TDD with JUnit

Test-Driven Development (TDD)

- **TDD Life Cycle**
- **TDD vs DLP (Debug Later Programming)**
- **Why TDD is matter**
- **Unit Testing with F.I.R.S.T**
- **Code and Test Coverage**
- **Structure of good unit testing (GUT)**

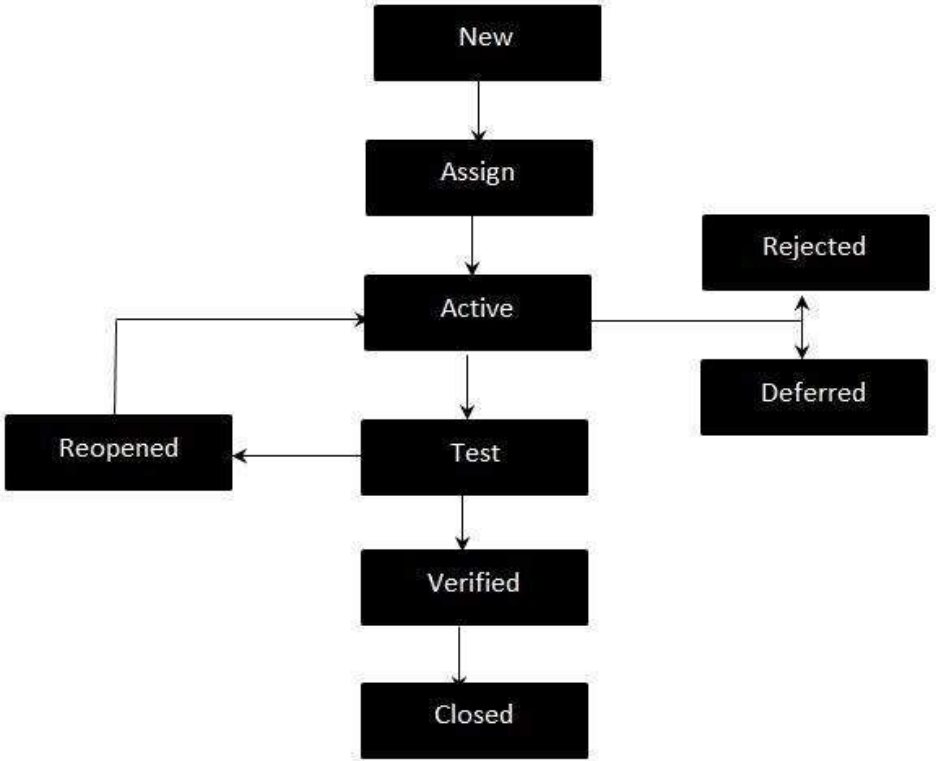
Unit Testing with JUnit

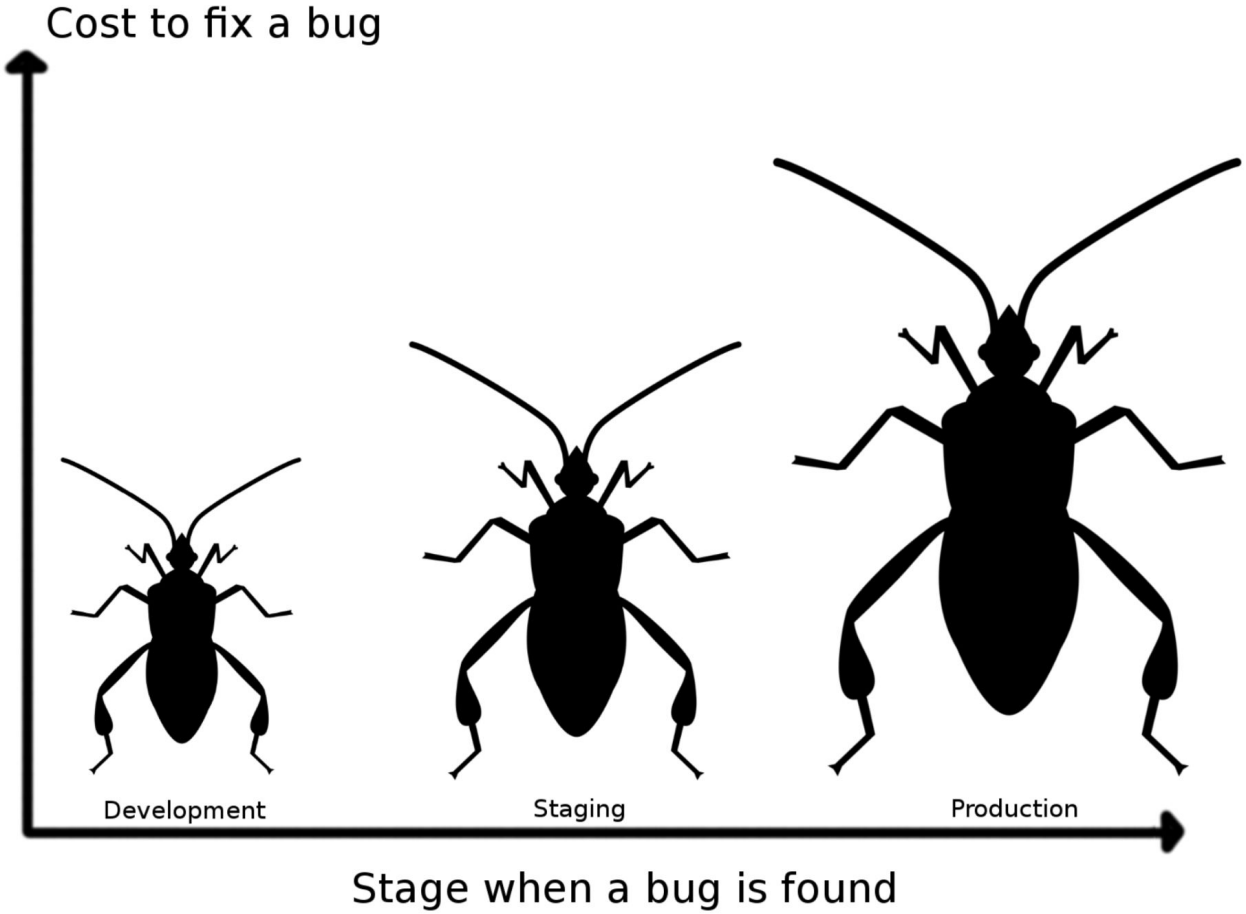
- JUnit lifeCycle
- Assertion
- Data-Driven Test with JUnit
- JUnit features
- Timeout
- Conditional
- Suite/Category
- Exception
- Parameterized Test

- Test Double
- Dummy
- Stub
- Spy
- Mock
- Fake

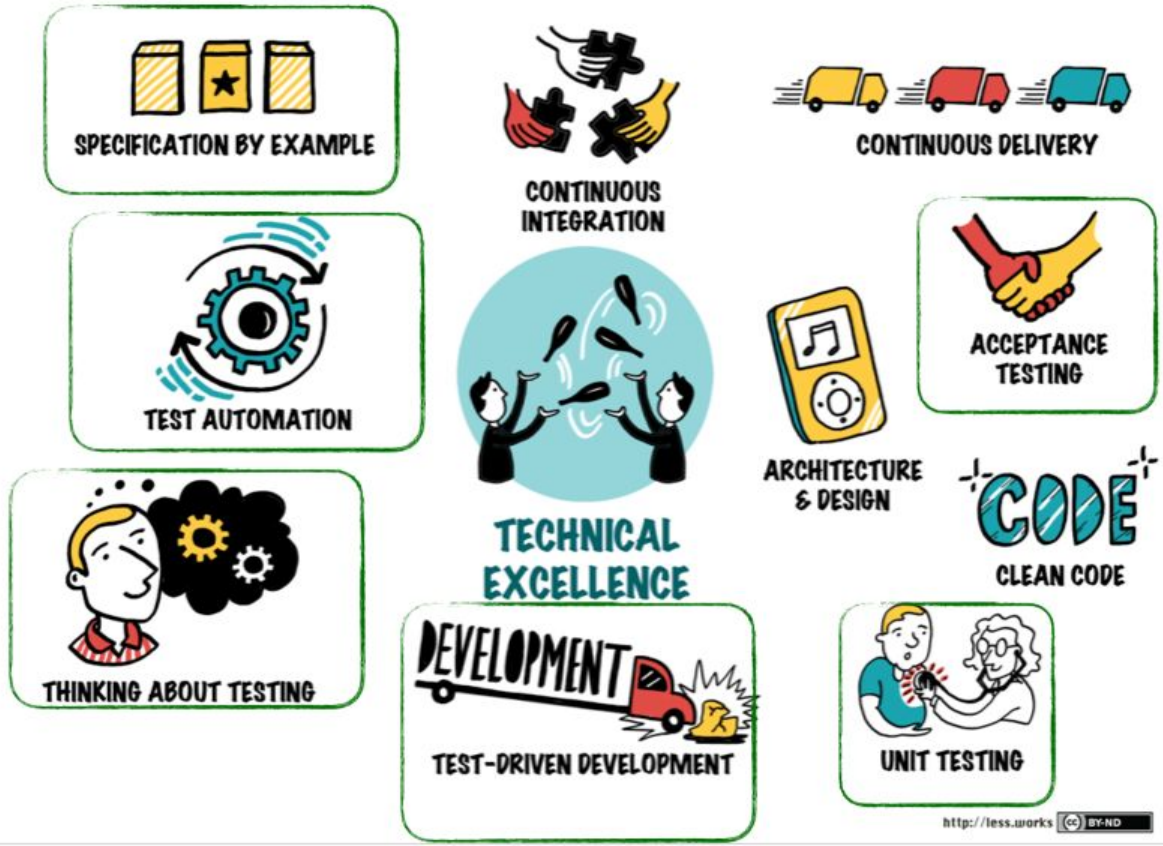
Defect

A **defect is a bug or an error** created in the application. A programmer, while designing and building the software, can make mistakes or errors. These errors mean that there are flaws in the software. These are called defects.




Cost to fix a bug
Development
Staging
Production
Stage when a bug is found

Technical Excellence

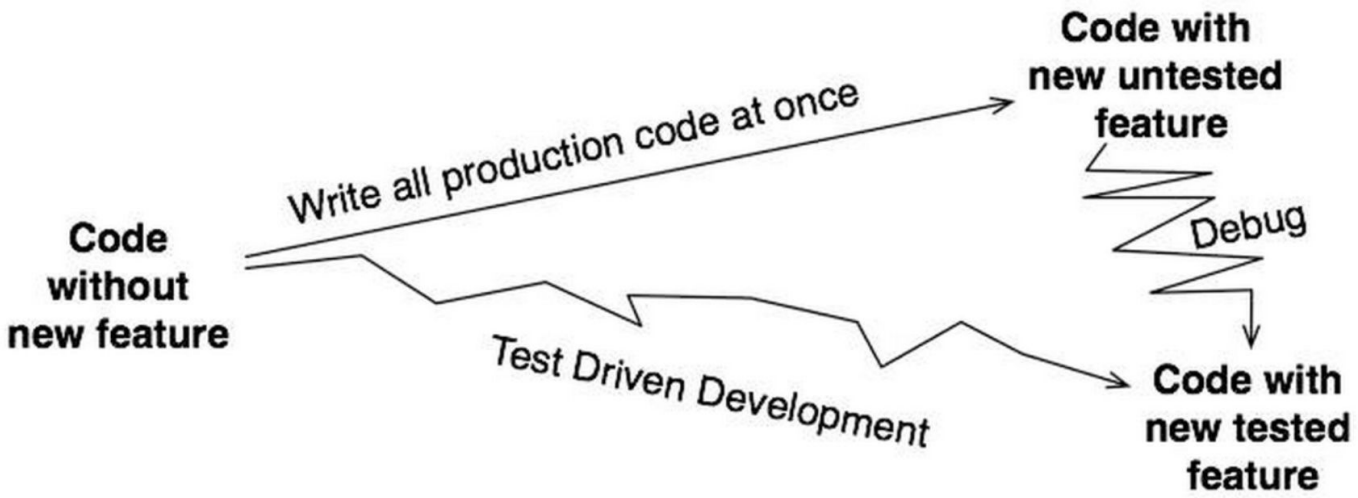


https://www.freecodecamp.org/news/test-driven-development-what-it-is-and-what-it-is-not-41fa6bca02a2/

TDD

Test-Driven-Development
Test-Driven Design

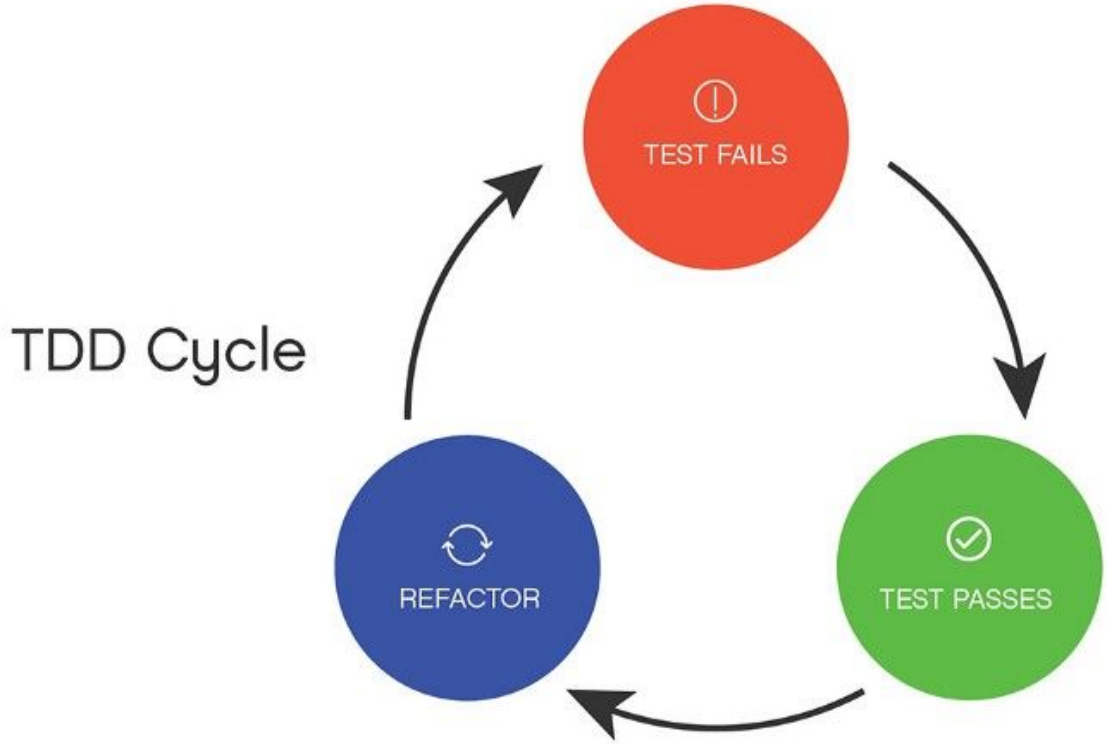
TDD vs DLP (Debug Later)



What Is Test-Driven Development

Test-driven development is a development style that drives the design by tests developed in short cycles of:

1. Write one test.
2. Implement just enough code to make it pass.
3. Refactor the code so it is clean.



Red, Green, Refactor

Red Green Refactor

A TDD cycle Should Be …

Short

The turnaround time for passing each test is short. It could take 5 mins per cycle.

Rhythmic

You'll feel the rhythm distinctly - "red, green, refactor... red, green refactor..."

Incremental

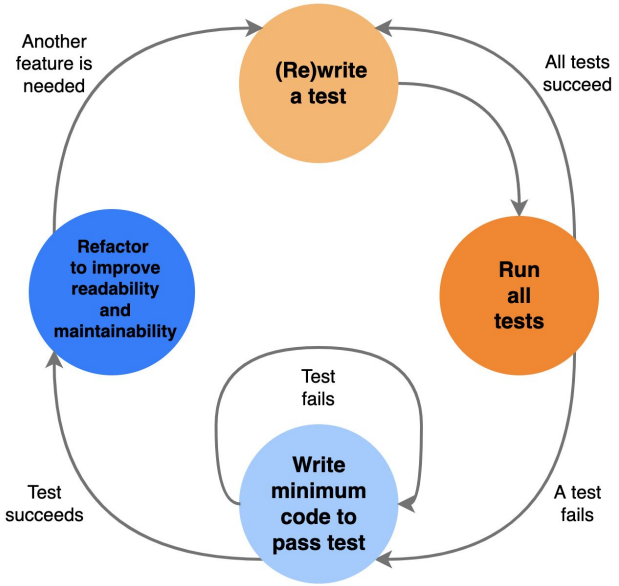
You'll know that as you write and pass more tests, working functionalities are being build up incrementally.

Design-focused

With good knowledge of software design principles, you'll discover TDD is not a testing technique but a method of designing software.

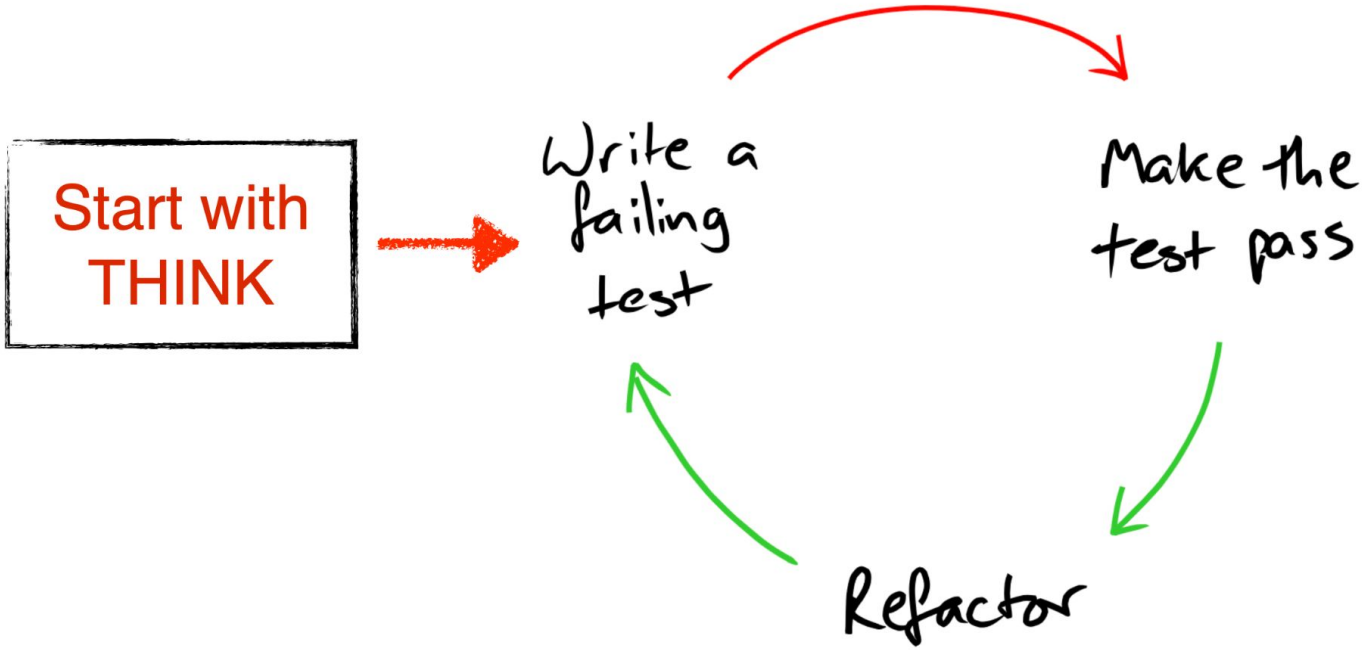
Disciplined

TDD is a different way of developing software. To break the old habit of "code and fix" and to adopt a new habit will require discipline and persistence.

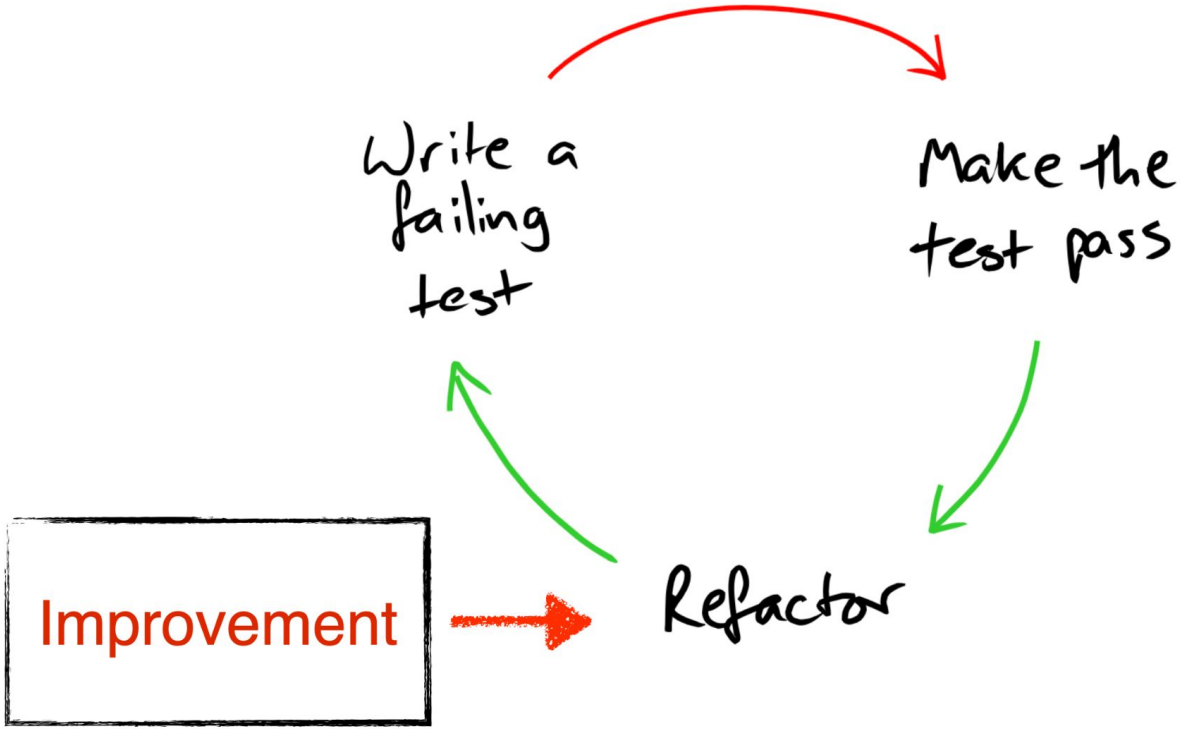


The cycle of test-driven development

Improve TDD Cycle



Improve TDD Cycle



Code Smell

Code Smells

– What? How can code "smell"??

– Well it doesn't have a nose... but it definitely can stink!

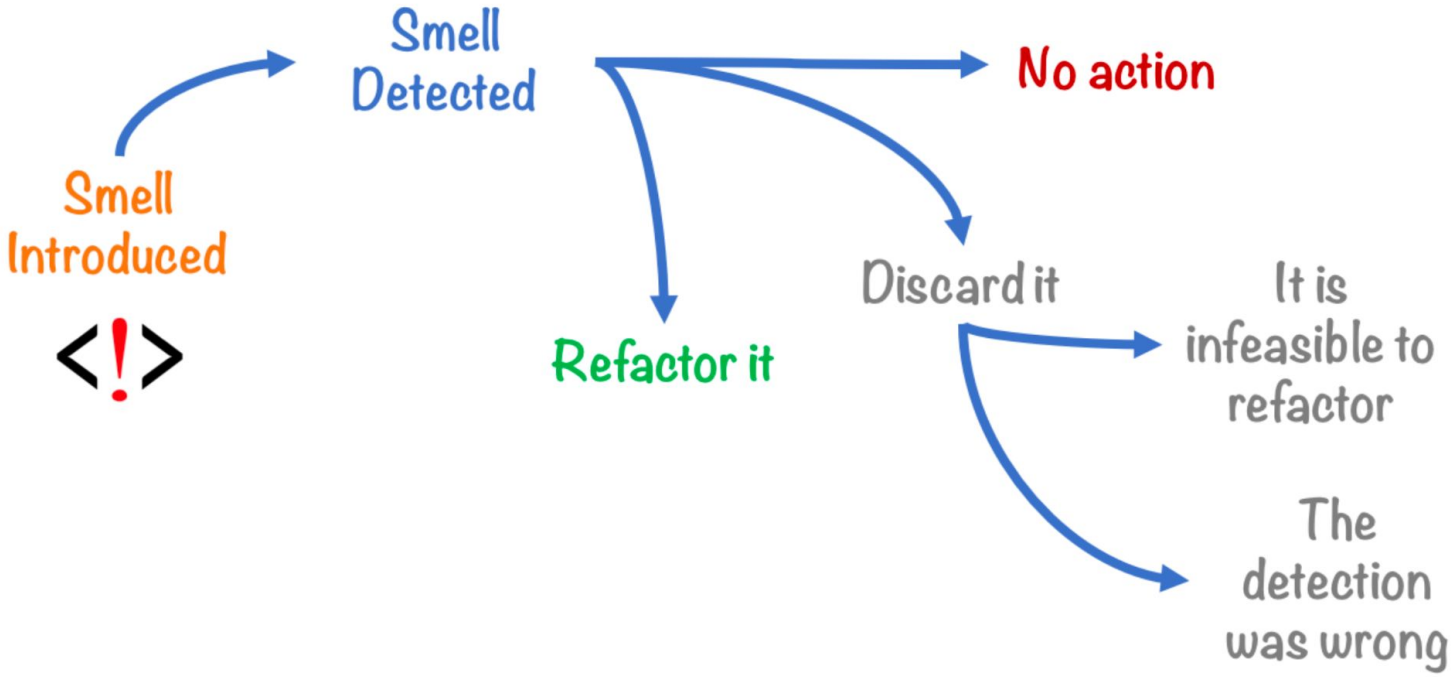
Bloaters

Bloaters are code, methods and classes that have increased to such gargantuan proportions that they are hard to work with. Usually these smells do not crop up right away, rather they accumulate over time as the program evolves (and especially when nobody makes an effort to eradicate them).

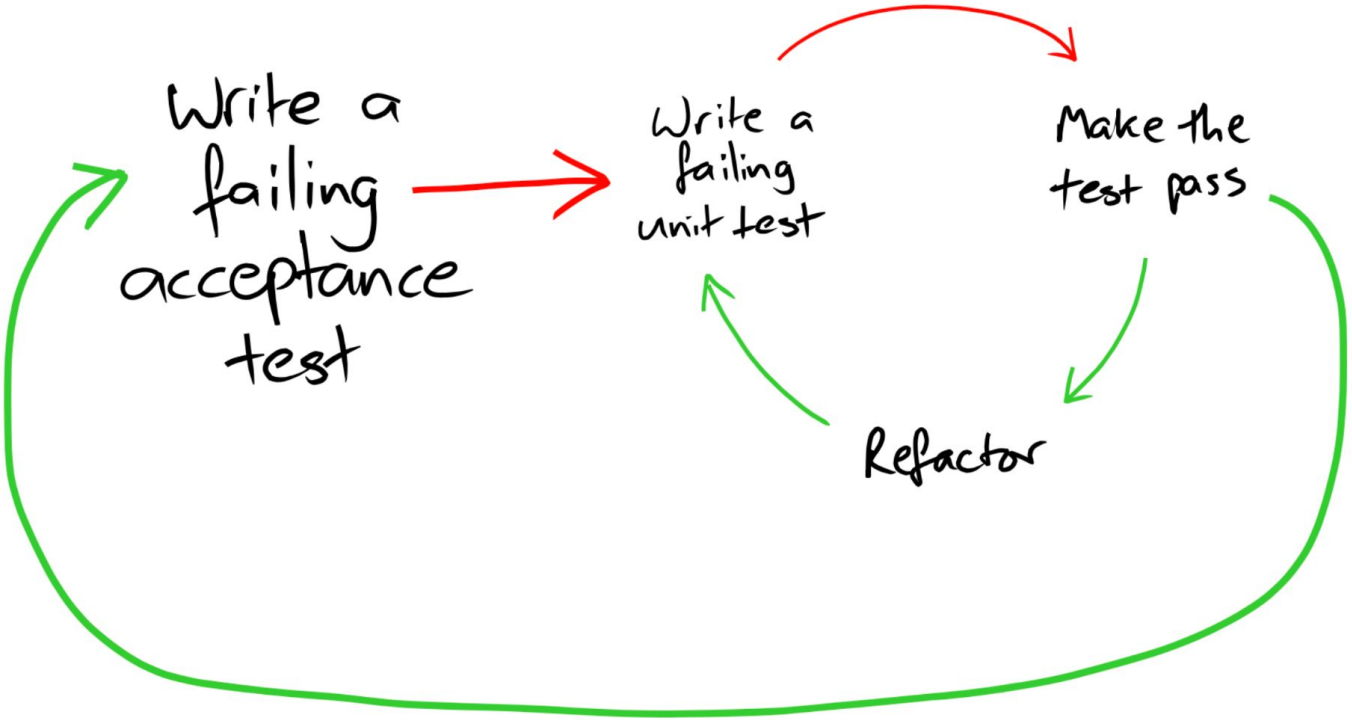
- Long Method
- Large Class
- Primitive Obsession
- Long Parameter List
- Data Clumps

https://sourcemaking.com/refactoring/smells

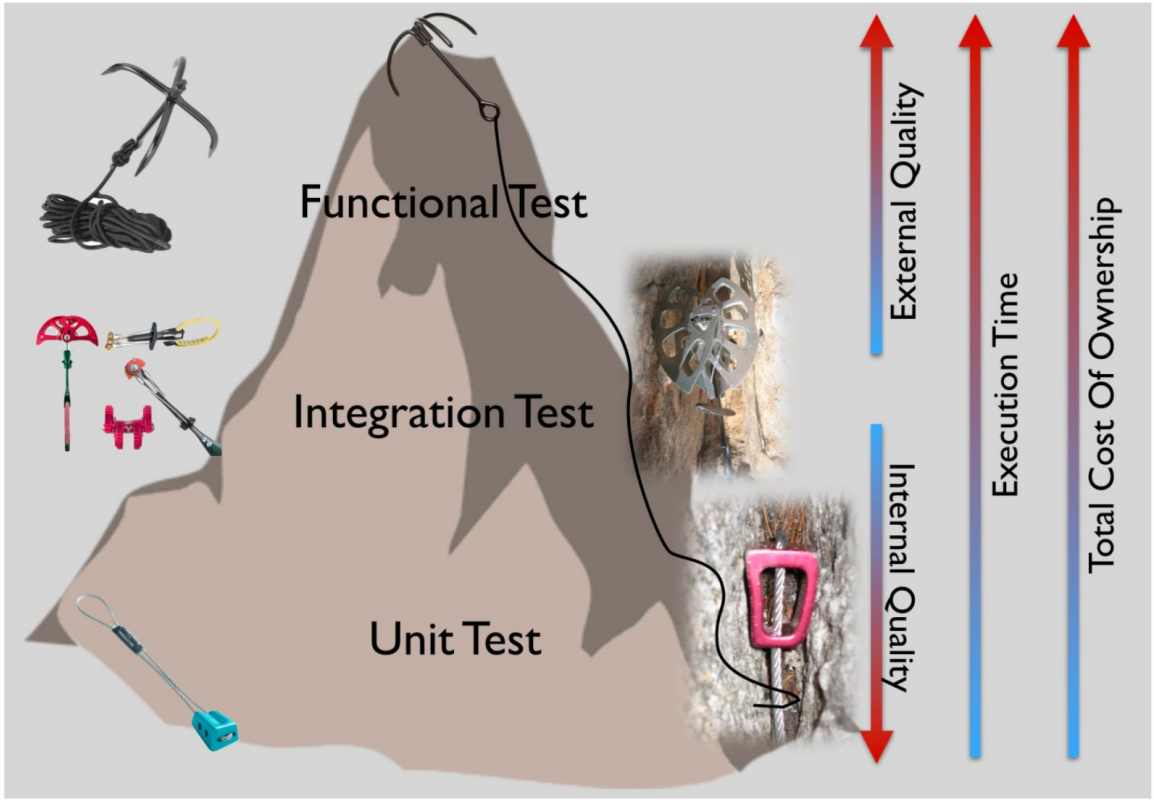
Code Smell


Smell Introduced
<!>
Smell Detected
No action
Refactor it
Discard it
It is infeasible to refactor
The detection was wrong

Acceptance tests



The Golden rule of TDD



https://less.works/jp/less/technical-excellence/unit-testing.html

The Golden rule of TDD

Discipline #1

You are not allowed to write production code until you have first written a failing unit test.

Discipline #2

You are not allowed to write more of a unit test than is sufficient to fail, and not compiling is failing.

Discipline #3

You are not allowed to write more production code than is sufficient to pass the currently failing test.

The Golden rule of TDD

"Never write a line of code without a failing test"

- Kent Beck -

Make the test pass !!

Fake or hard code
Triangulation
Professional code

What Is Unit Test?

Unit Tests are software programs written to exercise other software programs (called **Code Under Test**, or **Production Code**) with **specific** preconditions and verify the **expected behaviour**s of the CUT.

Unit tests are usually written in the same programming language as their code under test.

Each **unit test** should be small and test only limited piece of code functionality. Test cases are often grouped into **Test Groups** or **Test Suites**. There are many open source **unit test framework**s. The popular ones usually follow an **xUnit** pattern invented by Kent Beck, for example, **JUnit** for Java and CppUTest for C/C++.

Unit tests should also run very fast. Usually, we expect to **run hundreds of unit test cases within a few seconds**.

Good Unit Tests (F.I.R.S.T)

Fast

Independent/Isolate

Repeat

Self-validate

Thorough/Timely

Good Unit Test Patterns

A good pattern to follow in a unit test is “**AAA**”: **Arrange**, **Act** and **Assert**.

The AAA protocol is a recommended approach for structuring unit tests. As a unit testing best practice, it improves your test’s readability by giving it a logical flow. AAA is sometimes referred to as the “Given/When/Then” protocol.

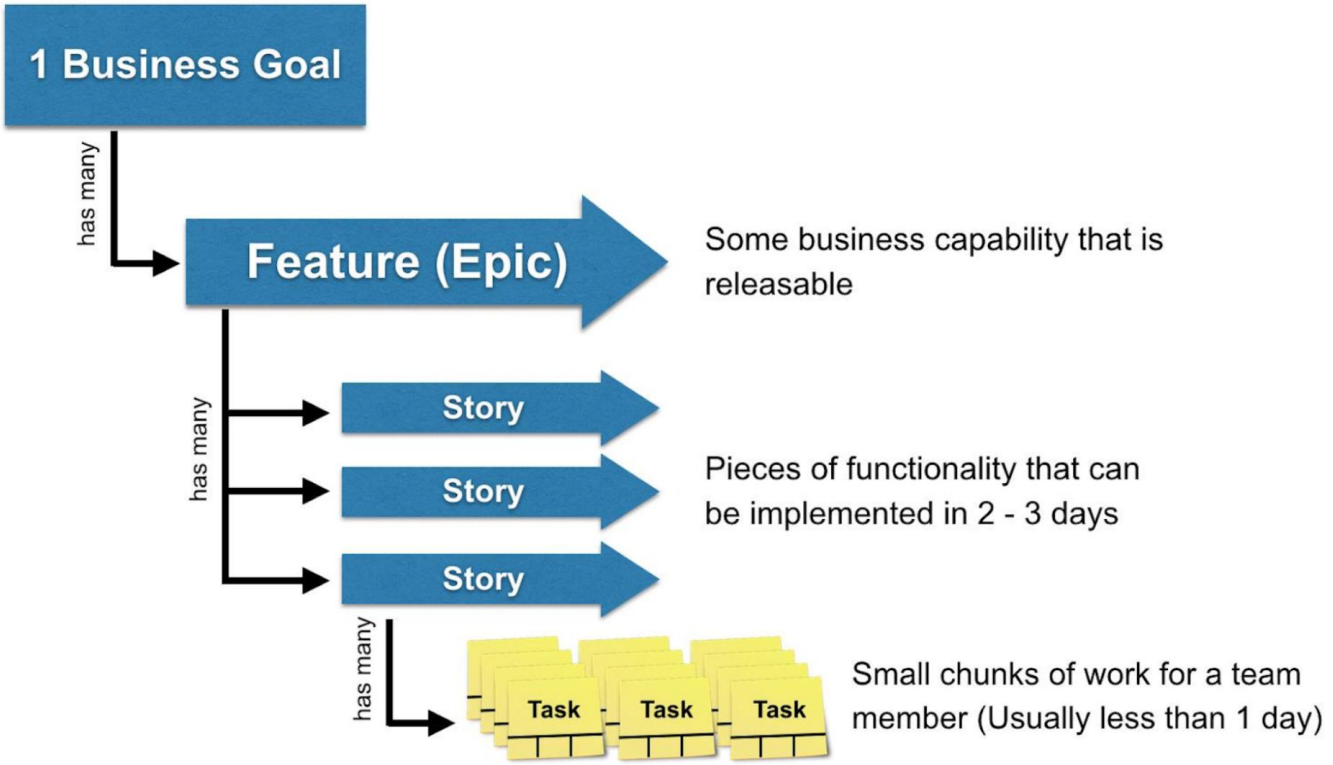
You can use the AAA protocol to structure your unit tests with the following steps:

- **Arrange**: Arrange the setup and initialization for the test
- **Act**: Act on the unit for the given test
- **Assert**: Assert or verify the outcome

Arrange, Act, and Assert (AAA)

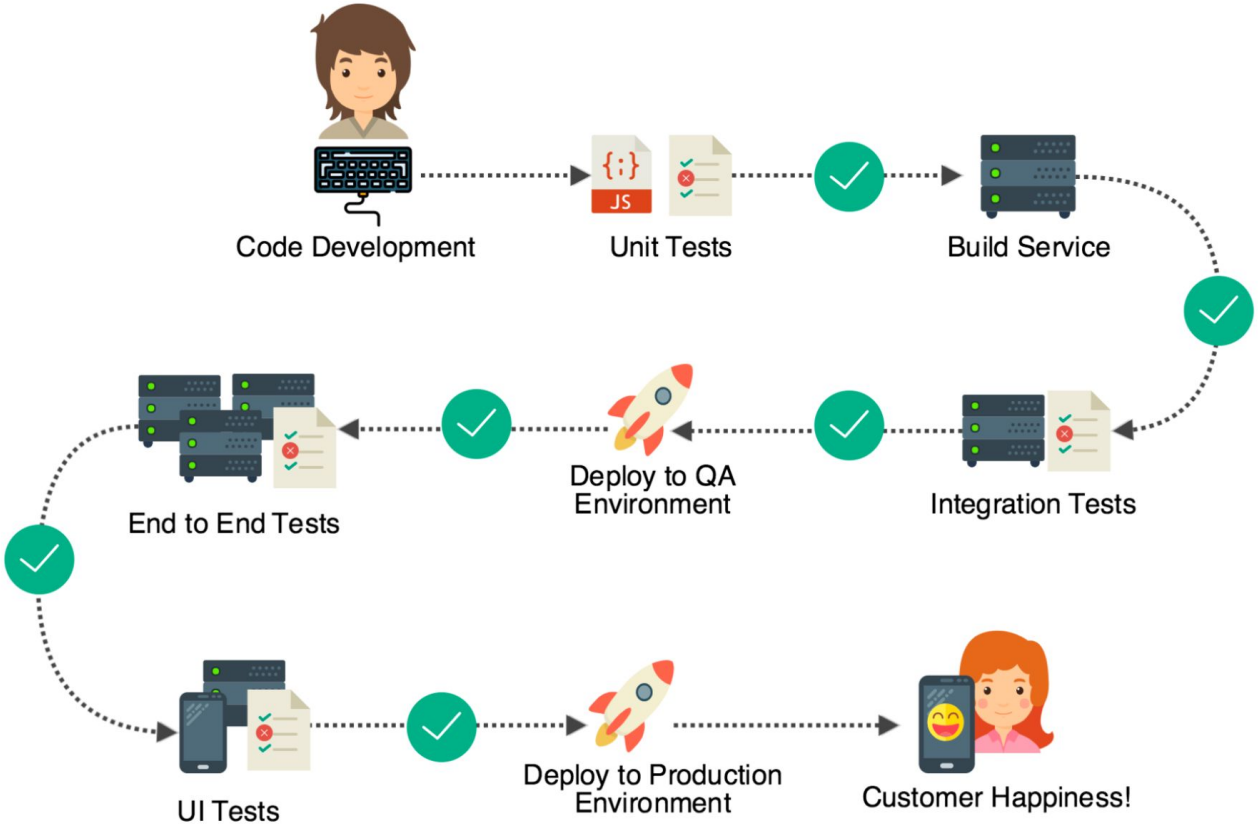
```
def test_abs_for_a_negative_number():

  # Arrange
  negative = -2

  # Act
  answer = abs(negative)

  # Assert
  assert answer == 2
```

Start with Business Goal to Tasks



Source: The Whole Team Approach to Agile Testing by Janet Gregory and Lisa Crispin

Delivery process



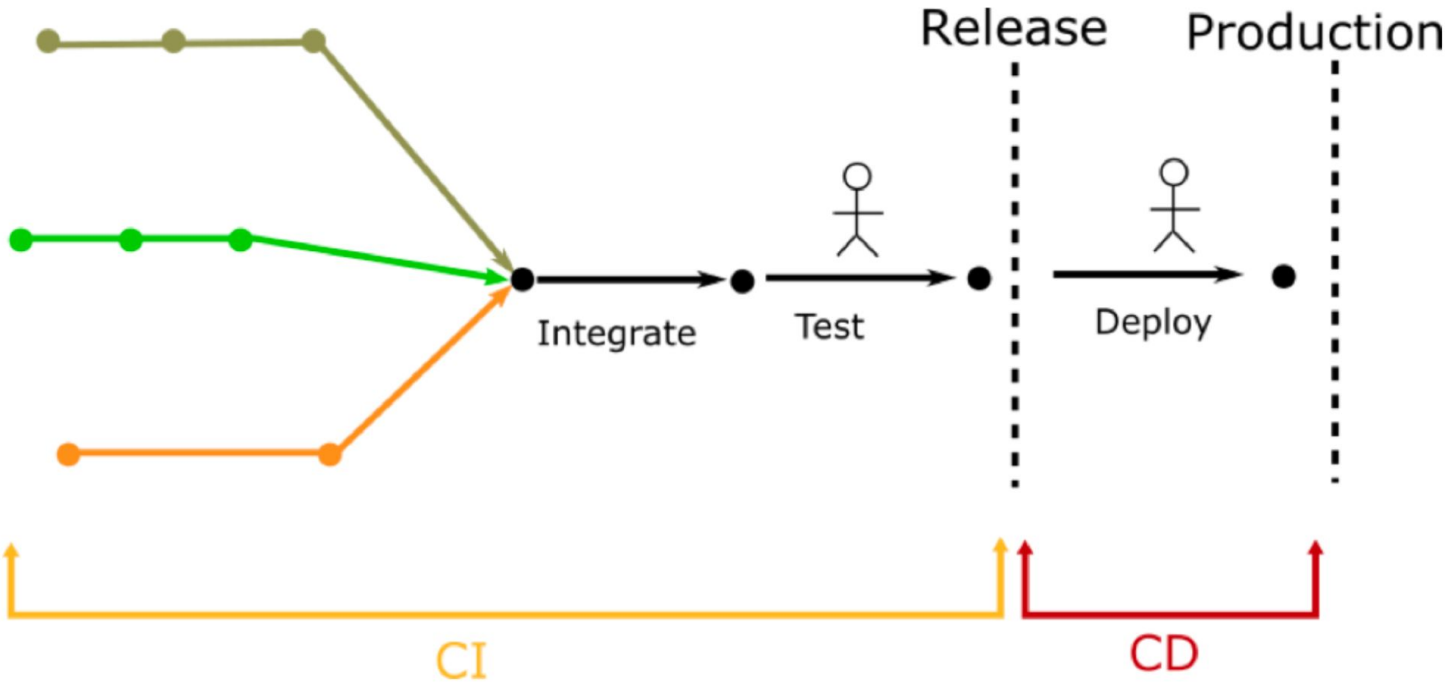
TDD in Iteration development

Iteration cycle 2-4 weeks

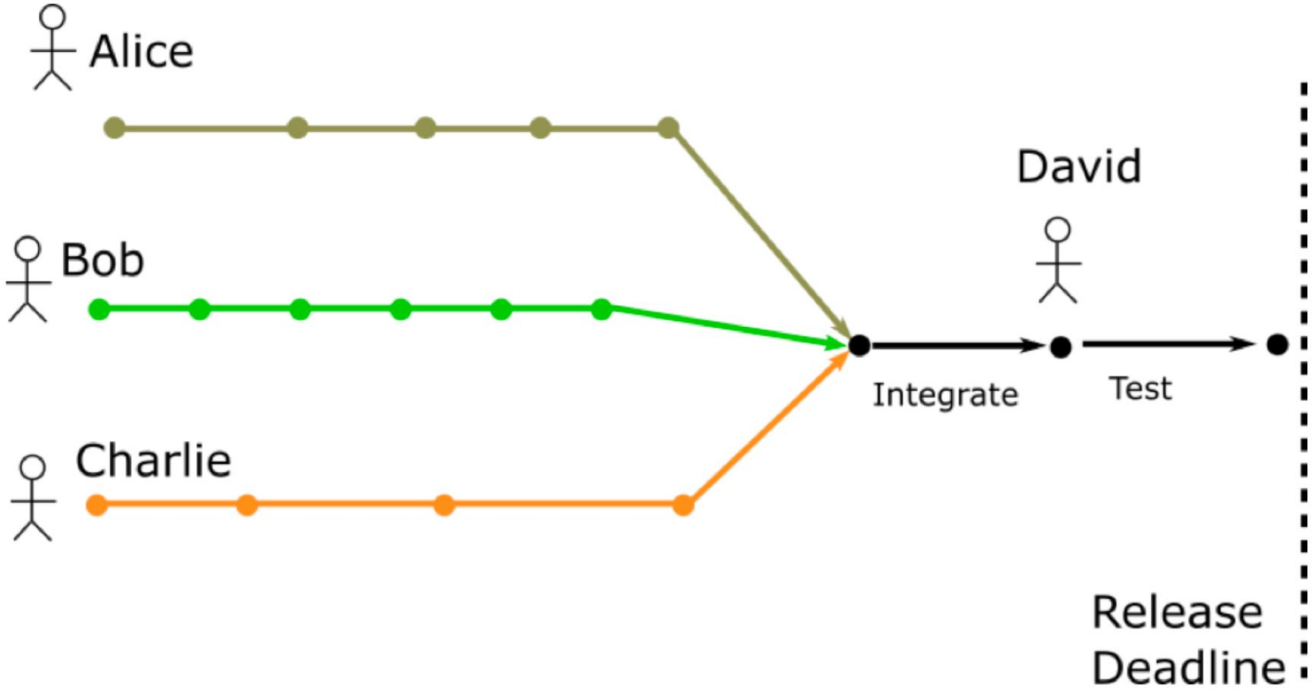
Continuous integration cycle
(multiple times a day)

TDD cycle in a few minutes (3-10 minutes)

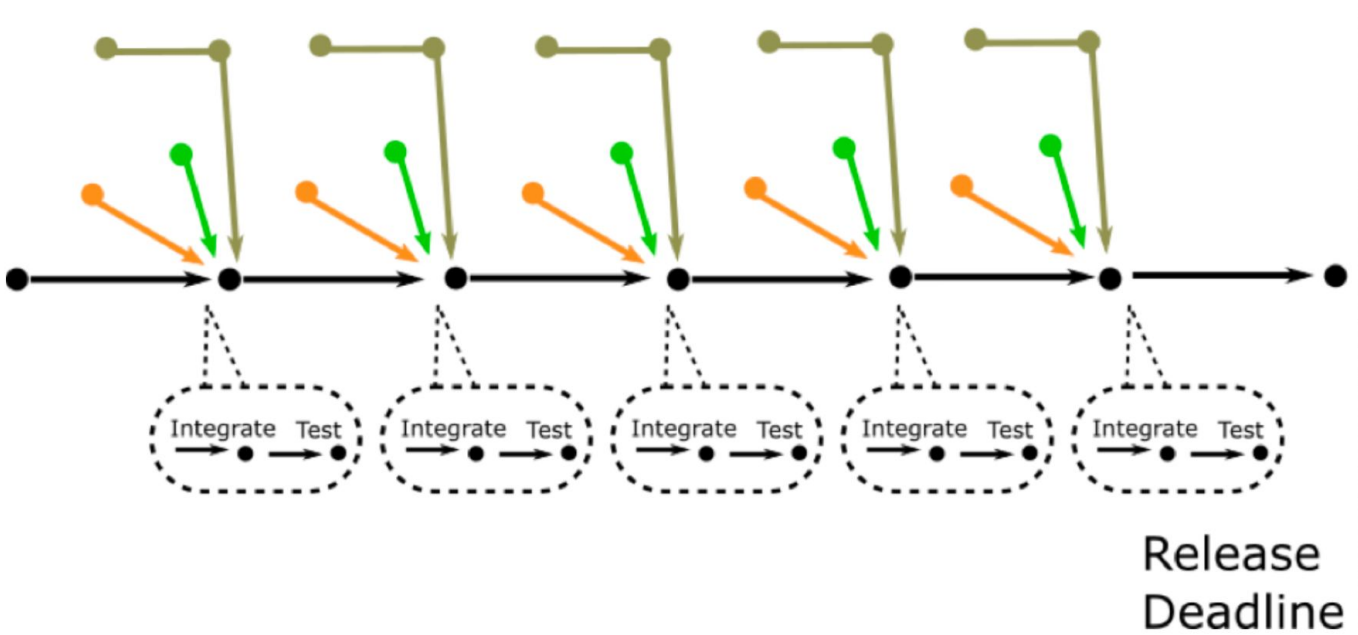
TDD in Iteration development



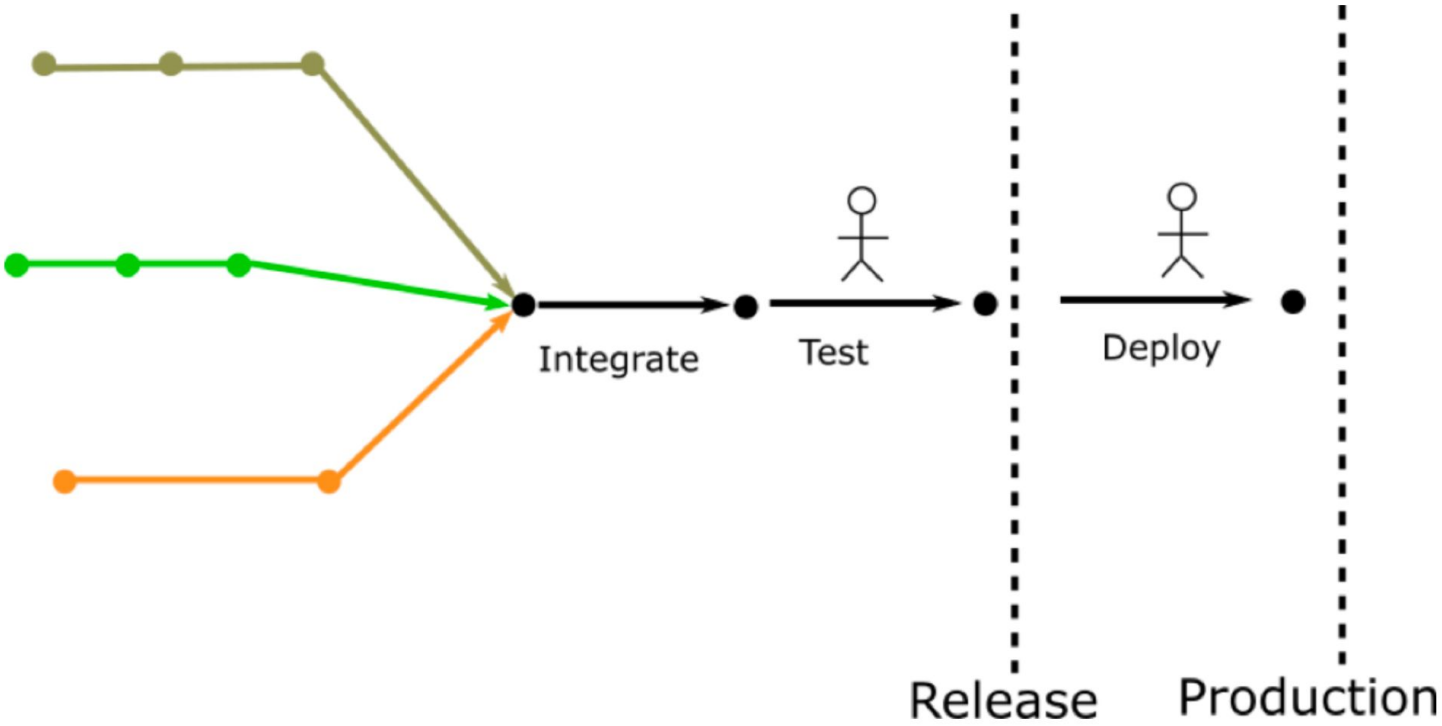
TDD in Iteration development



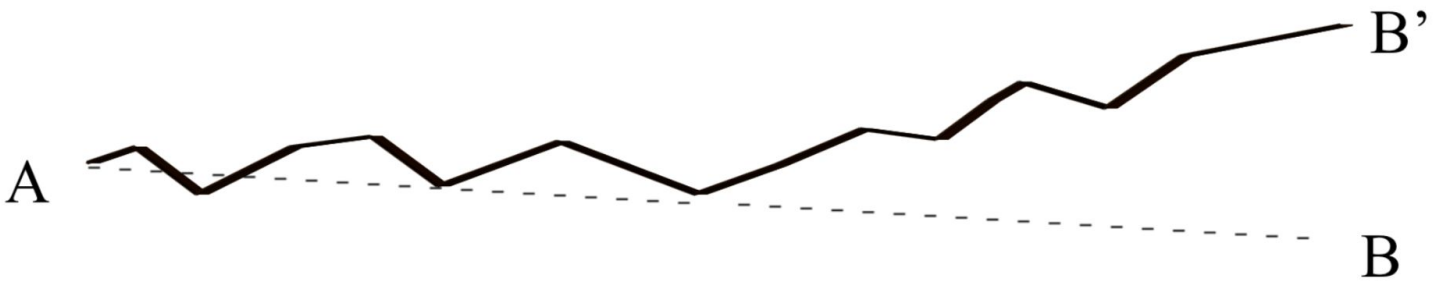
TDD in Iteration development



TDD in Iteration development



Small step



Exercise

- Fast
- Isolated/Independent
- Repeatable
- Self-validating
- Timely

1. Test Speed: According to the F.I.R.S.T principles, a well-written unit test should run quickly and not be bogged down by external dependencies like databases or network calls.
   - True / False

2. Test Dependency: A good unit test should depend on other tests to be executed first, ensuring the proper sequence for validation.
   - True / False

Exercise - Key answer

- Fast
- Isolated/Independent
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1. Test Speed: According to the F.I.R.S.T principles, a well-written unit test should run quickly and not be bogged down by external dependencies like databases or network calls.
   - **True** / False

2. Test Dependency: A good unit test should depend on other tests to be executed first, ensuring the proper sequence for validation.
   - True / **False**

Code coverage

Code coverage

A tool to measure how much of your code is covered by tests that break down into classes, methods and lines.

Code coverage

```
1.  public class MyRange {
2.      public boolean startWithInclude(String input) {
3.          return input.startsWith("[");
4.      }
5.
6.      public boolean endWithInclude(String input) {
7.          if(input == null) {
8.              return false;
9.          }
10.         return input.endsWith("]");
11.     }
12.
13.     public boolean startWithInclude2(String input) {
14.         return input.startsWith("[");
15.     }
16. }
```

Code coverage

Class coverage
Method coverage
Line coverage
Branch coverage

Code coverage

But 100% of code coverage **does not mean** that your code is 100% correct

"Code coverage can show the high risk areas in a program, but never the risk-free."

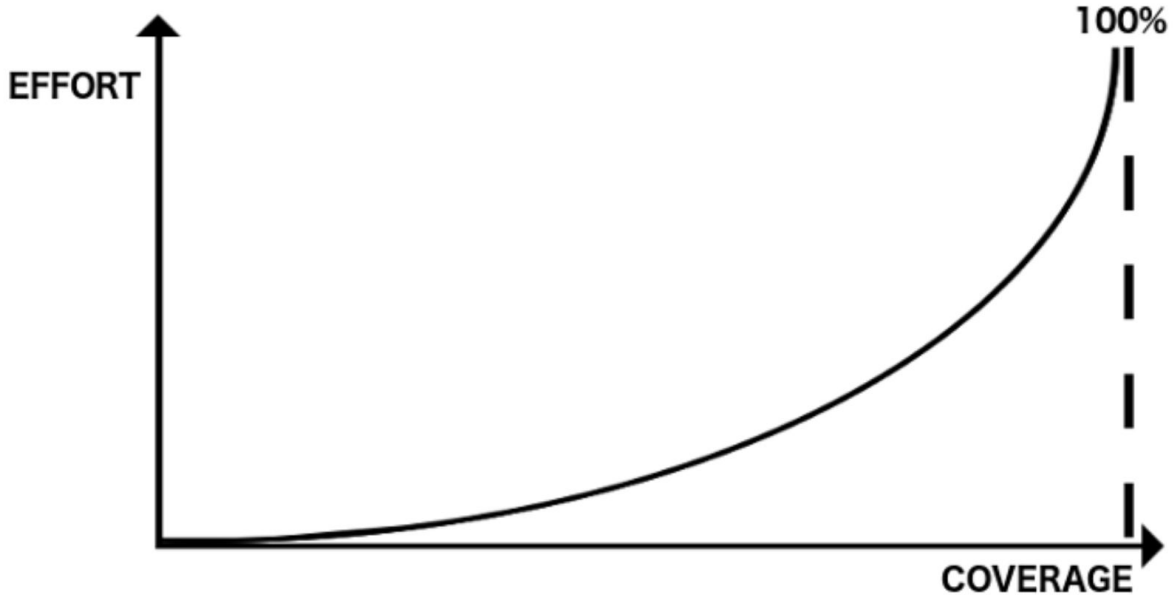
Paul Reilly, 2018, Kotlin TDD with Code Coverage

Code coverage

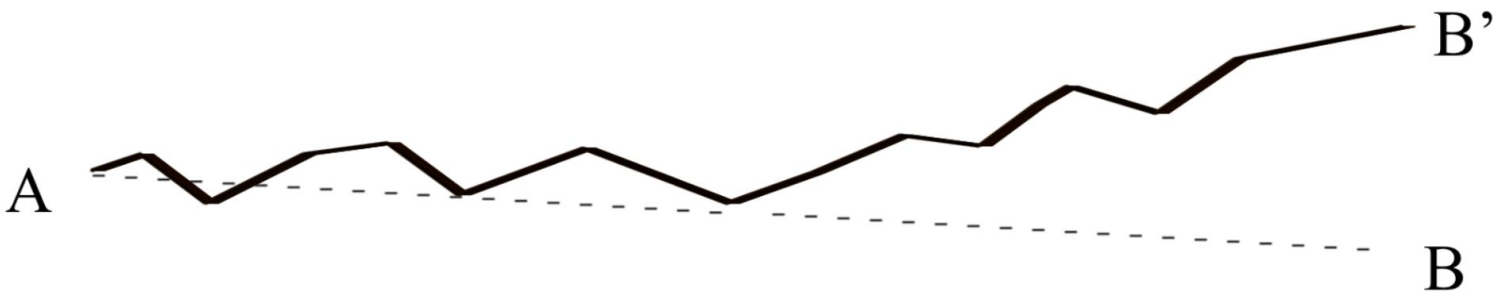
Powerful tool to improve the quality of your code

Code coverage != quality of tests

Code coverage 100% ?



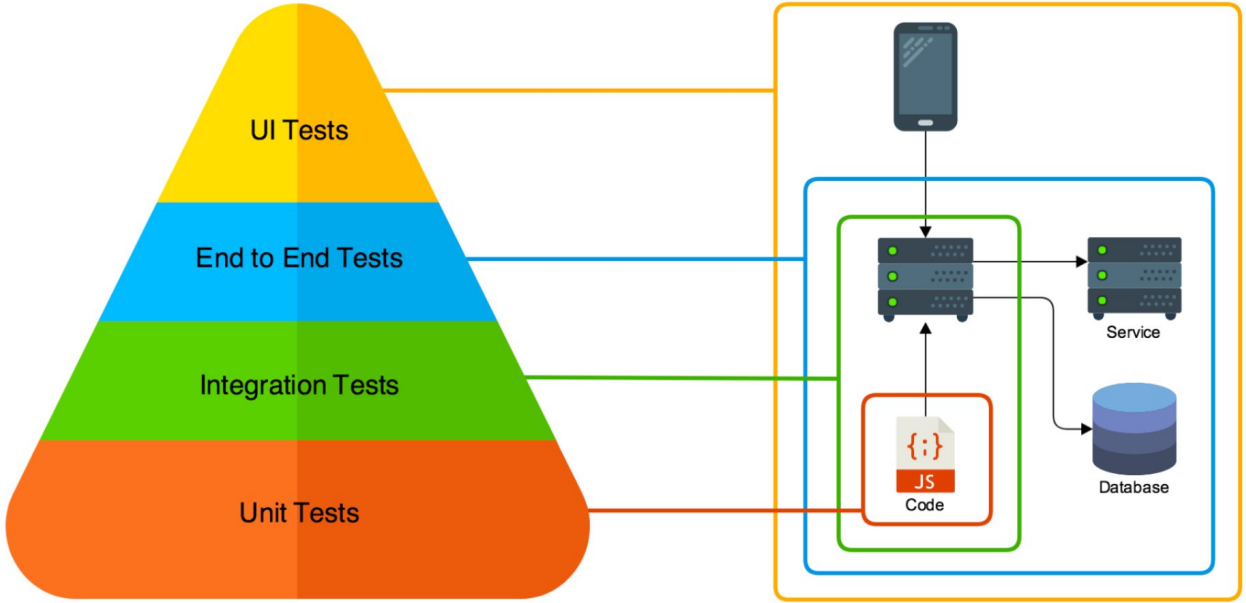
Small steps



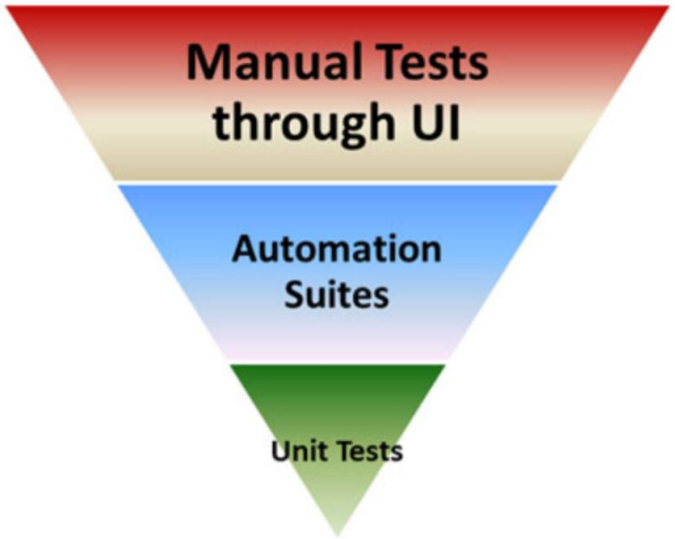
Mini Break! 5 > 10:00

Types of Test

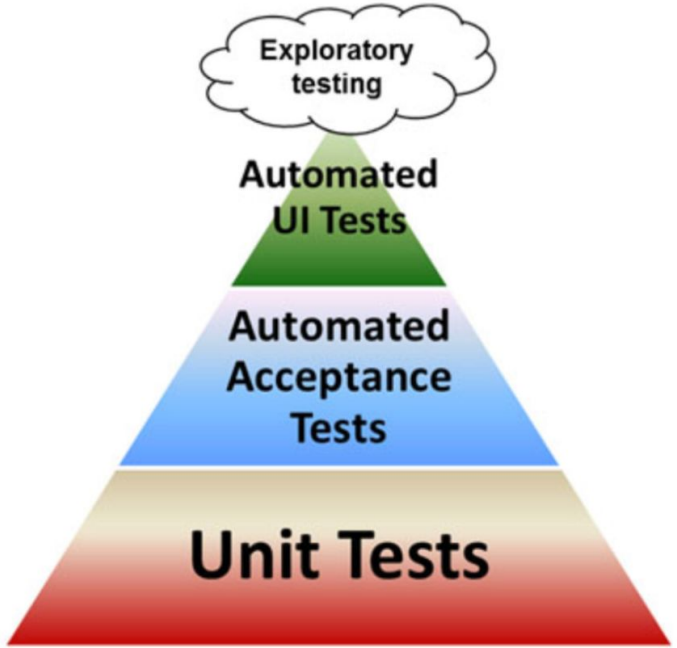
Scope of each test involved



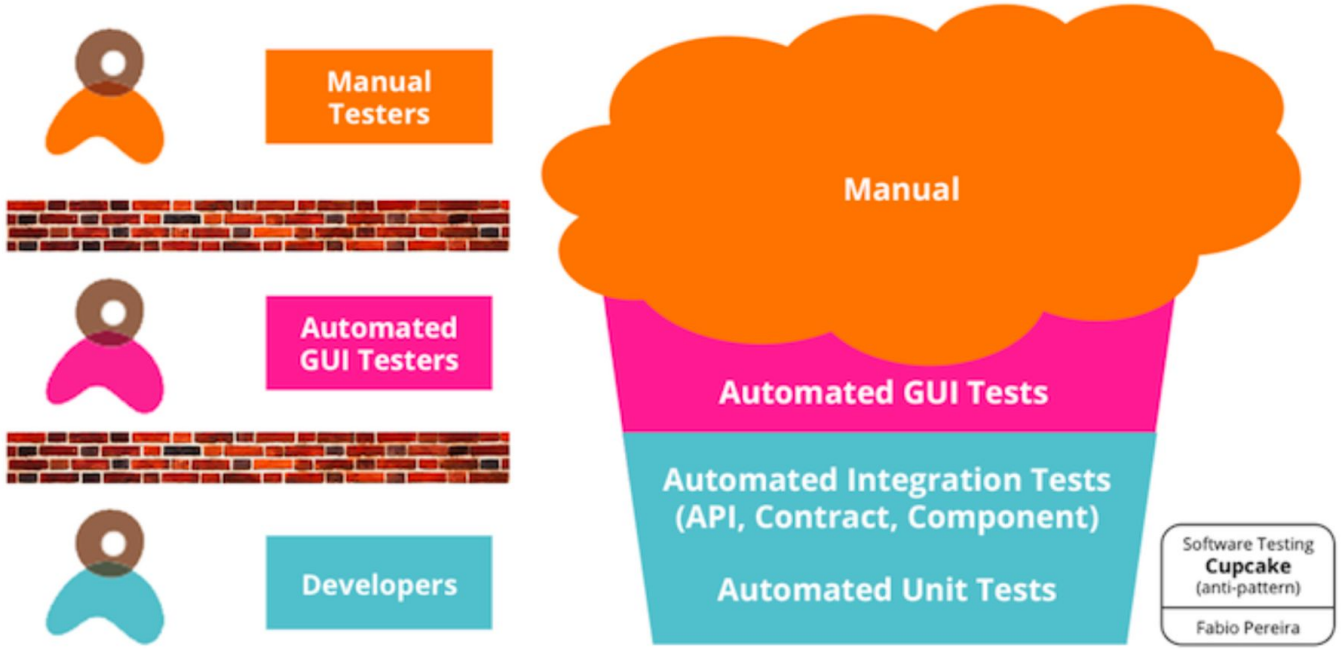

D D T D
T D T T
D T D D
Testing is an ACTIVITY!
I'm part of the board!
T
Todo
BUSY
SHOW ME
DONE



Traditional
(find bugs)



Agile
(prevent bugs)



https://www.thoughtworks.com/insights/blog/introducing-software-testing-cupcake-anti-pattern

Exercise: Preparing your Local environment for test

1. Red-Green-Refactor Cycle: In TDD, the cycle usually begins with writing a failing test (Red), followed by writing the minimal amount of code to make the test pass (Green), and finally refactoring the code to meet the proper standards (Refactor).
   - True / False

2. Initial Test Writing: In TDD, it's recommended to write all the tests for the entire application upfront before writing any functional code.
   - True / False

4.Test Granularity: TDD emphasizes writing tests at the system or integration level rather than the unit level.
   - True / False

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4.Test Granularity: TDD emphasizes writing tests at the system or integration level rather than the unit level.
   - True / **False**

5. Preparing your local dependency for JUnit+Jacoco Coverage

Break

10:45

TDD with JUnit

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- Why TDD is matter
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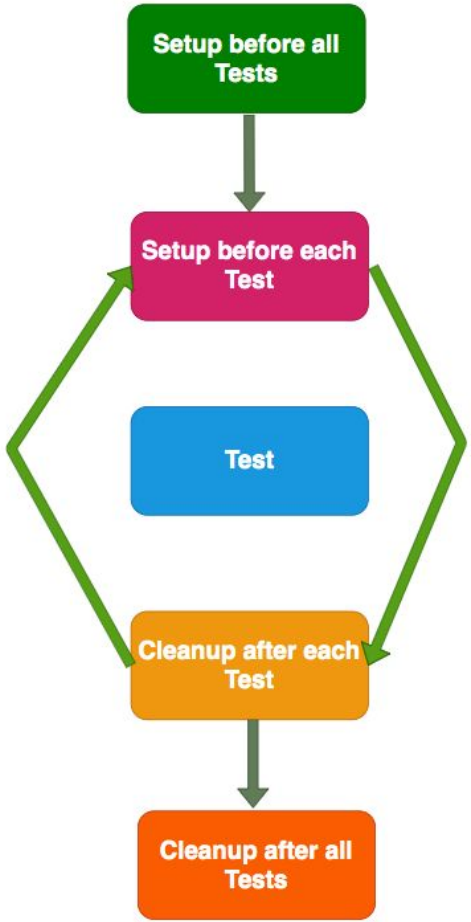
- Structure of good unit testing (GUT)

Unit Testing with JUnit

- **JUnit lifeCycle**
- **Assertion**
- **Data-Driven Test with JUnit**
- **JUnit features**
- **Timeout**
- **Conditional**
- **Suite/Category**
- **Exception**
- **Parameterized Test**



@BeforeAll

@BeforeEach

@Test

@AfterEach

@AfterAll

JUnit Life Cycle

```
Class DbTest {

@BeforeAll
Public setupDbConnect(){
        //make db connect
}

@BeforEach
Public setupData(){
        //Initial data for tests
}

@Test
Public testInsert(){
        expect(result,someQueryExecution())
}

@AfterAll
Public disconectDb(){
        //make disconnect db
        }
  }
}
```

Assertions and assumptions

Assert statement	Example
assertEquals	assertEquals(4, calculator.multiply(2, 2),"optional failure message");
assertTrue	assertTrue(**'a' < 'b',** () → "optional failure message");
assertFalse	assertFalse(**'a' > 'b',** () → "optional failure message");
assertNotNull	assertNotNull(**yourObject**, "optional failure message");
assertNull	assertNull(**yourObject**, "optional failure message");

AssertTimeout

if you want to ensure that a test fails, if it isn't done in a certain amount of time you can use the `assertTimeout()` method. This assert fails the method if the timeout is exceeded.

COPY JAVA

```java
import static org.junit.jupiter.api.Assertions.assertTimeout;
import static java.time.Duration.ofSeconds;
import static java.time.Duration.ofMinutes;

@Test
void timeoutNotExceeded() {
    assertTimeout(ofMinutes(1), () -> service.doBackup());
}

// if you have to check a return value
@Test
void timeoutNotExceededWithResult() {
    String actualResult = assertTimeout(ofSeconds(1), () -> {
        return restService.request(request);
    });
    assertEquals(200, request.getStatus());
}
```

```
=> org.opentest4j.AssertionFailedError: execution exceeded timeout of
1000 ms by 212 ms
```

Testing for exceptions

Testing that certain exceptions are thrown are be done with the `org.junit.jupiter.api.Assertions.expectThrows()` assert statement. You define the expected Exception class and provide code that should throw the exception.

COPY JAVA

```java
import static org.junit.jupiter.api.Assertions.assertThrows;

@Test
void exceptionTesting() {
    // set up user
    Throwable exception = assertThrows(IllegalArgumentException.class,
() -> user.setAge("23"));
    assertEquals("Age must be an Integer.", exception.getMessage());
}
```

JUnit Features

Conditions

Operating System Conditions

```
@Test
@EnabledOnOs({OS.WINDOWS, OS.MAC})
public void shouldRunBothWindowsAndMac() {
    //...
}
```

```
@Test
@DisabledOnOs(OS.LINUX)
public void shouldNotRunAtLinux() {
    //...
}
```

JUnit Features

Conditions

Java Runtime Environment Conditions

```
@Test
@EnabledOnJre({JRE.JAVA_10, JRE.JAVA_11})
public void shouldOnlyRunOnJava10And11() {
    //...
}
```

```
@Test
@EnabledForJreRange(min = JRE.JAVA_8, max = JRE.JAVA_13)
public void shouldOnlyRunOnJava8UntilJava13() {
    // this test will only run on Java 8, 9, 10, 11, 12, and 13.
}
```

```
@Test
@DisabledForJreRange(min = JRE.JAVA_14, max = JRE.JAVA_15)
public void shouldNotBeRunOnJava14AndJava15() {
    // this won't run on Java 14 and 15.
}
```

JUnit Features

Conditions

System Property Conditions

```
@Test
@EnabledIfSystemProperty(named = "java.vm.vendor", matches = "Oracle.*")
public void onlyIfVendorNameStartsWithOracle() {
    //...
}
```

```
@Test
@DisabledIfSystemProperty(named = "file.separator", matches = "[/]")
public void disabledIfFileSeperatorIsSlash() {
    //...
}
```

JUnit Features

Conditions

Environment Variable Conditions

```
@Test
@EnabledIfEnvironmentVariable(named = "GDMSESSION", matches = "ubuntu")
public void onlyRunOnUbuntuServer() {
    //...
}

@Test
@DisabledIfEnvironmentVariable(named = "LC_TIME", matches = ".*UTF-8.")
public void shouldNotRunWhenTimeIsNotUTF8() {
    //...
}
```

What is not Unit ?

External service

File system

Database

WebService API calls

UI specification

Compare screen image

Compare HTML

Test Naming

Test Name

```
public class FizzBuzzTest {

    @Test
    public void sayFizzWhenNumberIsDevidedByThree() {
        FizzBuzz fizzBuzz = new FizzBuzz();
        String actualResult = fizzBuzz.say(3);
        assertEquals("Fizz", actualResult);
    }

}
```

Annotation

Test Case Name

“What ’s in a name ?”

That which we call a rose

by any other name would smell

as sweet

Romeo and Juliet

Guide to Test Writing

Don’t say “**test**”, say “**should**”

Don’t use the word “test”

Use the word “should”

```
tranferShouldDeductSumFromSourceAccountBalance()

transferShouldAddSumLessFeesToDestinationAccountBalance()

depositShouldAddAmountToAccountBalance()
```

Guide to Test Writing

Don’t test your class, test **behaviour**

Guide to Test Writing

Test class names are important too

Structure your test well

Tests are **deliverable** too

FizzBuzz

Workshop

FizzBuzz

Input	Expected Result
1	1
2	2
3	Fizz
4	4
5	Buzz
6	Fizz
7	7
8	8
9	Fizz
10	Buzz
15	FizzBuzz

1-20 =>
1,2,[Fizz] // divide by 3 ==0 -> Fizz
1,2,[Fizz],4,[Buzz] // divide by 5 == 0 => buzz
…[Fizz],13,14, [FizzBuzz],16

Good Unit Test

Arrange

Act

Assert

```
@Test
public void sayFizzWhenNumberIsDevidedByThree() {
    FizzBuzz fizzBuzz = new FizzBuzz();

    String actualResult = fizzBuzz.say(3);

    assertEquals("Fizz", actualResult);
}
```

Setup Pattern

```
@Test
public void sayFizzWhenNumberIsDevidedByThree() {
    FizzBuzz fizzBuzz = new FizzBuzz();

    String actualResult = fizzBuzz.say(3);

    assertEquals("Fizz", actualResult);
}

@Test
public void sayBuzzWhenNumberIsDevidedByFive() {
    FizzBuzz fizzBuzz = new FizzBuzz();

    String actualResult = fizzBuzz.say(5);

    assertEquals("Buzz", actualResult);
}
```

Setup Pattern

Inline Setup

```
@Test
public void sayFizzWhenNumberIsDevidedByThree() {
    FizzBuzz fizzBuzz = new FizzBuzz();

    String actualResult = fizzBuzz.say(3);

    assertEquals("Fizz", actualResult);
}

@Test
public void sayBuzzWhenNumberIsDevidedByFive() {
    FizzBuzz fizzBuzz = new FizzBuzz();

    String actualResult = fizzBuzz.say(5);

    assertEquals("Buzz", actualResult);
}
```

Setup Pattern

Delegate Setup

```
@Test
public void sayFizzWhenNumberIsDevidedByThree() {
    FizzBuzz fizzBuzz = setup();
    String actualResult = fizzBuzz.say(3);
    assertEquals("Fizz", actualResult);
}

@Test
public void sayBuzzWhenNumberIsDevidedByFive() {
    FizzBuzz fizzBuzz = setup();
    String actualResult = fizzBuzz.say(5);
    assertEquals("Buzz", actualResult);
}

private FizzBuzz setup() {
    FizzBuzz fizzBuzz = new FizzBuzz();
    return fizzBuzz;
}
```

Setup Pattern

```
@Before
public void initial() {
    fizzBuzz = new FizzBuzz();
}
```

Implicit Setup

```
@Test
public void sayFizzWhenNumberIsDevidedByThree() {
    String actualResult = fizzBuzz.say(3);
    assertEquals("Fizz", actualResult);
}

@Test
public void sayBuzzWhenNumberIsDevidedByFive() {
    String actualResult = fizzBuzz.say(5);
    assertEquals("Buzz", actualResult);
}
```

Implicit Teardown

```
@After
public void clearResources(){
    fizzBuzz = null;
}
```

Ignore Testcase

```
@Ignore("Pending implemetation")
@Test
public void sayFizzWhenNumberIsDevidedByThree() {
    FizzBuzz fizzBuzz = new FizzBuzz();
    String actualResult = fizzBuzz.say(3);
    assertEquals("Fizz", actualResult);
}
```

Handle Exception

Traditional approach

```
@Test
public void invalidWhenNumberLessThanOne() {
    try {
        fizzBuzz.say(0);
        fail();
    } catch (IllegalStateException expected) {
    }
}
```

Expected Annotation

```
@Test(expected=IllegalStateException.class)
public void invalidWhenNumberLessThanOne() {
        fizzBuzz.say(0);
}
```

ExpectedException Rule

```
@Rule
public ExpectedException thrown = ExpectedException.none();

@Test
public void invalidWhenNumberLessThanOne() {
    thrown.expect(IllegalStateException.class);
    fizzBuzz.say(0);
}
```

Data-Driven with JUnit

Using parameterized

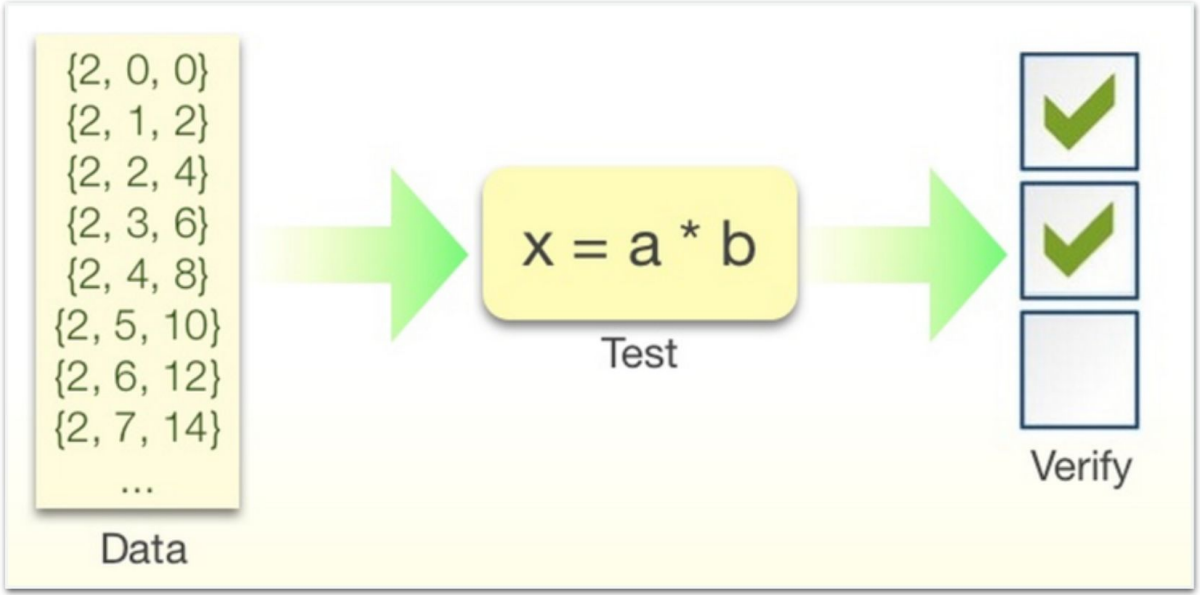
Set of test data

Expected result

Define test that uses the test data

Verify result against expected result

Data-Driven Development



@Parameterized
with Calculate Grade

Input	Expected Result
80	A
70	B
60	C
50	D
40	F

Workshop

@Parameterized

Setup: Add Dependencies

```
<dependency>
    <groupId>org.junit.jupiter</groupId>
    <artifactId>junit-jupiter-params</artifactId>
    <version>5.9.2</version>
    <scope>test</scope>
</dependency>
```

Step 1 :: Test Data

Input	Expected Result
80	A
70	B
60	C
50	D
40	F

Step 2 :: Add Runner

```
new *
@ParameterizedTest    You, 2 minutes ago • Uncommitted changes
public void shouldSayInputIfNotDivideBy3Or5(){
    //AAA

    //Arrange
    int input = 1;
```

Step 3 :: Matching fields

```
new *
@ParameterizedTest
@ValueSource(ints = {1,2,4,6,7,8,10})
public void shouldSayInputIfNotDivideBy3Or5(int input){
    //AAA

    //Arrange
    //int input = 1; // get it from input parameters    You,
```

Step 4 :: Define test case

```
new *
@ParameterizedTest
@ValueSource(ints = {1,2,4,6,7,8,10})
public void shouldSayInputIfNotDivideBy3Or5(int input){
    //AAA

    //Arrange
    //int input = 1; // get it from input parameters   You, 2 m

    //Act
    String result = fizzBuzz.say(input);

    //Assert
    assertEquals( String.valueOf(input), result);

}
```

Step 5 :: Add @parameters

```
new *
@ParameterizedTest
@ValueSource(ints = {1,2,4,6,7,8,10})
public void shouldSayInputIfNotDivideBy3Or5(int input){
    //AAA

    //Arrange
    //int input = 1; // get it from input parameters   You,
```

@CsvSource

supaket

```
@ParameterizedTest
@CsvSource({
        "1, 1",
        "2, 2",
        "3, Fizz",
        "5, Buzz",
        "7, 7",
        "9, Fizz",
        "15, FizzBuzz"
})
public void ShouldSayFizzBuzAsAnInputProvided(int pInput, String pExpected){
    String result = fizzBuzz.say(pInput);
    assertEquals(pExpected, result);
}
```

@CsvFileSource

```
supaket
@ParameterizedTest
@CsvFileSource(resources="/input.csv")
public void ShouldSayFizzBuzWithCsvFilesInput(int pInput, String pExpected){
    String result = fizzBuzz.say(pInput);
    assertEquals(pExpected, result);
}
```

Selfie