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Unit Testing

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What is the average cost to fix a bug?

At the XP Day London(2009) conference, Mark Striebeck from Google reports cost estimate for delaying bug fixes in Google.

Google spends **\$100M** per year on test automation, and they estimated that a bug found during TDD costs **\$5** to fix,

which surges to **\$50** for tests during a full build and **\$500** during an integration test.

It goes to **\$5000** during a system test.

Fixing bugs earlier would save them an estimated **\$160M** per year. Returns **\$60M** more than invested.

<https://gojko.net/2009/12/07/improving-testing-practices-at-google/>

What is unit testing?

Unit tests are typically automated tests written and run by software developers to ensure that **a section of an application** (known as the "unit") meets its design and behaves as intended.

In procedural programming, a unit could be an entire module, but it is more commonly an **individual function** or procedure. In object-oriented programming, a unit is often an entire interface, such as a class, or an individual method.

— Wikipedia

What does unit testing measure?

method/function

What questions should unit testing answer?

1. Target to test
2. Expected results
3. Test premise

What questions should unit testing answer?

For example, we need to write unit testing for a transfer method

```
public void transferTo(double amount, Account to)
```

What questions should unit testing answer?

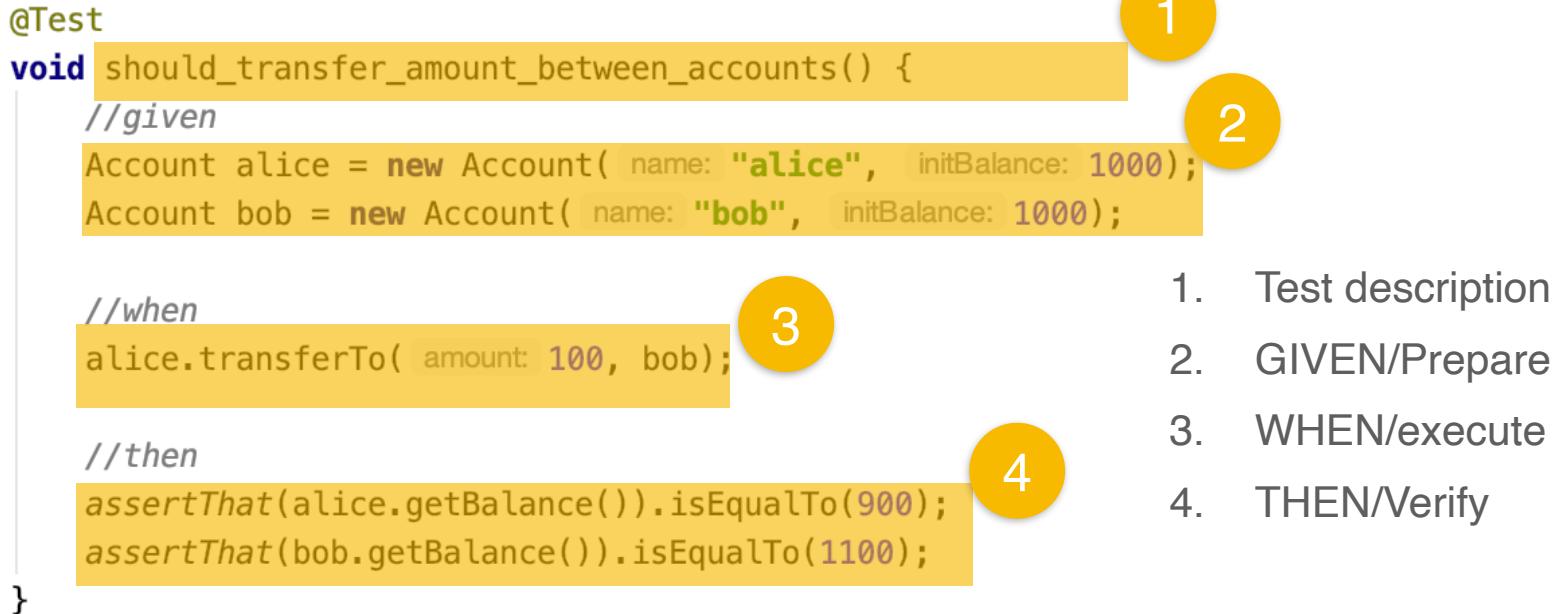
For example, we need to write unit testing for a transfer method

```
public void transferTo(double amount, Account to)
```

1. Target to test
2. Expected results
3. Test premise

Elements of Unit Testing

```
@Test  
void should_transfer_amount_between_accounts() {  
    //given  
    Account alice = new Account( name: "alice", initBalance: 1000);  
    Account bob = new Account( name: "bob", initBalance: 1000);  
  
    //when  
    alice.transferTo( amount: 100, bob);  
  
    //then  
    assertThat(alice.getBalance()).isEqualTo(900);  
    assertThat(bob.getBalance()).isEqualTo(1100);  
}
```



1. Test description
2. GIVEN/Prepare
3. WHEN/execute
4. THEN/Verify

Unit Test Demo & Practice

<https://github.com/afs-public-202211/unit-test-basic>



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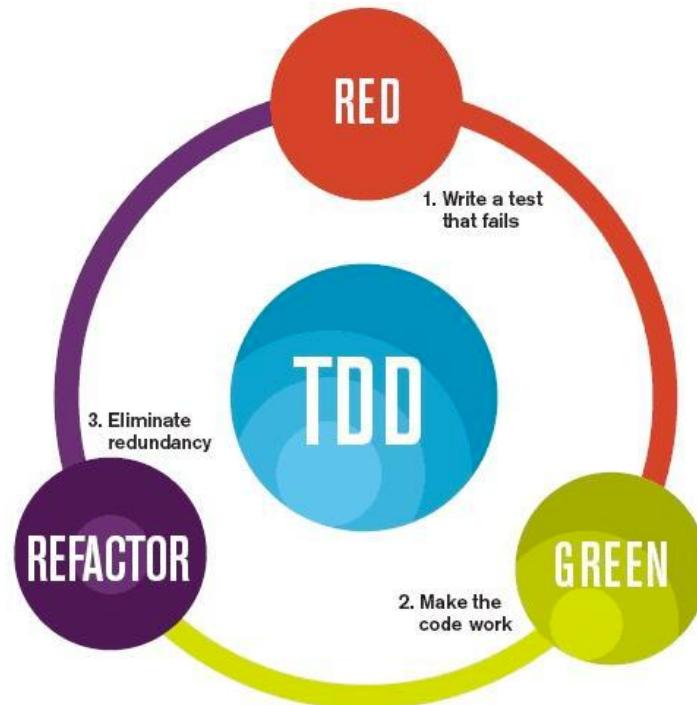
TDD

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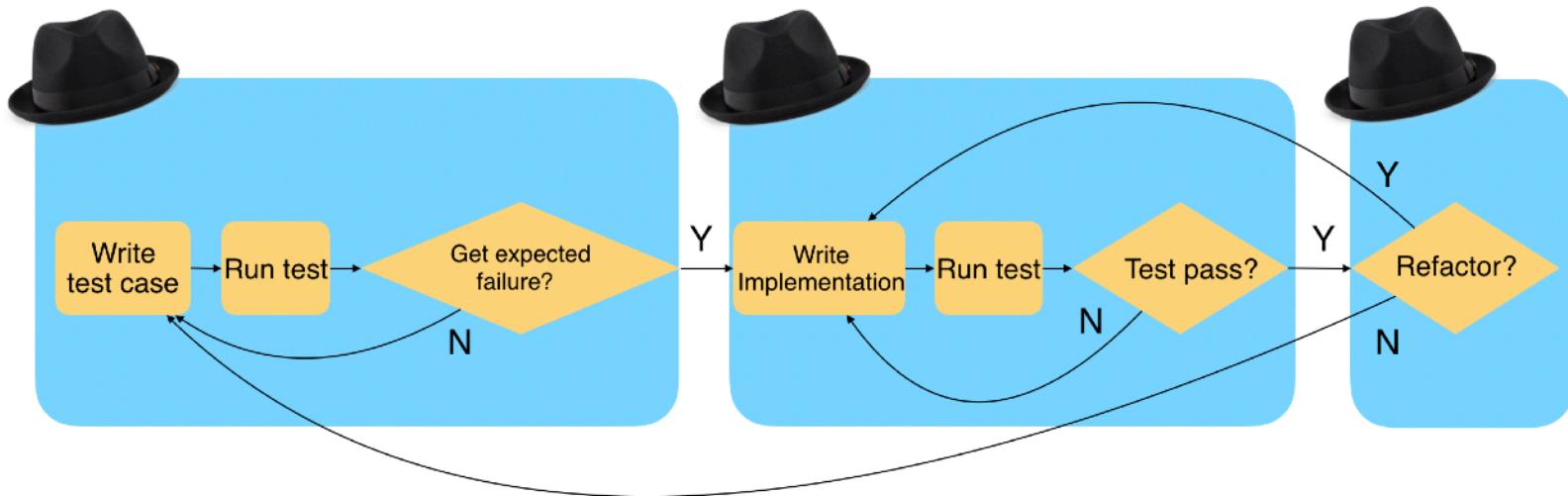
What is TDD ?

Type your answer or unmute your microphone

TDD Test Driven Development



How to TDD



FizzBuzz Game



You are a physical education teacher, you decide to play a game before get out of class. The rules of the game are:

All students stand in line and count off in order. When students count off:

- if the order number is a multiple of 3, then they should say “Fizz” instead;
- if the order number is a multiple of 5, then say “Buzz”;
- if the order number is common multiple of 3 and 5, then say “FizzBuzz”;

FizzBuzz Game

1 ALAN WAN	6 MICHAEL NAM	11 KELVIN TO	16 THOMAS K Y KWOK
2 ALVIN LEUNG	7 THOMAS K Y KWOK	12 POLLY LEUNG	17 ANTONY CHOI
3 HEINRICH SIU	8 ANTONY CHOI	13 VINCENT TAM	18 CHRIS T C WONG
4 JENNY WONG	9 CHRIS T C WONG	14 ALVIN LEUNG	19 ALAN WAN
5 MARIE CHOW	10 JOYCE LI	15 MARIE CHOW	20 KELVIN TO

FizzBuzz Game

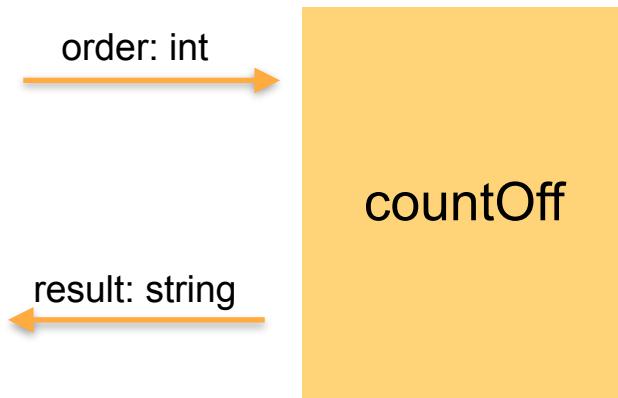


- 1 -> 1
- 2 -> 2
- 3 -> Fizz
- 4 -> 4
- 5 -> Buzz
- 6 -> Fizz
- 7 -> 7
- 8 -> 8
- 9 -> Fizz
- 10 -> Buzz
- ...
- 13 -> 13
- ...
- 15 -> FizzBuzz
- ...
- 21 -> Fizz
- ...
- 30 -> FizzBuzz
- ...
- ...

FizzBuzz Game Context Map

countOff

FizzBuzz Game Context map



Test Cases

- 1 -> “1”
- 2 -> “2”
- 3 -> “Fizz”
- 4 -> “4”
- 5 -> “Buzz”
- 6 -> “Fizz”
- ...
- 13 -> “13”
- ...
- 15 -> “FizzBuzz”
- ...
- 21 -> “Fizz”
- ...
- 30 -> “FizzBuzz”
- ...

General equivalence class

- 1 -> “1”
- 2 -> “2”
- 3 -> “Fizz”
- 4 -> “4”
- 5 -> “Buzz”
- 6 -> “Fizz”
- ...
- 13 -> “13”
- ...
- 15 -> “FizzBuzz”
- ...
- 21 -> “Fizz”
- ...
- 30 -> “FizzBuzz”
- ...



	Input (int)	Output (String)
Normal cases	1、2、4 ...	“1”、“2”、“4” ...
Multiple of 3	3、6、9...	“Fizz”
Multiple of 5	5、10、20 ...	“Buzz”
Multiple of 3 and 5	15、30、45 ...	“FizzBuzz”

FizzBuzz Game- list test cases

Given 1 When countOff Then “1”

Given 3 When countOff Then “Fizz”

Given 5 When countOff Then “Buzz”

Given 15 When countOff Then “FizzBuzz”



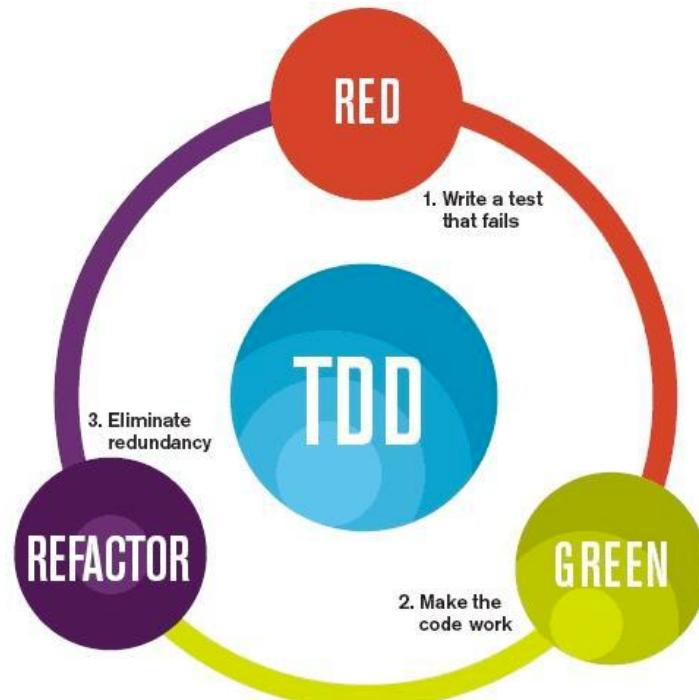
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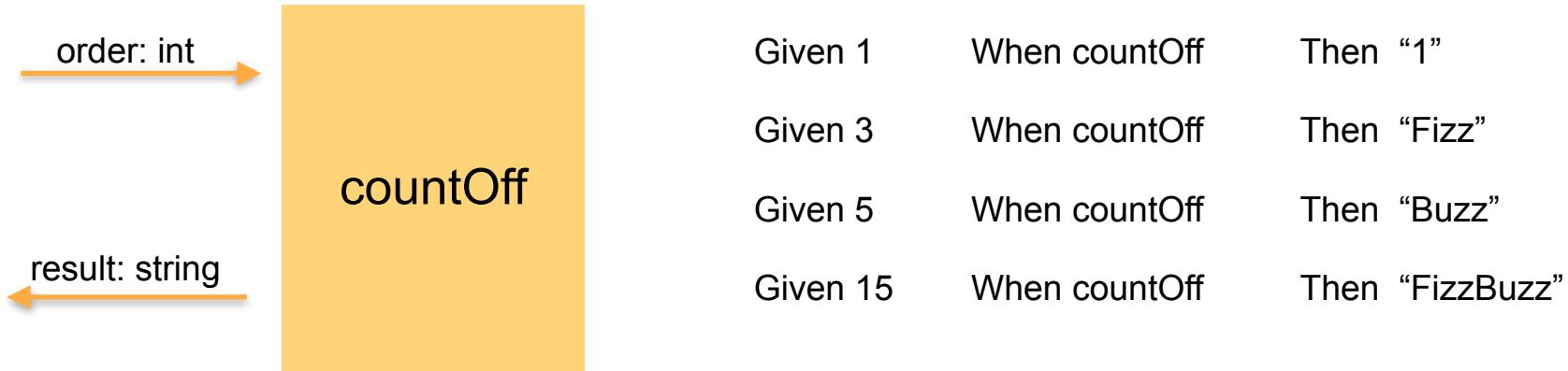
TDD Practice

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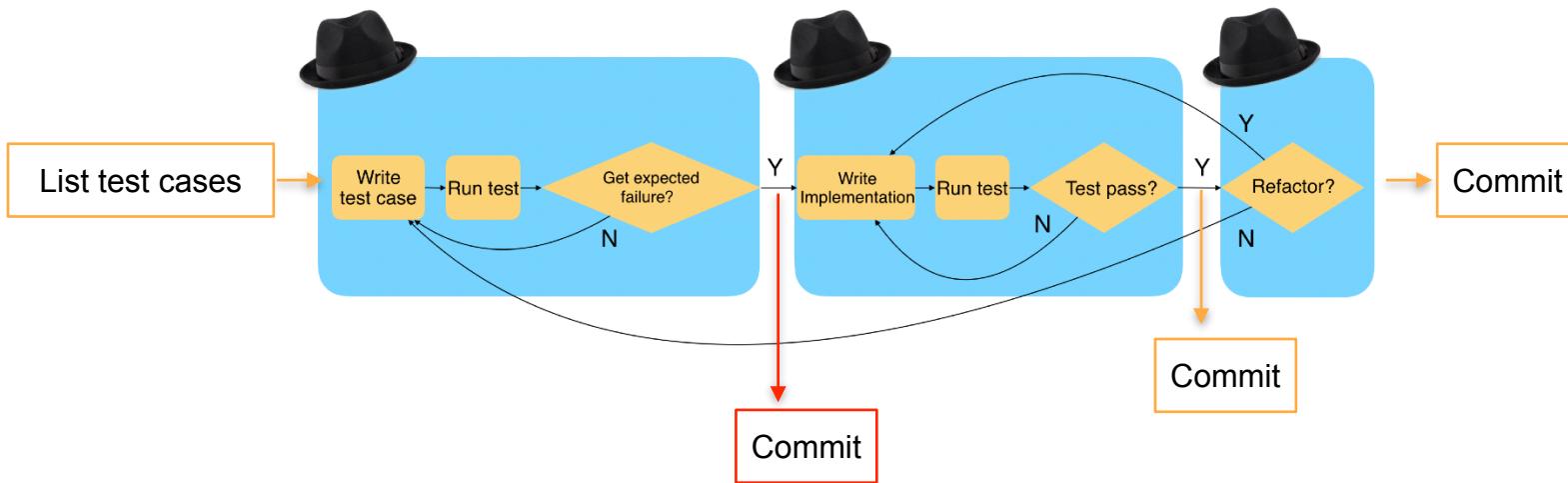
TDD: Test Driven Development



FizzBuzz Game - TDD Demo



What did we do



This commit is for us to confirm you have written test first.
We don't need this commit in our real work.

TDD - Best Practice

- Baby step - small commit
- All naming needs to be meaningful (including test methods)
- Use `should_xxx_when_xxx_given_xxx` as test method name
- Given ... When ... Then to construct the test

TDD - Practice

- Fork the repository, and clone to local.
- Coding with TDD (30 minutes)
- Small commit with message format as **type: detail message**
 - Commit after writing a test with expectation failure
 - Commit after writing code to make failed test pass
 - Commit after refactoring



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Thank You !

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