

# Testing

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Module Team: Seb Blair & Fayaz Iqbal

# Why do we Test?

- Ensures a high quality of code.
- Catches bugs early.
- Ensures we are 'building the product right'.
- If tests pass, the behaviour of the program is what you expect.
- If tests fail, then your program is likely not performing as it should.
- If tests fail then one of two things has happened:
  - Programming errors: You have made an error in the logic of your code (perhaps an out of bounds error)
  - Understanding errors: You have not understood the requirements, or overlooked definition in the problem

# Types of Testing

- Feature Tests
- Functional Testing
- Performance and Load Testing
- Security Testing
- Test Driven Development
- Unit Testing
- User Testing

# Feature Tests

- When units become a feature, you may want to write tests to check the functionality of the entire feature to ensure that:
- The units are interacting with each other
- The feature acts as it should

# Functional Testing

- Functional testing is a way of testing all of the ‘moving parts’ of a software product.
- You should aim to test the entire codebase
- For enterprise level systems this could mean test suites of thousands of tests.
- You will be familiar with unit testing which is a type of test that we employ to test the smallest parts (or units) of a program
- We also use feature tests, system testing and release testing.

# Performance and Load Testing

- If you are developing an API or system that is going to receive millions of calls per day, the last thing you want is for your software to fail ([Pokémon Go makers call for calm as servers crash across Europe and US](#))
- Many services will have [service level agreements](#) (SLA's) such as guaranteeing 99.999% uptime
- During development you need to ensure that performance will continue as expected and that your system is capable of handling the transactional load required.

# Security Testing

- Security testing is, as it sounds, testing to find the vulnerabilities in the software product being developed. Pen testing teams will usually be outsourced to test the vulnerabilities in your system.
- Unhashed passwords
- Unsanitised text inputs ( `"Enter your surname:" DROP TABLE customer_list; )`
- DDoS attacks
- HTTP session cookies are visible
- *Pressing the back button and then 'show password'*

# Test Driven Development

- You should have many test cases for this one method/ function.
- In fact most code will be written after the test
- We call this test-driven development (TDD)



# Test Driven Development

- We also use the Red Green Refactor cycle
  - We write a (failing) test where the test cases will pass when we build the right function
  - We write our code until the test is passing
  - We refactor our code



# Test Driven Development

- Test driven development is a skill that is highly sought after...
- ... and one that not many graduates possess
- “I didn’t realise how different my university experience was from industry standard coding. When we briefly looked at unit testing at uni we wrote the code first and then the test; here I’ve written more tests than actual lines of code, and always the tests first.”
- TDD can lead to Behavior Driven Development (BDD)

# TDD vs BDD

- TDD is more developer-centric, revolving around code correctness, with programming language-specific frameworks.
- On the other hand, BDD is more user-centric, revolves around system behavior, and promotes collaboration between relevant stakeholders with a domain-specific language.
- BDD starts with analyzing the desired behavior that developers want to create. After that, they'll express the desired behavior using the Gherkin syntax, which consists of **Given - When - Then - And** statements. These statements show developers how to develop the code that fulfills the behaviors described.

# BDD

- Gherkin is a plain-text language with a simple structure. It is designed to be easy to learn by non-programmers, yet structured enough to allow concise description of test scenarios and examples to illustrate business rules in most real-world domains.

**Feature:** Account Holder withdraws cash

**Scenario:** Account has sufficient funds

**Given** The account balance is \$100

**And** the card is valid

**And** the machine contains enough money

**When** the Account Holder requests \$20

**Then** the ATM should dispense \$20

**And** the account balance should be \$80

**And** the card should be returned

# Unit Testing

- We write unit tests to test units of the program
- They are usually functions or class methods
- Unit tests take a function, present it some input and test its output
- When writing unit tests it is a good idea to use the **Arrange-Action-Assert pattern**

# Unit Testing

- Consider the `abs()` function in Python
- `abs()` returns the absolute value of a number (the distance of the number from zero)
- Using **Arrange-Action-Assert** we can write a test to ensure the behaviour of `abs()` is what we expect

# Unit Tests - Python

```
# Test abs
def test_abs()

    # Arrange (Setup the testing scenario, mock any data)
    value = 7.5

    # Action (call the function to be tested)
    result = abs(value)

    # Assert (Provide the expected outcome)
    assert result == 7.5
```

# Unit Tests - C#

```
[TestClass]
public class MathTests
{
    [TestMethod]
    public void TestAbs()
    {
        // Arrange (Setup the testing scenario, mock any data)
        double value = 7.5;

        // Action (call the function to be tested)
        double result = Math.Abs(value);

        // Assert (Provide the expected outcome)
        Assert.AreEqual(7.5, result);
    }
}
```



# User Testing

- Usability testing
  - Can users learn to use the system quickly
  - Can the users complete tasks using the system without making errors?
- Utility testing
  - Can the users do what they need with the system?
- User interface testing
  - Are the users happy with the interface?

# User Testing

- Alpha testing
  - Usually the job of UX Designers
  - Do the users actually want these features?
  - What have you missed?
  - Involve focus groups early on
- Beta testing
  - Far more users
  - Aware that some bugs may persist, but may be edge cases
  - Windows Release candidates, iOS betas etc.

## System Tests and Release Tests

- When features make up a product or usable system, you will of course want to test that system and in turn when this becomes a release (think about the end of a sprint when you are ready to release your product to your users) you will again want to test that the release functions on all platforms/ hardware etc.

# Testing as part of the Pipeline

- Remember when we said last week that we ran our tests before we deployed our software?
  - What we really mean are our **functional** tests (Unit, Feature, System and Release tests)
- Things like user testing are undertaken ad-hoc and usually arranged by the Product Manager or Scrum Master
- In bigger organisations performance and load testing may undertaken by you infrastructure team
- Security testing should always involve a third party. Either you don't have the expertise in your organisation or you will be biased and fail to test something important.

## Summary & takeaways

- Four types of testing. You should focus most on functional testing, and of those functional tests concentrate on unit tests.
- All companies with software engineering teams will use TDD
  - Remember **Arrange-Action-Assert** ...
  - ...and Red, Green, Refactor.
- Testing is a requirement in Agile, it isn't optional
- In most agile teams testing is undertaken by everyone, the 'software tester' is dying out rapidly.