Lab 2: Advanced Unit Testing

Software Testing 2022

2022/03/03

Remember Lab 1 ?

Class Vehicle

```
class VehicleTest {
    @Test
    void setSpeed() {...}

    @Test
    void setDir() {...}

    @Test
    void getSpeed() {...}

    @Test
    void getDir() {...}

    @Test
    void totalVehicle() {...}
}
```

An Intelligent Vehicle, How To Test It?

Spotify®

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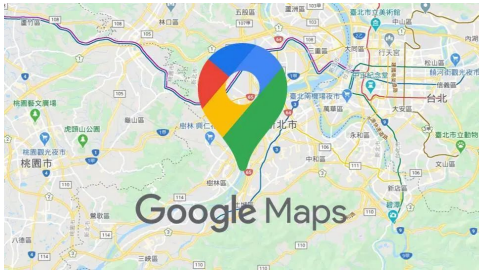


NETFLIX

Problem

Usually, the classification to be tested will have some external dependencies, may cause:

- Testing may be slow due to dependencies.
  eg. Network, database, files, external objects, etc.

- The result of the misjudgment test is whether the SUT itself is wrong or the dependent object is wrong

- Wait for the development of dependent objects to be completed before testing the object under test

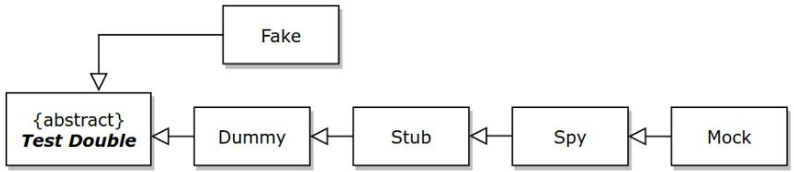
- Unable to test.
  eg. the development environment is different from the formal environment

Solution: Test Double

Dummy:
- It is used as a placeholder when an argument needs to be filled in.

Stub:
- It provides fake data to the SUT (System Under Test).

Spy:
- It records information about how the class is being used.



Mock:
- It defines an expectation of how it will be used. It will cause a failure if the expectation isn't met.

Fake:
- It is an actual implementation of the contract but is unsuitable for production.

Reference: https://jesusvalerareales.medium.com/testing-with-test-doubles-7c3abb9eb3f2

Example

Real World

authorization code / token


```
{
    "name":"Meow Yang",
    "email":"aesophor0613@gmail.com",
    "token":"Wu13RnH0w22OsE"
}
```

Fake

authorization code / token

Simple logic implements


```
{
    "name":"Meow Yang",
    "email":"aesophor0613@gmail.com",
    "token":"Wu13RnH0w22OsE"
}
```

Stub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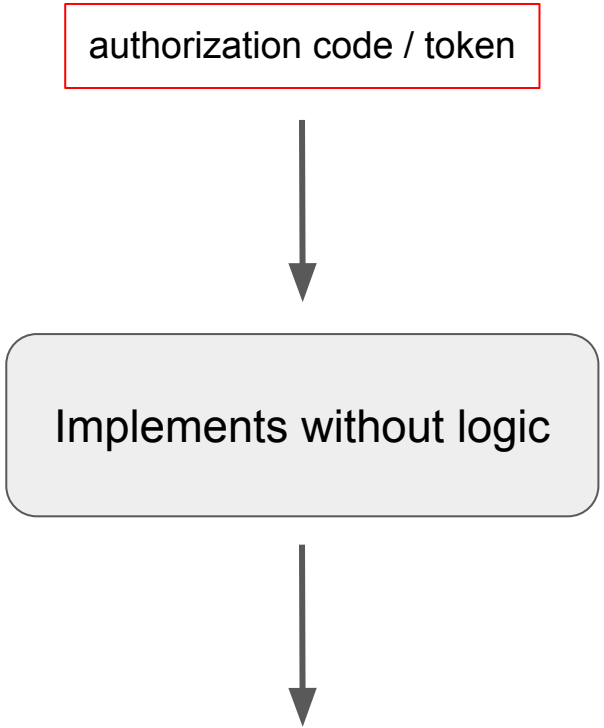

authorization code / token
Implements without logic
{
"name":"Meow Yang",
"email":"aesophor0613@gmail.com",
"token":"Wu13RnH0w22OsE"
}

Mock

Only care the interactive between target and Mock object

Spy

Can check the interactive between target and stub object

Fake

Fake

```
public interface GoogleApi {
    String login(String code);
}

public class MyGoogleApi implements GoogleApi {
    public String login(String code) {
        //do something and return something
    }
}
```

Stub

In Case Require Network Connection

```
final String initialString = "From Server : Hi !";
//Guess what server respones //Not good

final Socket socket = new Socket("127.0.0.1", 6666);

TcpClientParseCommunicate tcpClientParseCommunicate = new TcpClientParseCommunicate(socket);
tcpClientParseCommunicate.communicate();
tcpClientParseCommunicate.parseInput();
StringBuffer sb = tcpClientParseCommunicate.getBuf();

assertEquals(initialString, sb.toString());
```

Stub Test

```
class SocketStub extends Socket {
    SocketStub(String host, int port) {
        //Without connect with remote
    }

    public InputStream getInputStream() {
        return targetStream;
    }
}
```

SocketStub does not make network connection
Only return the written targetStream

Stub Test - Cont.

```
final String initialString = "testTcpClientWithStub";
final InputStream targetStream = new ByteArrayInputStream(initialString.getBytes());

final Socket socket = new SocketStub(null, -1);

TcpClientParseCommunicate tcpClientParseCommunicate = new TcpClientParseCommunicate(socket);
tcpClientParseCommunicate.communicate();
tcpClientParseCommunicate.parseInput();
StringBuffer sb = tcpClientParseCommunicate.getBuf();

assertEquals(initialString, sb.toString());
```

Mockito

It is a widely used testing framework, especially it can easily handle dependency injection scenarios, and it is relatively helpful to write Unit Test with it.

Can more easily handle and construct a variety of Test Double to conduct Unit Test.

https://javadoc.io/doc/org.mockito/mockito-core/latest/org/mockito/Mockito.html

Basic Structure

```
@ExtendWith(MockitoExtension.class)
 public class ExampleTest {

     @Mock
     private List<Integer> list;

     @Test
     public void shouldDoSomething() {
         list.add(100);
     }
 }
```

Constructor Injection

```
//instead:
@Spy BeerDrinker drinker = new BeerDrinker();
//you can write:
@Spy BeerDrinker drinker;

//same applies to @InjectMocks annotation:
@InjectMocks LocalPub;
```

mockito will try to initialize the **@InjectMocks** variables in **@Spy**, either by constructing method, set method or variable injection.

Stub Test With Mockito

```
final String initialString = "testTcpClientWithStubMockito";
final InputStream targetStream = new ByteArrayInputStream(initialString.getBytes());

Socket clientStub = mock(Socket.class);
when(clientStub.getInputStream()).thenReturn(targetStream);

TcpClientParseCommunicate tcpClientParseCommunicate = new TcpClientParseCommunicate(socket);
tcpClientParseCommunicate.communicate();
tcpClientParseCommunicate.parseInput();
StringBuffer sb = tcpClientParseCommunicate.getBuf();

assertEquals(initialString, sb.toString());
```

Cheat Sheet

```
// Only one stub method
FooClass mockObject = mock(FooClass.class);
when(mockObject.method(value)).thenReturn(returnValue);

// Two stub method
FooClass mockObject = mock(FooClass.class);
when(mockObject.method1(value)).thenReturn(returnValue);
when(mockObject.method2(value1, value2)).thenReturn(returnValue2);

// Use matcher to match stub method
when(mockObject.method(anyInt(), anyBoolean())).thenReturn(value);
```

Mock

Mock Test With Mockito

```
Socket clientMock = mock(Socket.class);

TcpClientParseCommunicate tcpClientParseCommunicate
= new TcpClientParseCommunicate(clientMock);
tcpClientParseCommunicate.communicate();

verify(clientMock).getInputStream();
```

Mock Test With Mockito - Cont.

```
Socket clientMock = mock(Socket.class);

TcpClientParseCommunicate tcpClientParseCommunicate
= new TcpClientParseCommunicate(clientMock);

verify(clientMock, never()).getInputStream();
```

Cheat Sheet

- Frequency
  - `verify(mockObject).method();`
  - `verify(mockObject, times(666)).method();`
  - `verify(mockObject, never()).method();`

- Argument Type
  - `verify(mockObject).method("robert");`
  - `verify(mockObject).method(anyString());`
  - `verify(mockObject).method(2021, 3, 11);`
  - `verify(mockObject).method(anyInt(), anyInt(), anyInt());`

Cheat Sheet - Cont.

- Capturing Arguments

```
ArgumentCaptor<Person> argument = ArgumentCaptor.forClass(Person.class);
verify(mock).doSomething(argument.capture());
assertEquals("John", argument.getValue().getName());
```

```
//capturing varargs:
ArgumentCaptor<Person> varArgs = ArgumentCaptor.forClass(Person.class);
verify(mock).varArgMethod(varArgs.capture());
List expected = asList(new Person("John"), new Person("Jane"));
assertEquals(expected, varArgs.getAllValues());
```

Spy

Example

```
List list = new LinkedList();
List spy = spy(list);

//optionally, you can stub out some methods:
when(spy.size()).thenReturn(100);

//using the spy calls *real* methods
spy.add("one");
spy.add("two");

//prints "one" - the first element of a list
System.out.println(spy.get(0));

//size() method was stubbed - 100 is printed
System.out.println(spy.size());

//optionally, you can verify
verify(spy).add("one");
verify(spy).add("two");
```

Example - Cont.

```
List list = new LinkedList();
List spy = spy(list);

//Impossible: real method is called so spy.get(0) throws IndexOutOfBoundsException
//(the list is yet empty)
   when(spy.get(0)).thenReturn("foo");

//You have to use doReturn() for stubbing
doReturn("foo").when(spy).get(0);
```

Cheat Sheet

You can use doThrow(), doAnswer(), doNothing(), doReturn() and doCallRealMethod() in place of the corresponding call with when(), for any method. It is necessary when you :

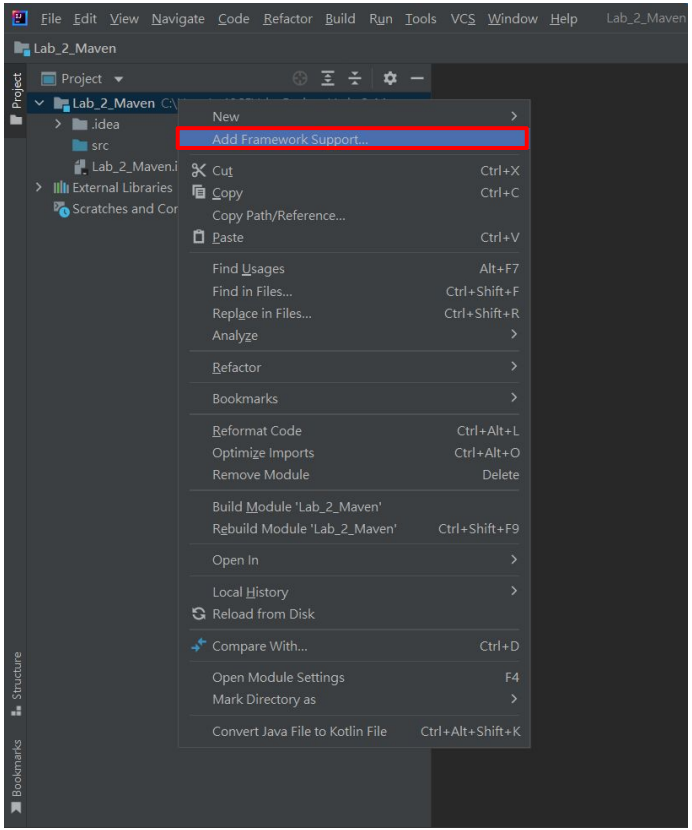
- stub void methods
- stub methods on spy objects
- stub the same method more than once, to change the behaviour of a mock in the middle of a test.

Lab

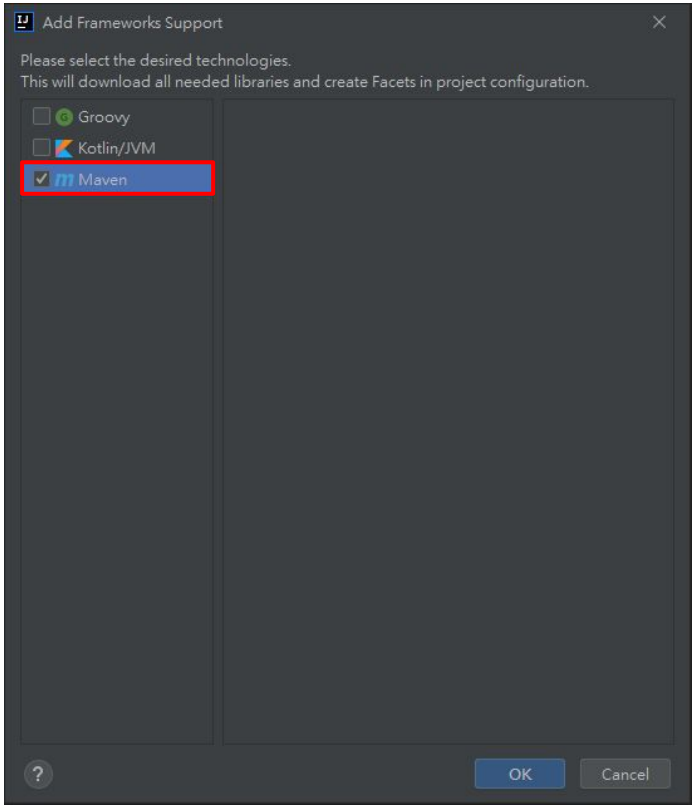
Lab 2

1. Download **StrangeGame.java** from Github.
   a. https://github.com/a4865g/NYCU-Software-Testing-2022
2. Write tests for StrangeGame class which satisfy the following case:
   a. If a **notorious** player **enter the game** on **0:00 - 11:59**, verify that prison doesn't do any imprisonment.
   b. If a **notorious** player **enter the game** on **12:00 - 23:59**, assert the output correct.
   c. Suppose 3 players go to the prison. Verify **prisonerLog** in **prison** will record prisoner's **playerid** with **spy** method. **Don't stub getLog function**.
   d. Use **stub** method to test **getScore** function (PlayerID = your StudentID) to avoid connection to outer database.
   e. Implement **paypalService** interface as a **fake** object to test donate function.
3. Name your test function test_a to test_e which belong to each case.
4. Upload StrangeGameTest.java to E3

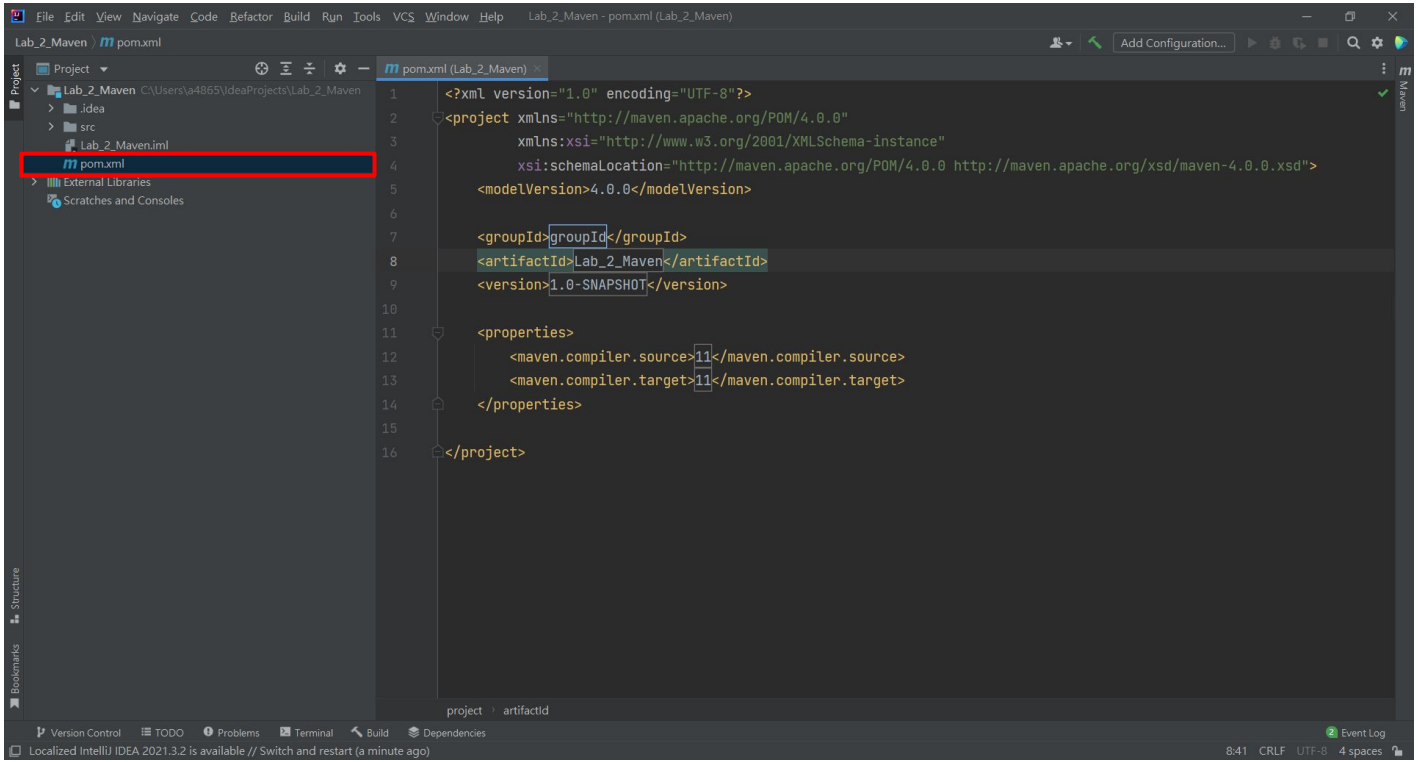
Import mockito - Method 1 (Maven)



Import mockito - Method 1

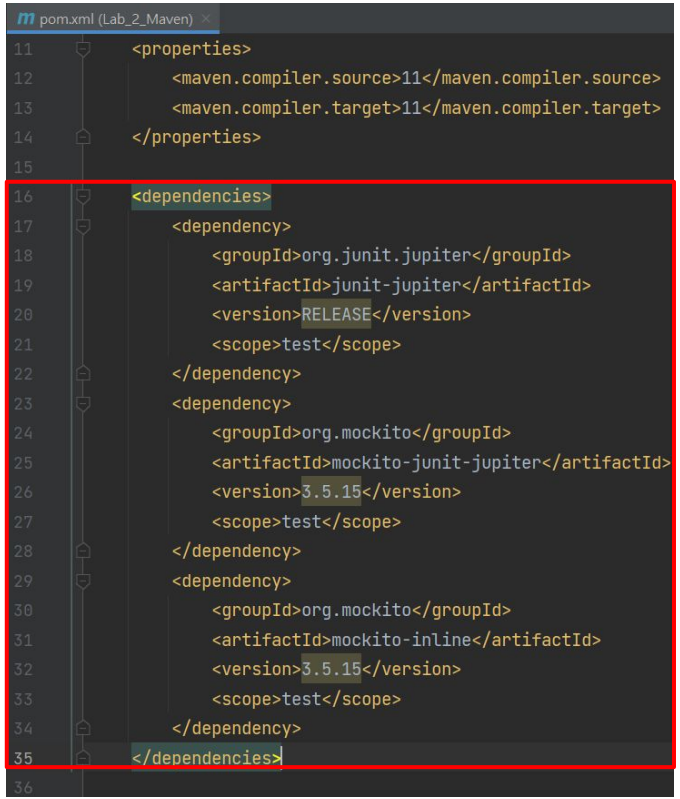


Import mockito - Method 1

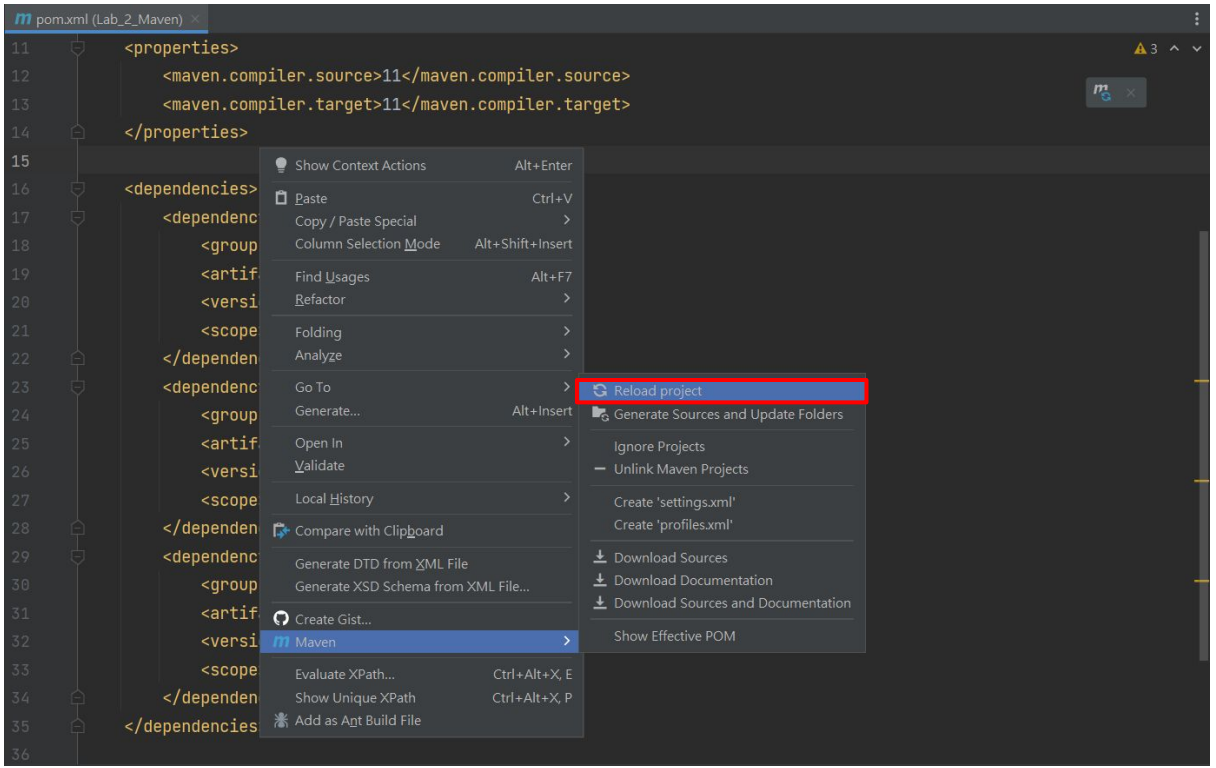


Import mockito - Method 1

```
<dependencies>
    <dependency>
        <groupId>org.junit.jupiter</groupId>
        <artifactId>junit-jupiter</artifactId>
        <version>RELEASE</version>
        <scope>test</scope>
    </dependency>
    <dependency>
        <groupId>org.mockito</groupId>
        <artifactId>mockito-junit-jupiter</artifactId>
        <version>3.5.15</version>
        <scope>test</scope>
    </dependency>
    <dependency>
        <groupId>org.mockito</groupId>
        <artifactId>mockito-inline</artifactId>
        <version>3.5.15</version>
        <scope>test</scope>
    </dependency>
</dependencies>
```



Import mockito - Method 1



Import mockito - Method 2 (JAR)

Steps for adding external jars in IntelliJ IDEA:

1. Click `File` from the toolbar
2. Project Structure (CTRL + SHIFT + ALT + S on Windows/Linux, ⌘ + ; on Mac OS X)
3. Select Modules at the left panel
4. Dependencies tab
5. '+' → JARs or directories

```
import org.junit.jupiter.api.extension.ExtendWith;
import org.mockito.*;
import org.mockito.junit.jupiter.MockitoExtension;

import static org.mockito.Mockito.*;
```