TDD Lecture Supplement: Behavior-Driven Development (BDD)

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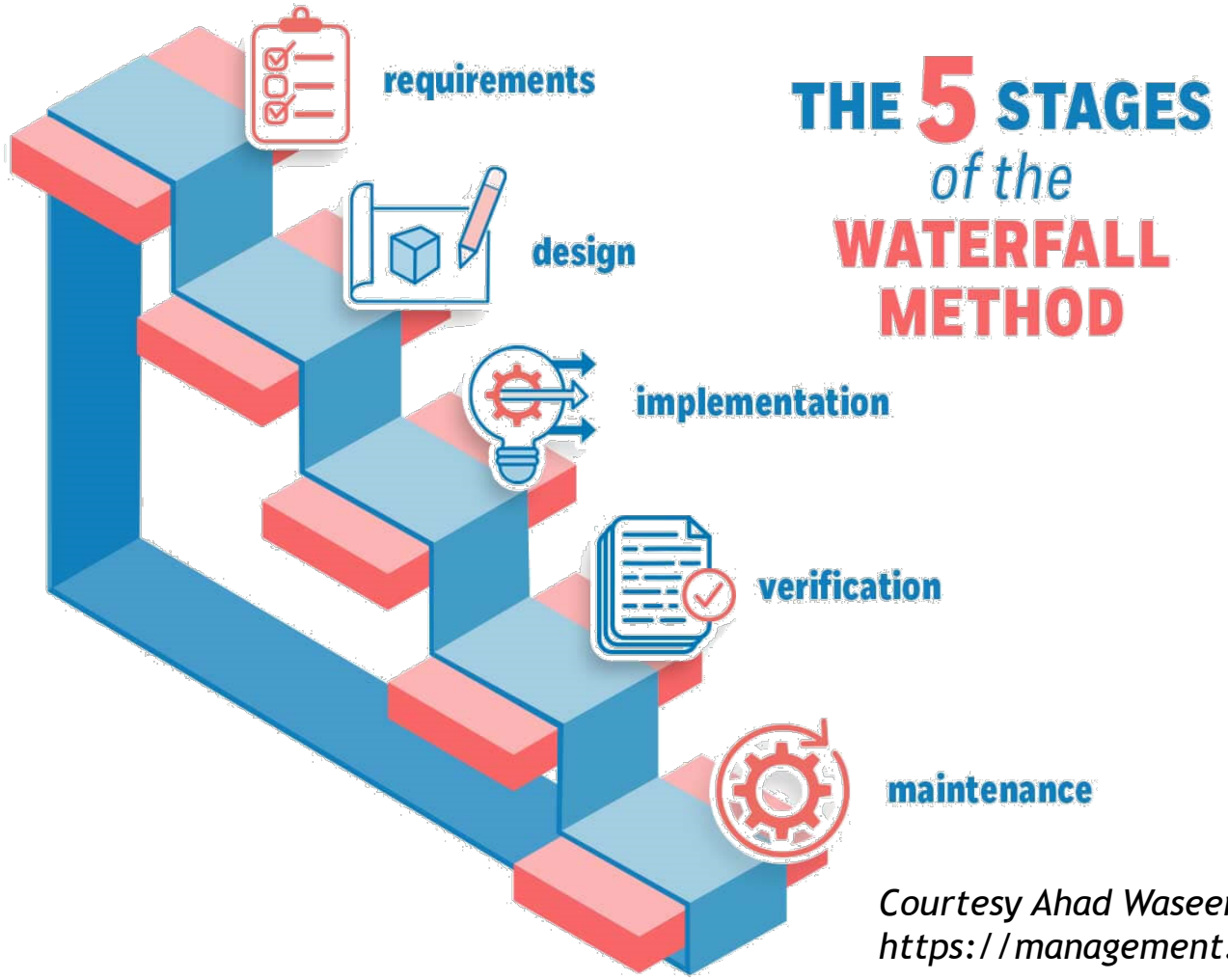
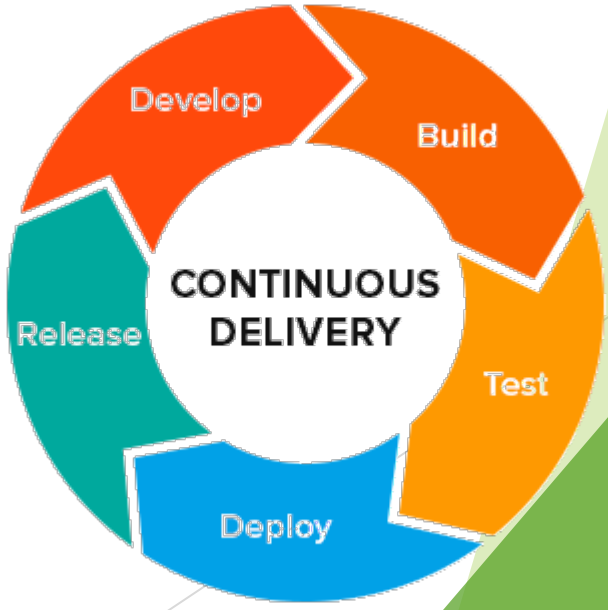
Waterfall Model:
Linear sequential approach do development



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.

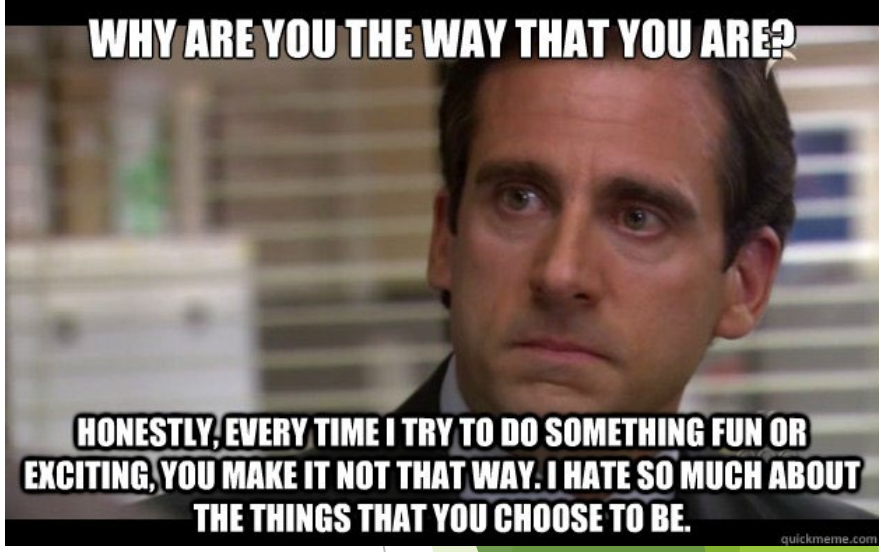
Each line in a listing of cats shall consist of the string “ID” followed by one space (ASCII code 32) followed by the numerical ID of the cat followed by the string “:” followed by the name of the cat followed by a UNIX-style newline ‘\n’ (ASCII code 10).

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?



- 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

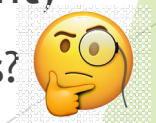
- If requirements change often, since Requirements → Tests → Code,
  - Testing infrastructure needs to change often as well

- 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 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

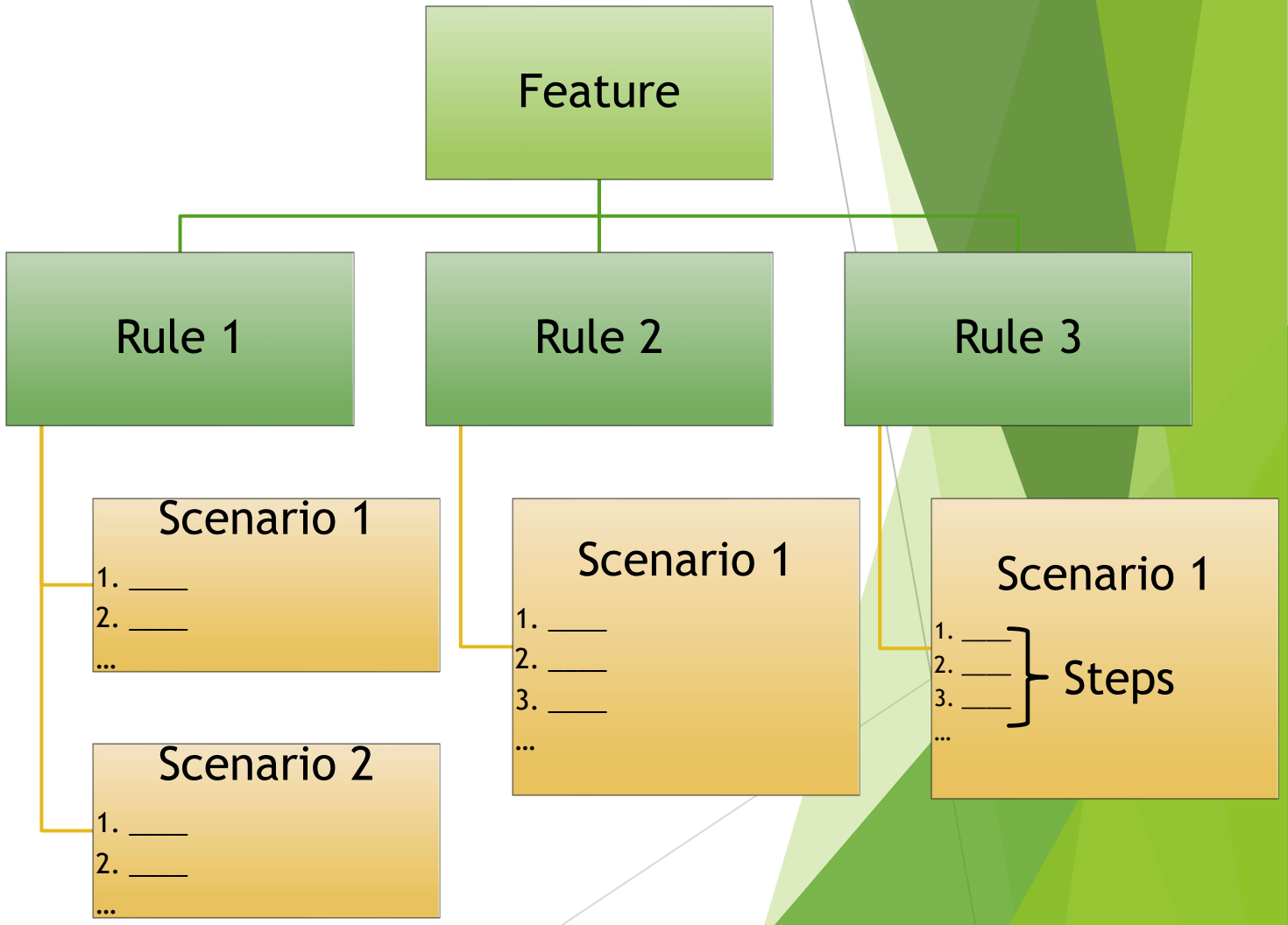
- Dialect for describing behaviors must satisfy two criteria
  1. Must be like plain English so end-users can understand it
  2. Must have some structure so testing behaviors can be automated

- 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 *user story*).
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