Ch2 Code Unit Testing

Write Code to Test Code(2)

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Available Time: Wednesday 8:00 -12:00 a.m.

Agenda

- Introduction to Unit Testing
- Common Code Defect Categories
- Unit Tests Design Heuristic Rules
- Unit Tests Implementation
  - Junit & Mockito & Qualified test scripts
- Code Test Adequacy Criteria
  - Control flow based & Jacoco
  - Data flow based
  - Mutation Based
- Code Test Generation

Readability

Good programmers write code that humans can understand

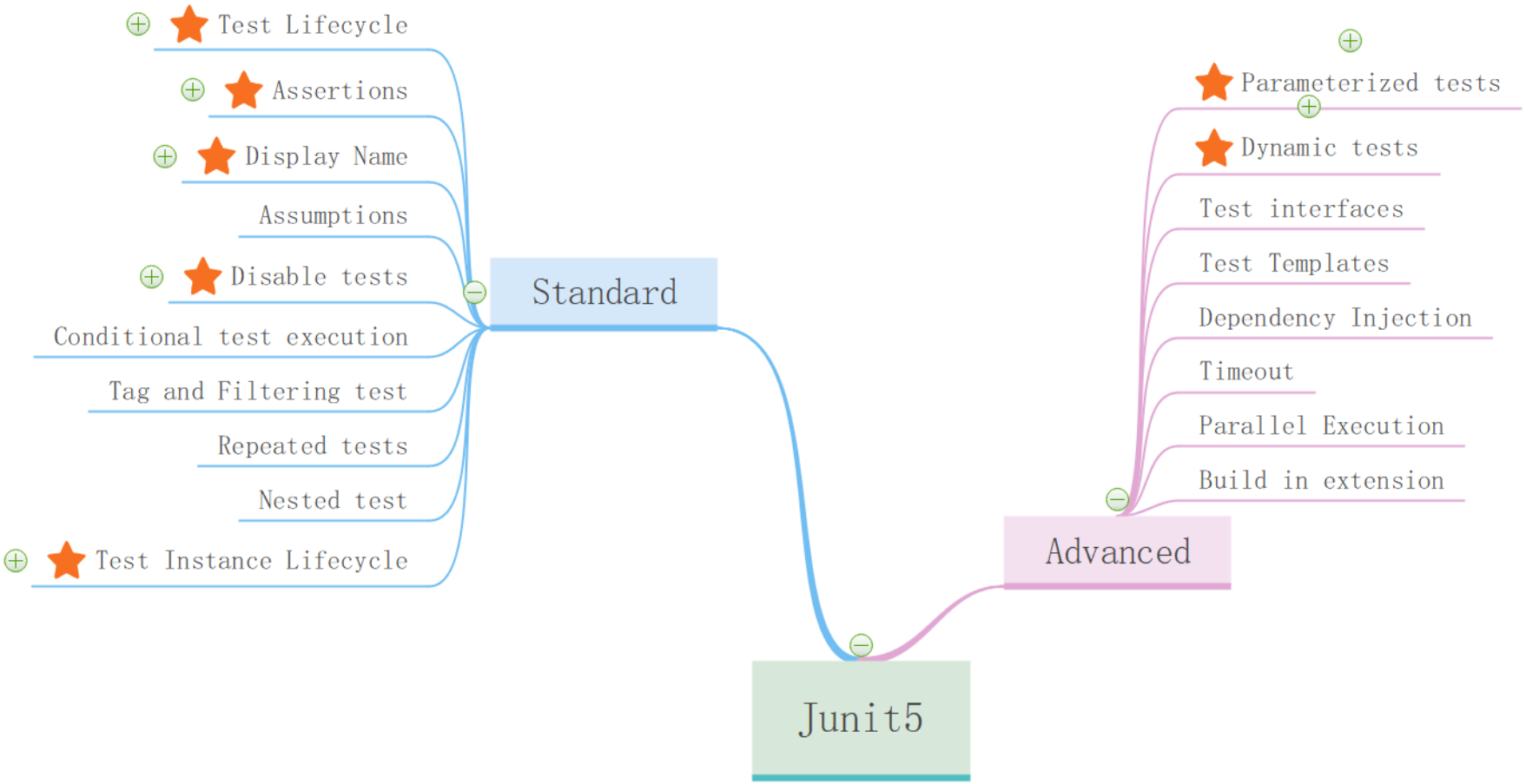
Martin Fowler

What is JUnit

JUnit is a simple, open source framework to write and run repeated tests

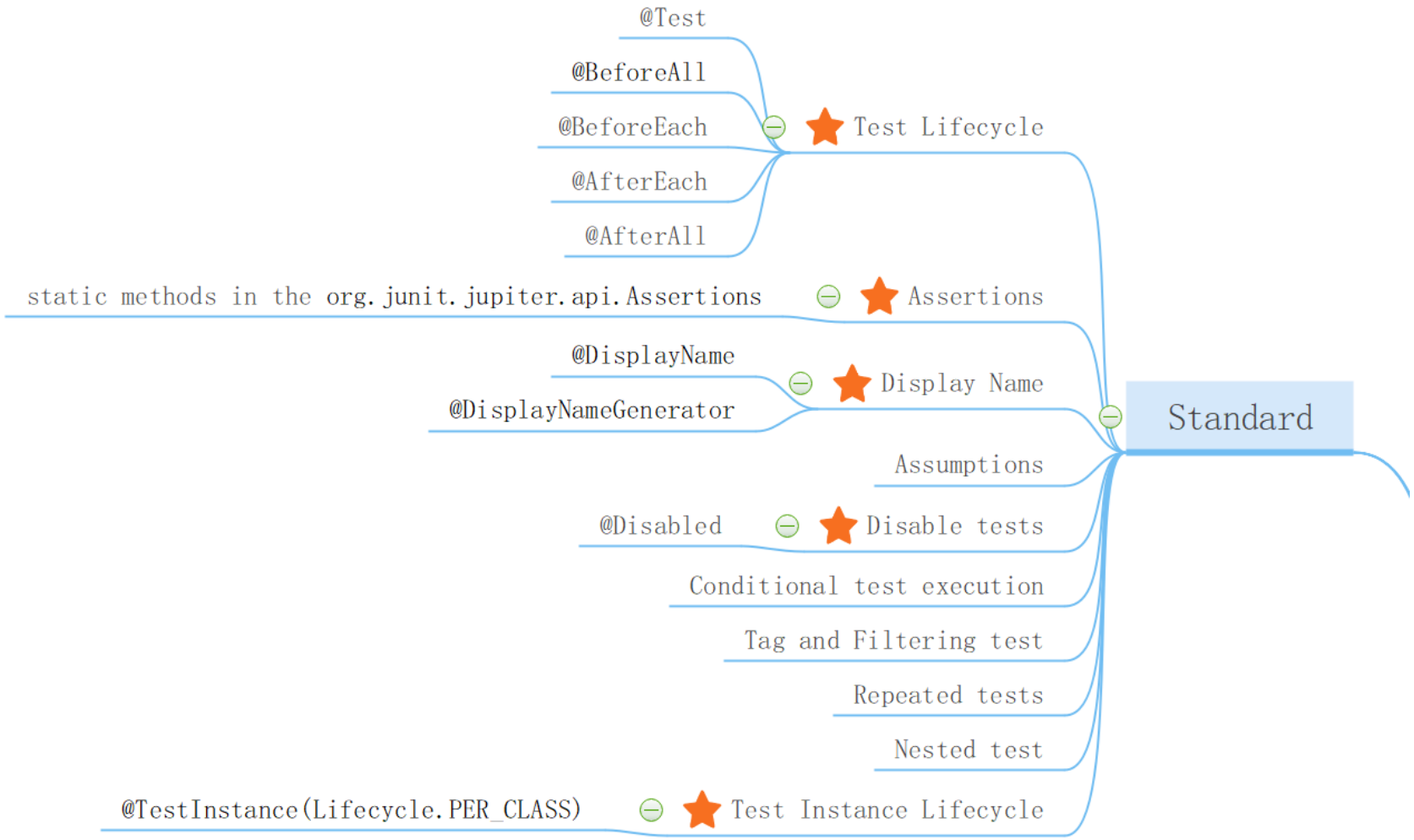
-- Org Junit

Junit5 Features

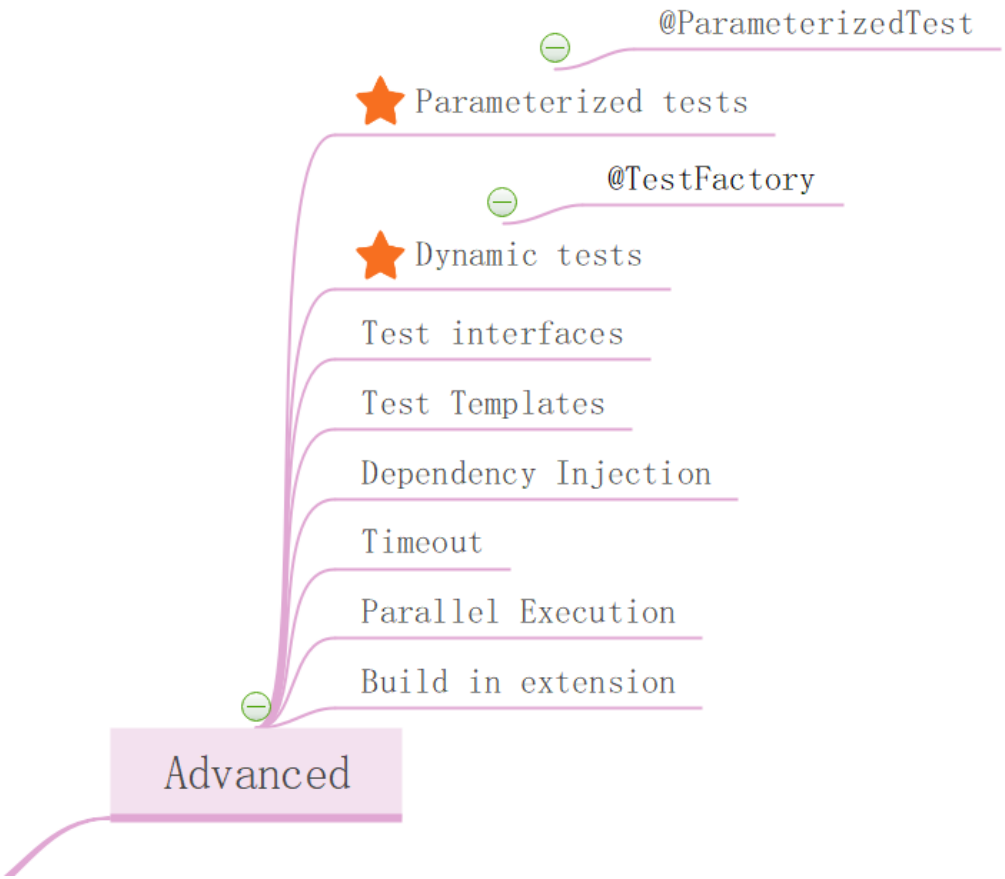


https://junit.org/junit5/docs/current/user-guide/

Junit5 Features

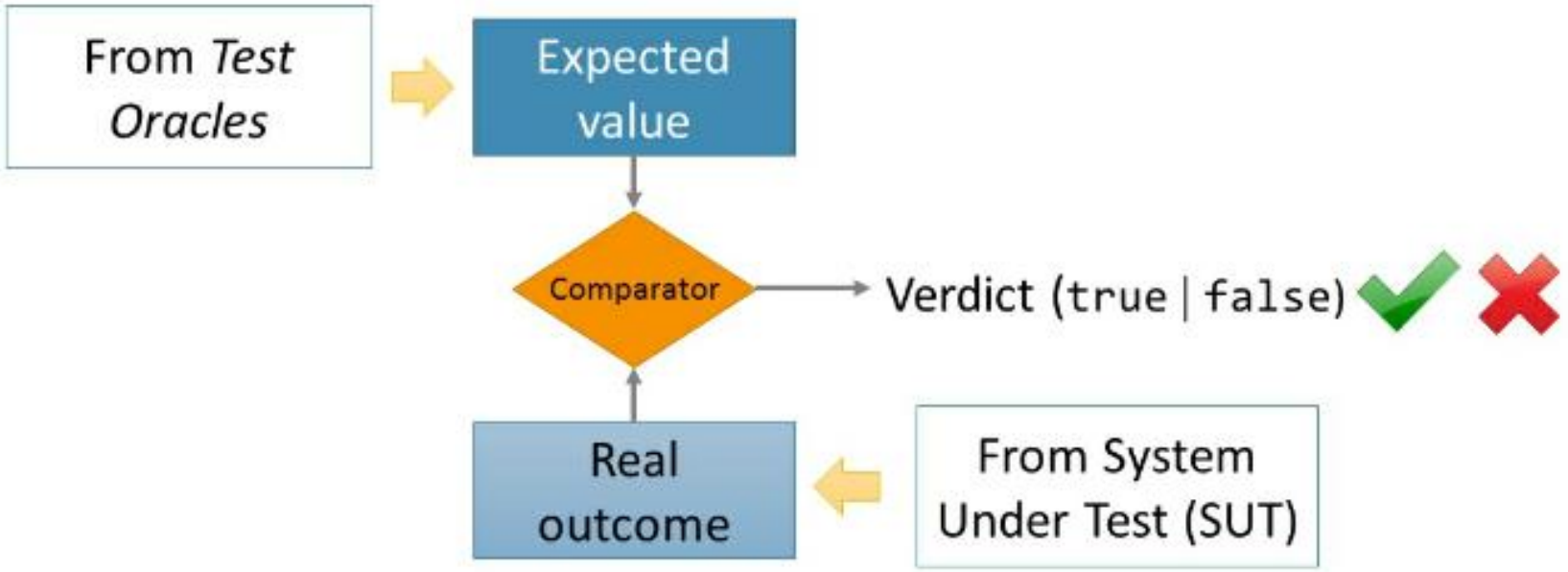


Junit5 Features

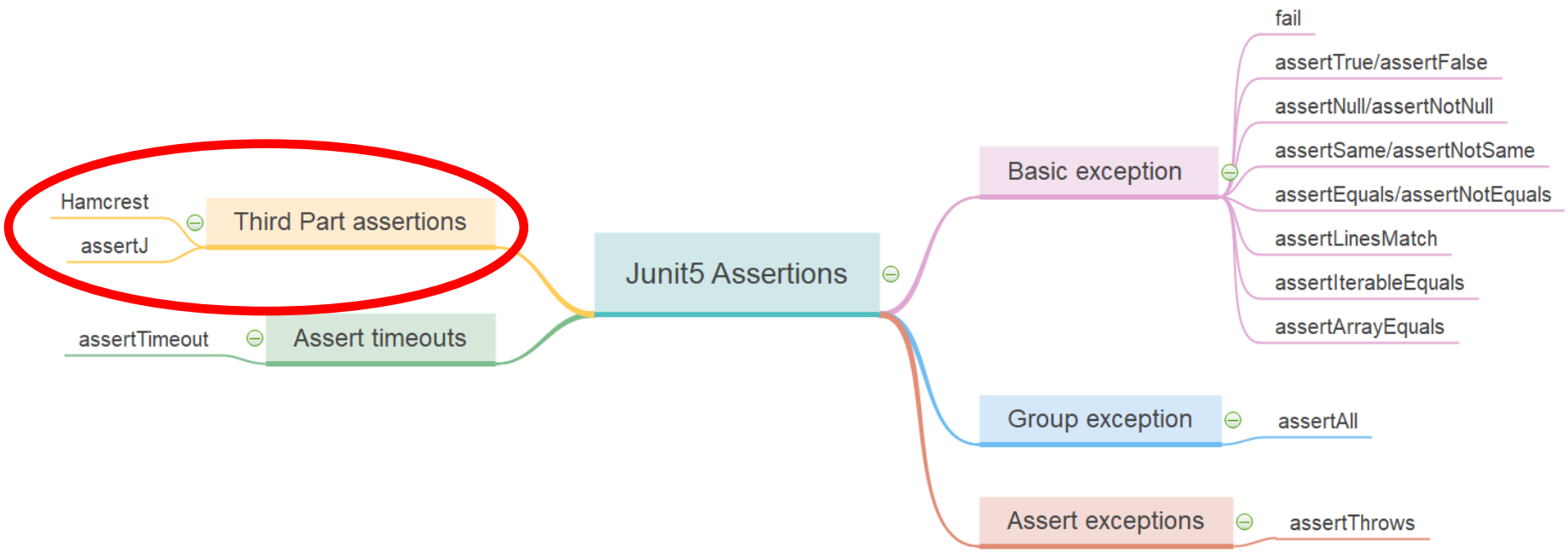


Assertions

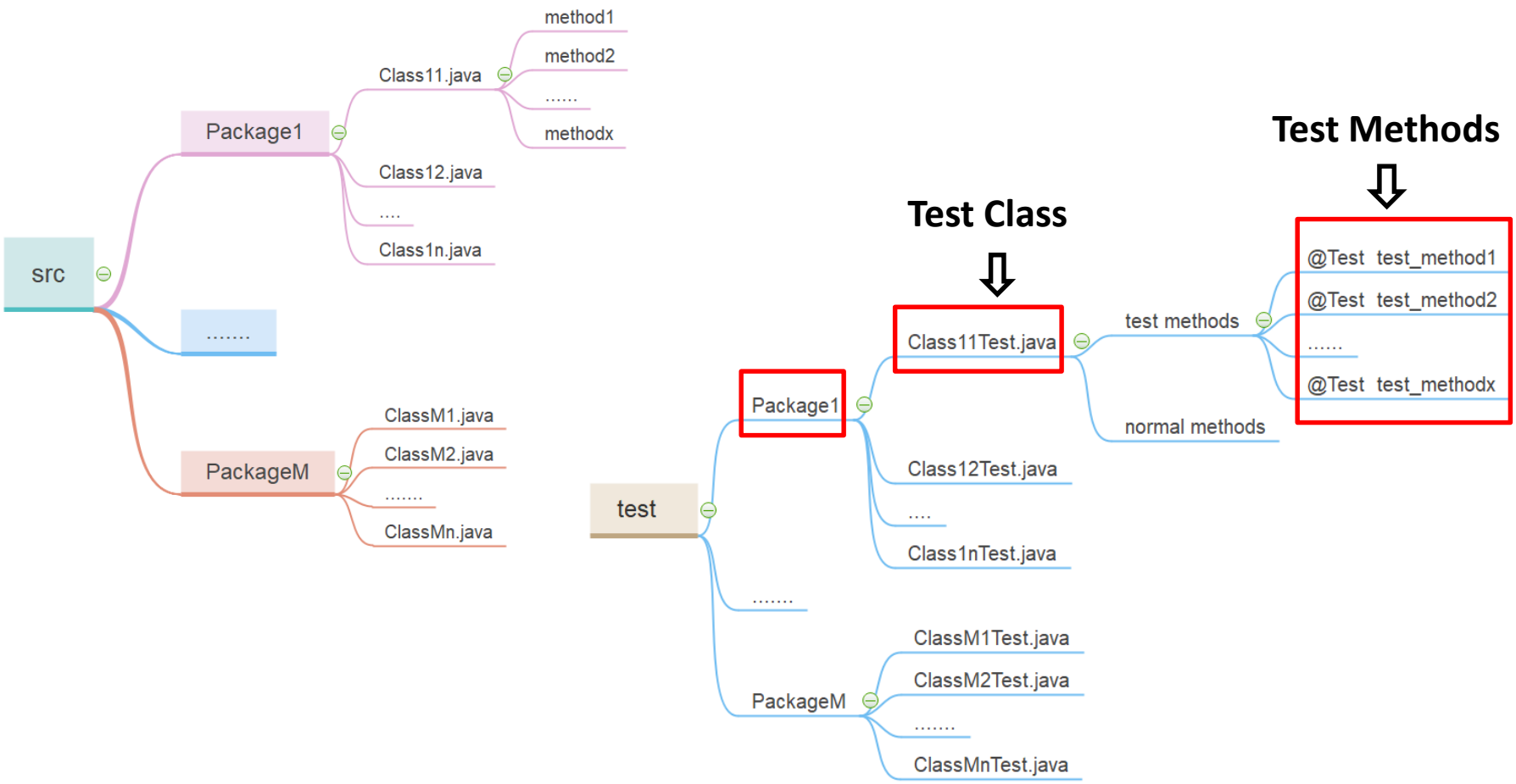
- An assertion (predicate) is a boolean statement typically used to reason about software correctness.



Junit5 Assertions



JUnit Test Code Structure



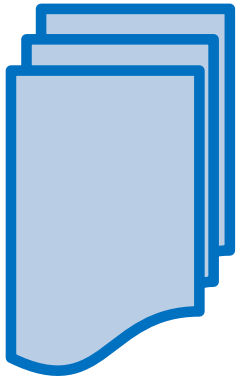
JUnit Test Code Structure

- Test Class
  - 命名方式：被测类名 + Test ， 例， MeetCalendarTest
- Test Method
  - 真正执行测试发现缺陷的地方
  - 使用@Test, @RepeatedTest, @ParameterizedTest, @TestFactory, @TestTemplate 标注的方法
  - 3A Pattern
    1. Arrange: preparation for the coming test
    2. Action: execute code under test
    3. Assertion: compare actual outputs with expected ones

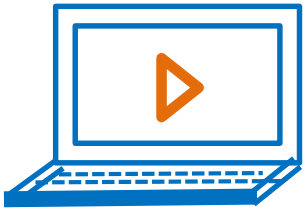
Test Lifecycle

- A test composed of 4 stages:
  1. Setup (optional): the test initializes the test fixture
  2. Exercise: the test interacts with the SUT, getting some outcome from it as a result.
  3. Verify: the outcome from the system under test is compared to the expected value using one or several assertions (also known as predicates). As a result, a test verdict is created.
  4. Teardown (optional): the test releases the test fixture to put the SUT back into the initial state.

Test Lifecycle

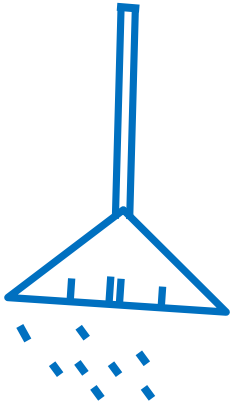


Setup:
preparation for the coming test



Exercise:
execute code under test

Verify:
compare actual outputs with expected ones

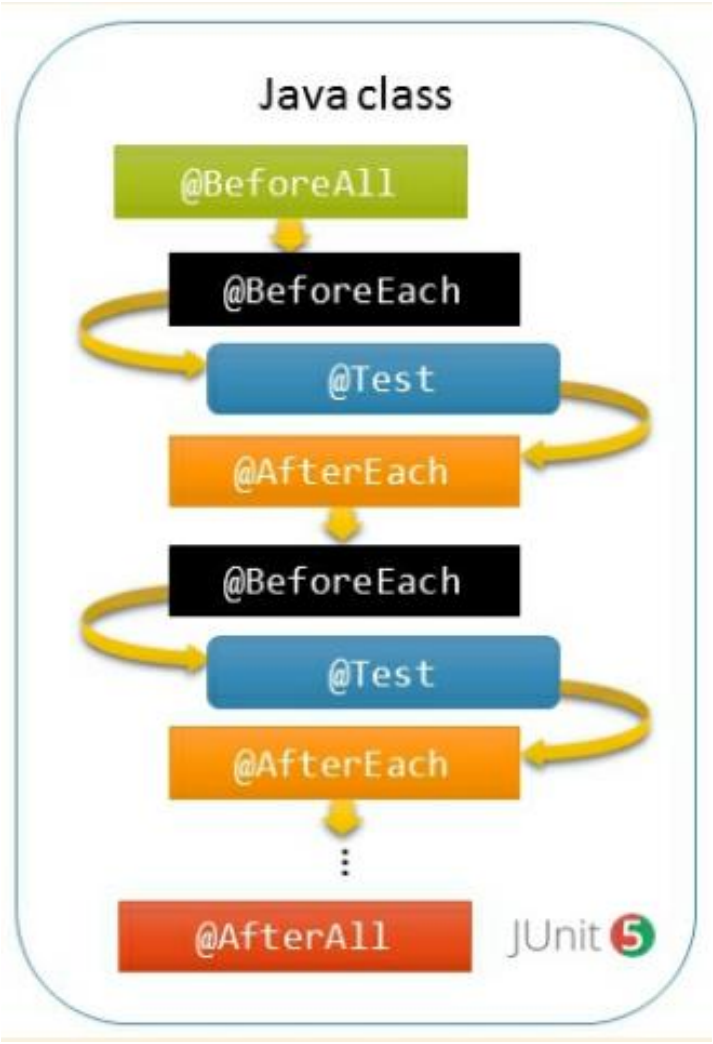


tearDown:
clean up test environment

@BeforeAll→@BeforeEach→@Test→@AfterEach→ @BeforeEach→@Test→@AfterEach →…… @AfterAll

Test Lifecycle

- @BeforeAll (static method): executed before all @Test
- @BeforeEach: executed before each @Test
- @AfterEach: executed after each @Test
- @AfterAll (static method): executed after all @Test

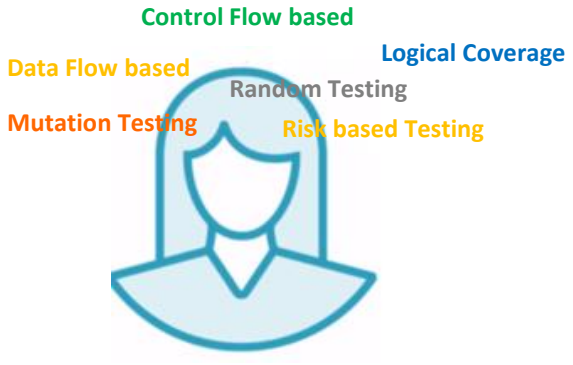


Deal With Repeated Test

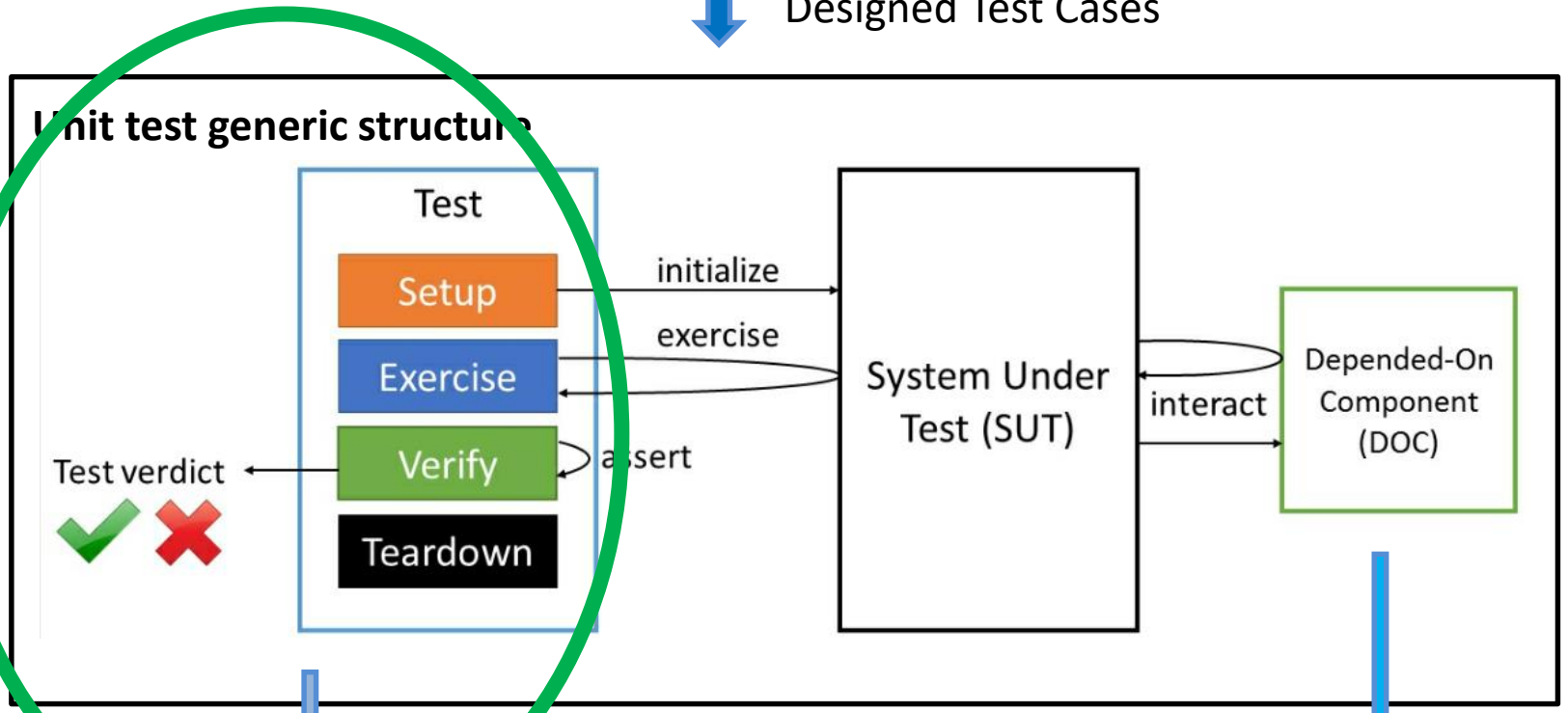
- Data Driven Test
  - Separated test data from test code
  - @ParameterizedTest，Example Code： JUnitDemo.zip

- 操作练习

1. 课程网站下载**MeetHereMaven.zip**：视频资料　JUnit + mockito视频
2. 解压**MeetHereMaven. zip**到当前目录（**目录中不要有中文**）
3. Idea中打开**MeetHereMaven**，等待Maven更新完毕
4. 查看test目录下SitePriceTest代码
5. 运行SitePriceTest
6. 查看运行测试的个数及测试执行情况



Designed Test Cases



JUnit 5

mockito

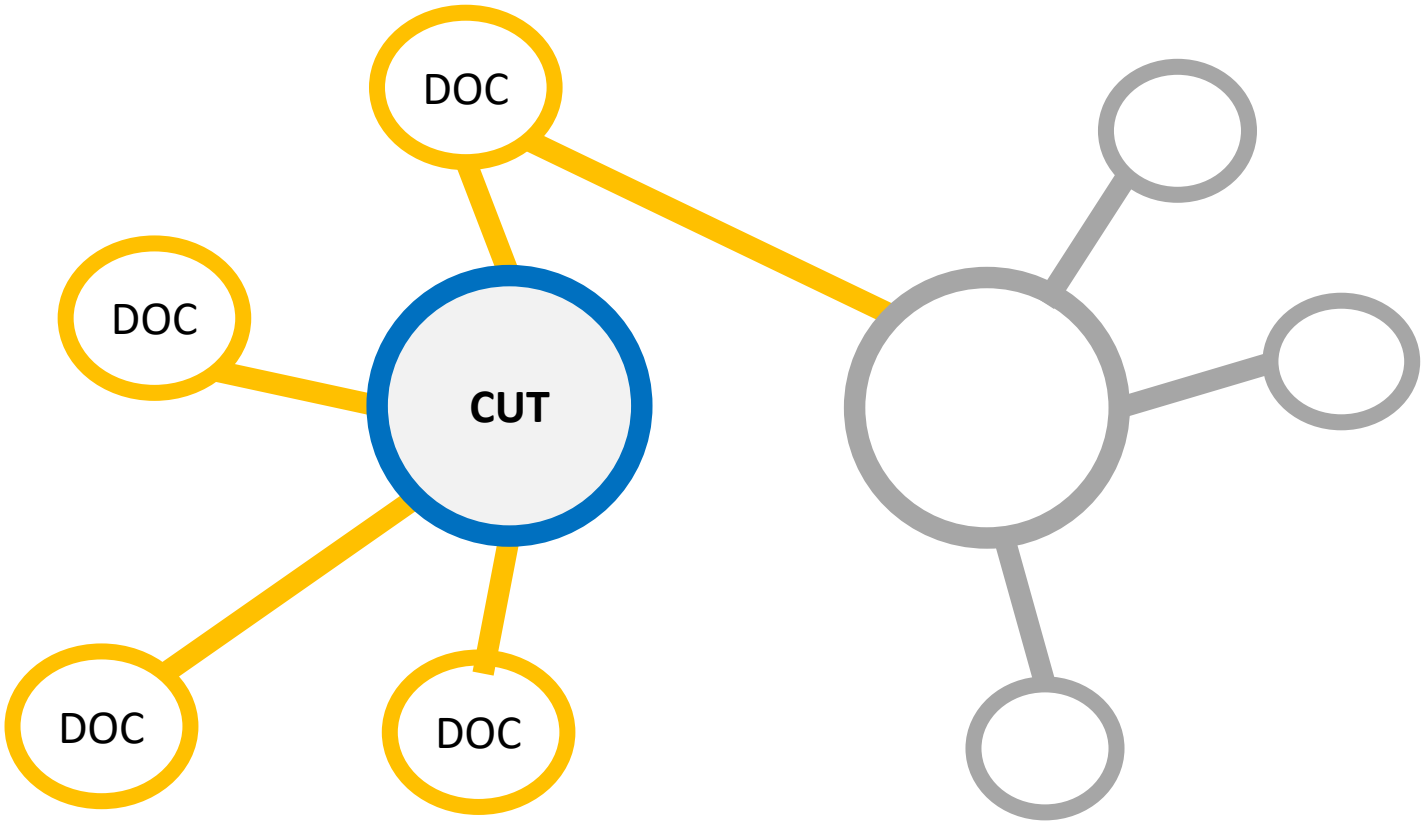
Practice

- 实验准备
  1. 课程网站下载**MockitoDemo.zip**： 视频资料→ JUnit + mockito视频
  2. 解压**MockitoDemo.zip**到当前目录（**目录中不要有中文**）
  3. Idea中打开**MockitoDemo.zip注意JDK版本**）
- 实验任务
  - 阅读PhoneBookDAO.java，PhoneBookH2DAO.java, PhoneEntry.java
  - 编写测试用例测试PhoneBookH2DAO的create（）

Difficulties

DOC Dependence On Component

CUT Code Under Test



Difficulties

测试断言写什么？

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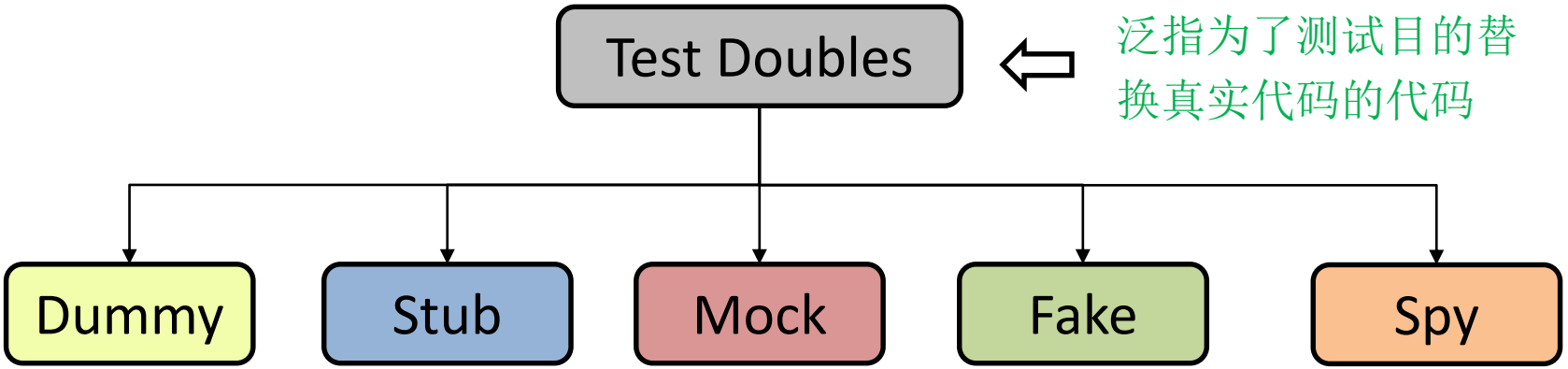
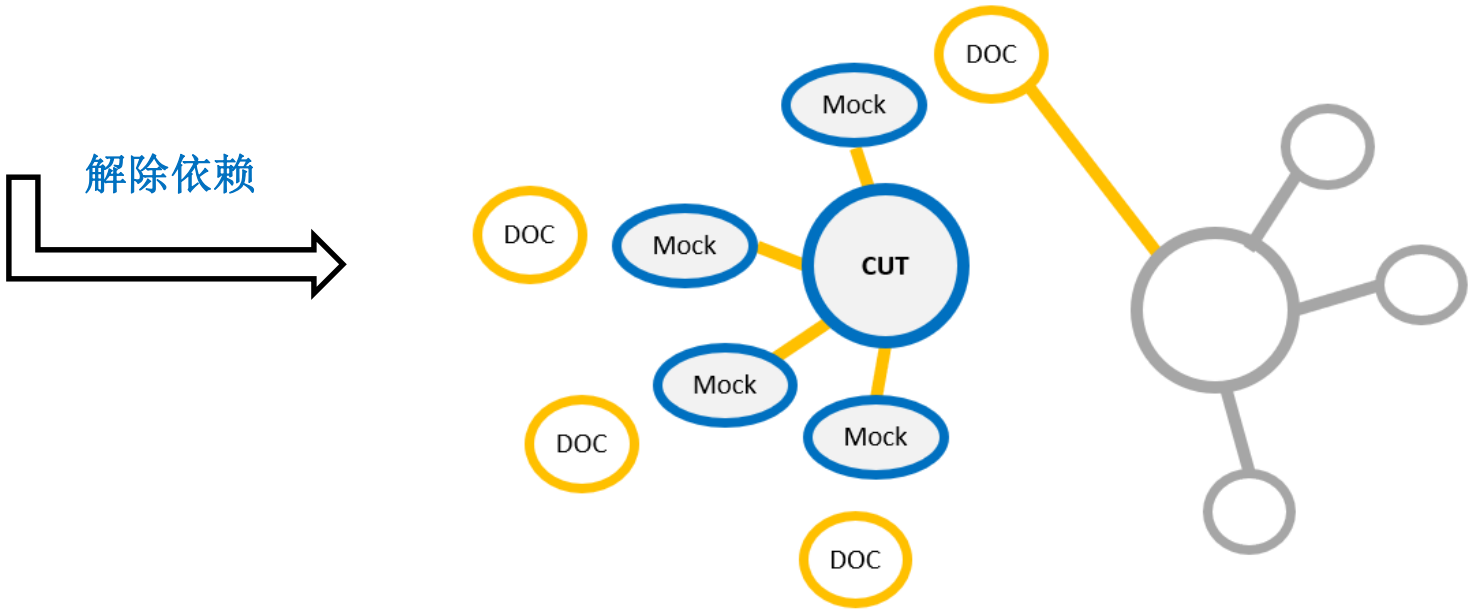
Test Doubles





Test Doubles

- Dummy
  - 在测试方法中不使用其任何方法的测试替身
  - 一般出现在方法的参数处
  - 通常为了防止NullPointerException的出现，保证测试方法可以顺利执行

```
class DummyDemoTest {
    @Test
    void s1_is_null_return_null() {
        DummyDemo dd = new DummyDemo();
        PhoneEntry entry1 = null;
        PhoneEntry entry2 = new PhoneEntry();
        assertNull(dd.replaceEntryName(entry1,entry2));
    }
}
```

A dummy

MockitoDemo项目DummyDemoTest示例

Test Double

- Fake
  - 一种简化真实代码的测试替身，通常采用继承被Fake对象（真实代码），成为其子类的方法实现
  - 不能作为产品代码，单纯为了测试快，不在测试中出现耗时行为
  - Example: In-memory database

```
class PhoneBookH2DaoFake extends PhoneBookH2Dao {
    protected void loadDriver() {
    }

    protected Connection getConnection() throws SQLException {
        return connection;
    }
}
```

MockitoDemo项目PhoneBookDatabaseDaoTest示例

Test Doubles

- Stub
  - Provide canned answer：为其调用者提供测试过程中需要使用的信息
  - 通常应用响应待测系统的请求，然后返回特定的值

```
// You can mock concrete classes and interfaces
TrainSeats seats = mock(TrainSeats.class);

// stubbing appears before the actual execution
when(seats.book(Seat.near(WINDOW).in(FIRST_CLASS))).thenReturn(BOOKED);
```

Mockito中的打桩代码

Test Doubles

- spy
  - Spy are stubs that also record some information based on how they were called
    1. 使用真实代码的测试替身，返回其真实值
    2. 可以打桩
    3. 可以记录使用轨迹，便于在后续的测试活动中验证是不是安排的事情按照期望发生

```java
package edu.ecnu.sei.mockito.trading;

public class DemoClass {

    public String foo() {

        return "I like mock";

    }
}
```

```java
package edu.ecnu.sei.mockito.trading;

import static org.mockito.Mockito.spy;

import org.junit.Test;

public class FirstSpy {

    DemoClass demo = spy(DemoClass.class);

    @Test
    public void what_is_a_mock() {

        System.out.println(demo.foo());
    }
}
```

Output: I like mock

```java
package edu.ecnu.sei.mockito.trading;

public class DemoClass {

    public String foo() {

        return "I like mock";

    }
}
```

```java
package edu.ecnu.sei.mockito.trading;

import static org.mockito.Mockito.mock;

import org.junit.Test;

public class FirstMock {

    DemoClass demo = mock(DemoClass.class);

    @Test
    public void what_is_a_mock() {

        System.out.println(demo.foo());
    }
}
```

Output: null

Test Double

- Mock
  - 按照期望实现的用于测试方法中的行为代码
  1. 正常路径：返回正常值
  2. 异常路径：返回期望的错误/异常
- Mockito
  - mock被测对象外部依赖的Java开源测试框架

Two Approaches of Test Verdict Construction

- State based testing (Test by Result)
  - determine whether the CUT worked correctly by examining the state of the SUT and its collaborators after the method was exercised
- Behavioral based testing (Test by Process)
  - determine whether the CUT worked correctly by examining its action process

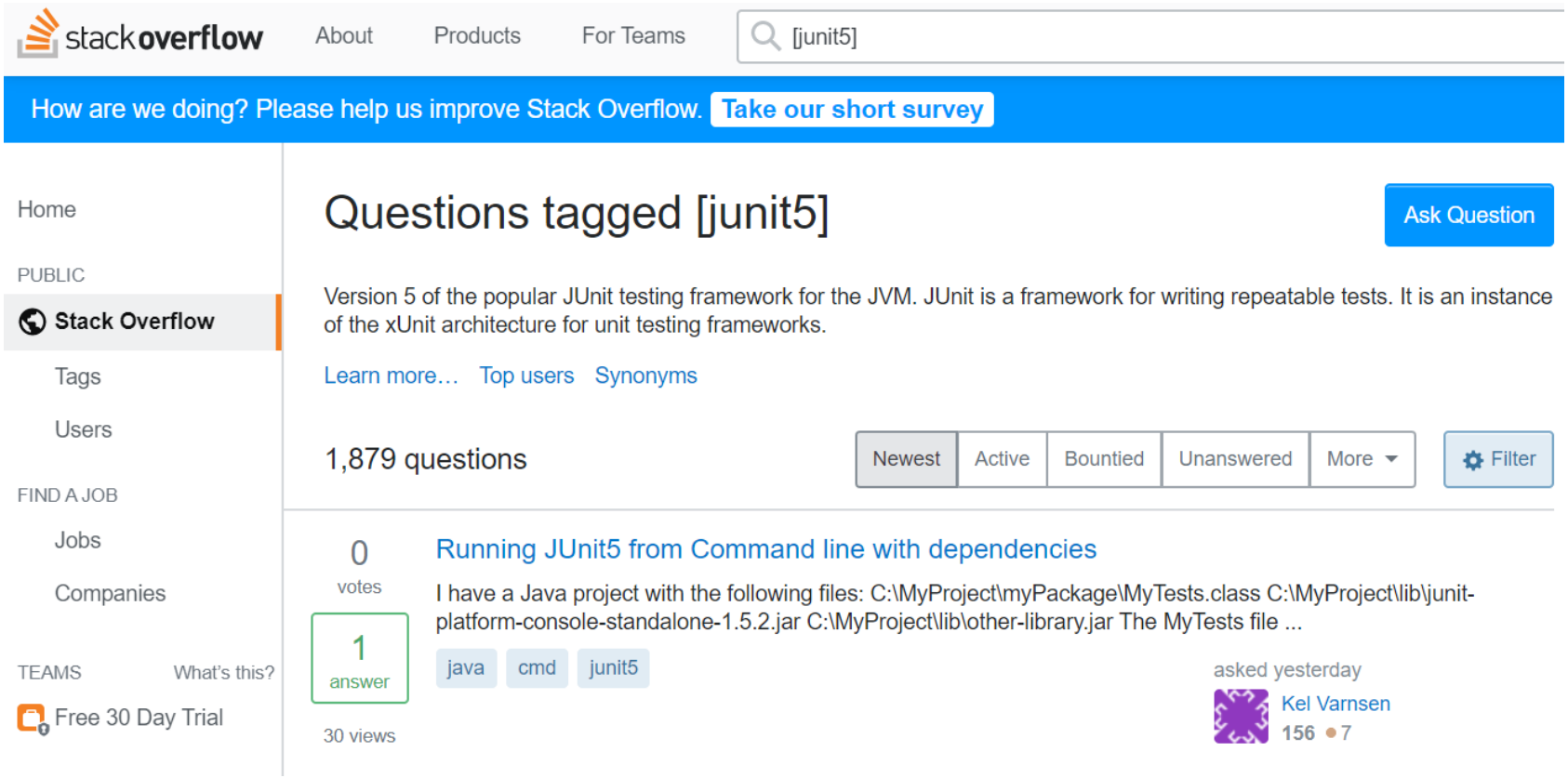
Typical Scenario for Mock Object

- objects supplies nondeterministic results
  1. maximum/minimum value
  2. random result
  3. current time
- objects difficult to create or reproduce
  1. Network error
- objects not yet exist or may change behavior.
  1. want database query return same result

More about Junit5

Junit org： https://junit.org/junit5/

More About Junit5



Questions on stackoverflow : https://stackoverflow.com/questions/tagged/junit5

More About Junit5

Junit Gitter: an instant chat room which can talk directly with the Junit5 members

https://gitter.im/junit-team/junit5

Summary

- Junit is the most popular unit test frame for Java which sharpens the unit test techniques
- Mockito is a mock library used for which helps running code under test isolatedly

The End