2 and name "Old Deuteronomy”
```

  - **Minimizes Java “glue” code** that needs to be maintained.

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