Test Driven Development

Using JUnit to Test DVD.java

Produced
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Let's first write a complete test class and then we will discuss the theory behind it.

Testing DVD.java

DVD.java

```java
public class DVD
{
    private String title;

    public DVD(String title){
        setTitle(title);
    }

    public DVD(){
    }

    public String getTitle(){
        return title;
    }
```
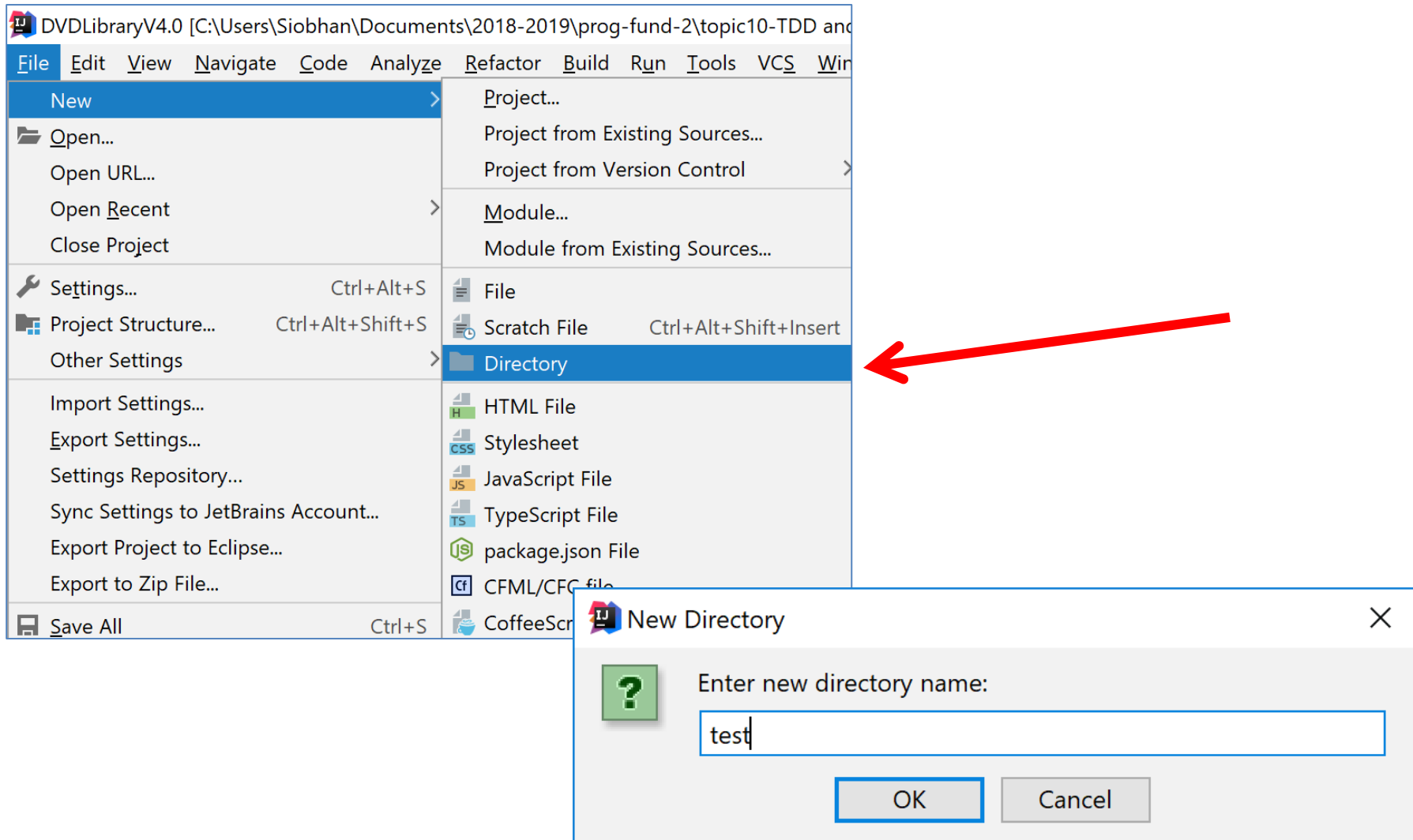
```java
    public void setTitle(String title){
        if (title.length() <= 20){
            this.title = title
        }
        else{
            this.title = title.substring(0,20);
        }
    }

    public String toString(){
        return "DVD Title is: " + title;
    }
}
```
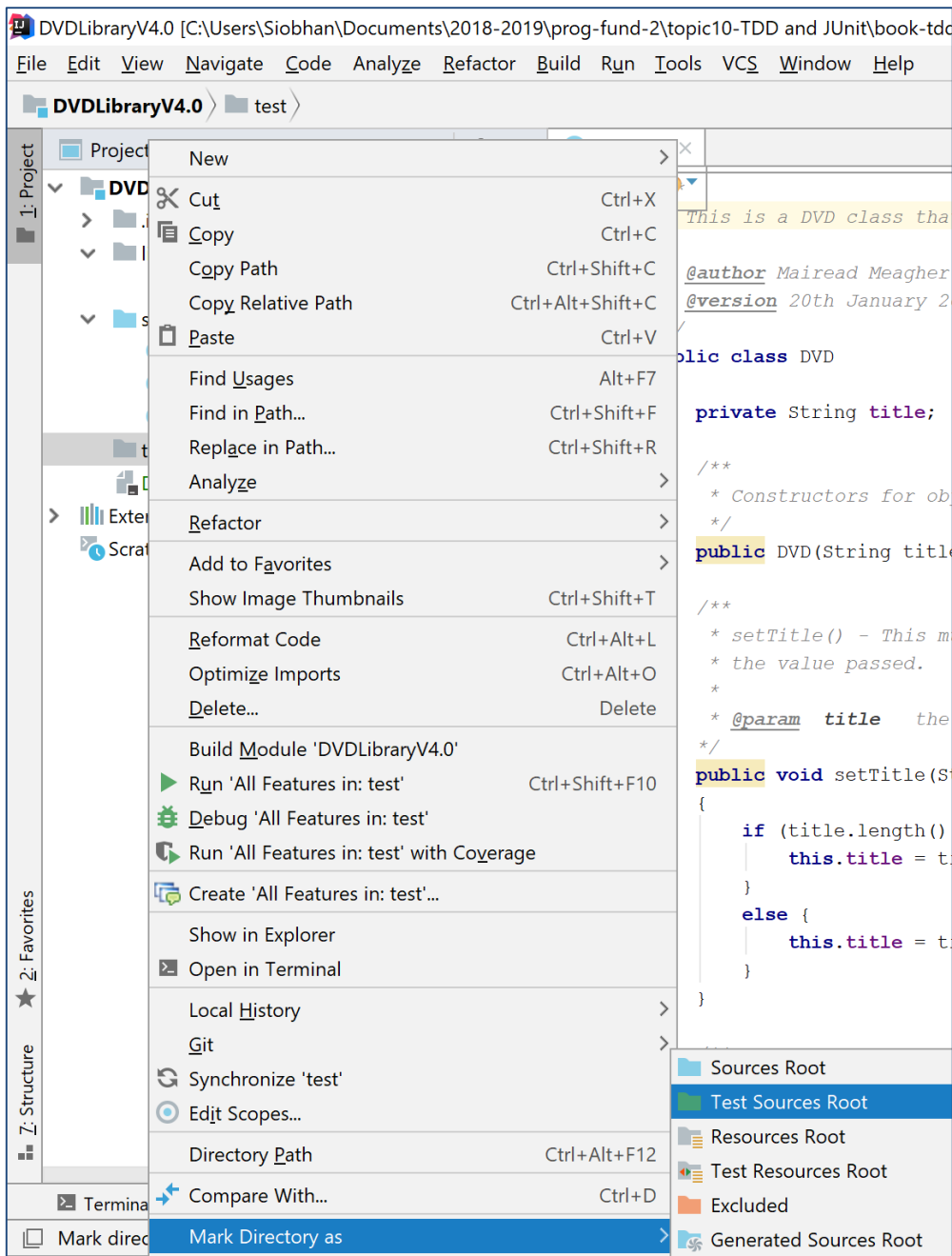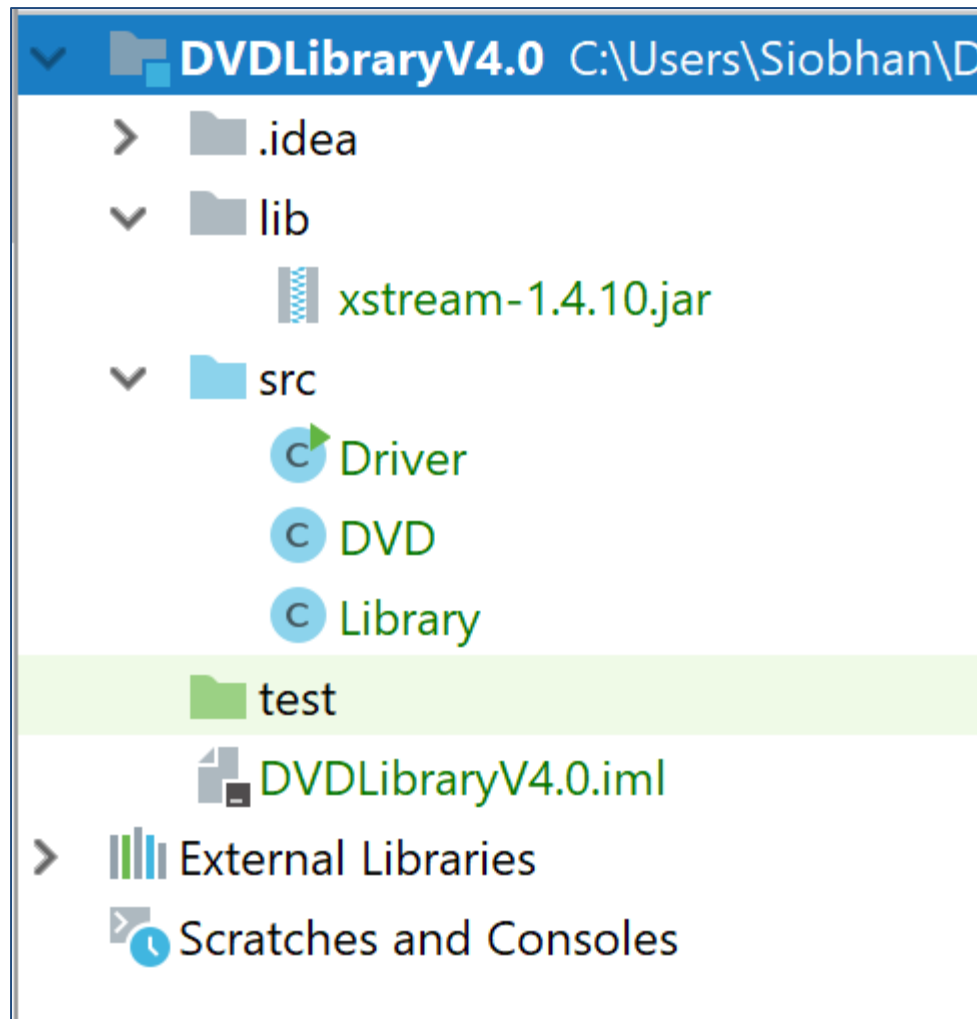
Creating a Test Source Directory…

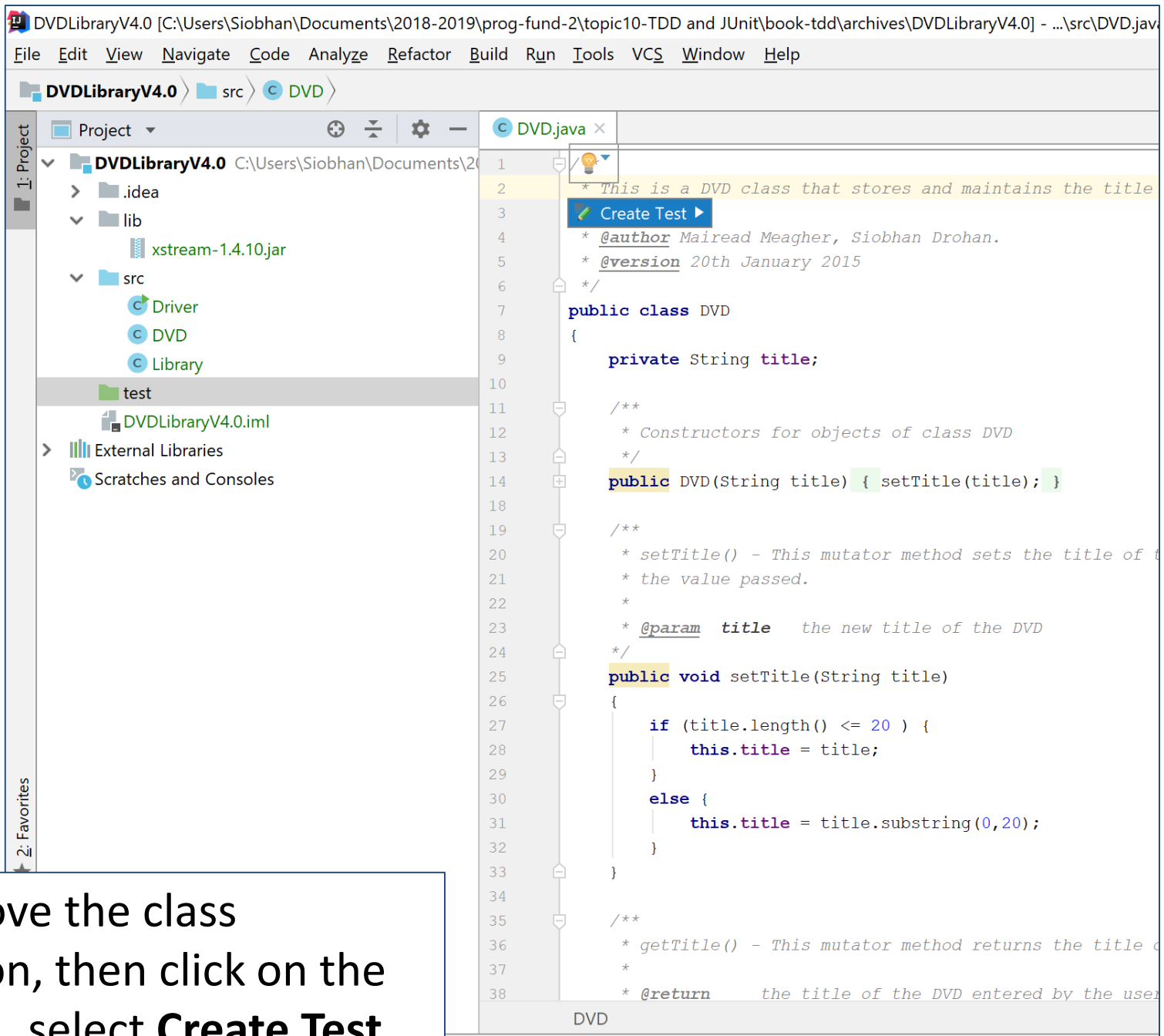# In IntelliJ, create a new "test" directory to hold your test classes

Then "mark" this new directory as a **Test Sources Root** directory

Current Folder Structure

Generating a test class for DVD.Java …

File   Edit   View   Navigate   Code   Analyze   Refactor   Build   Run   Tools   VCS   Window   Help

DVDLibraryV4.0 > src > DVD

Project ▼   DVD.java ✕

DVDLibraryV4.0 C:\Users\Siobhan\Documents\2(
  > .idea
  ∨ lib
       xstream-1.4.10.jar
  ∨ src
       Driver
       DVD
       Library
     test
     DVDLibraryV4.0.iml
  > External Libraries
     Scratches and Consoles

```java
1
2   * This is a DVD class that stores and maintains the title
3   ✎ Create Test ▶
4   * @author Mairead Meagher, Siobhan Drohan.
5   * @version 20th January 2015
6   */
7  public class DVD
8  {
9      private String title;
10
11     /**
12      * Constructors for objects of class DVD
13      */
14     public DVD(String title) { setTitle(title); }
18
19     /**
20      * setTitle() - This mutator method sets the title of t
21      * the value passed.
22      *
23      * @param  title   the new title of the DVD
24      */
25     public void setTitle(String title)
26     {
27         if (title.length() <= 20 ) {
28             this.title = title;
29         }
30         else {
31             this.title = title.substring(0,20);
32         }
33     }
34
35     /**
36      * getTitle() - This mutator method returns the title o
37      *
38      * @return   the title of the DVD entered by the user
```

DVD

1

Click above the class declaration, then click on the light bulb...select **Create Test**

Create Test   ✕

Testing library: ◀▶ JUnit5   ⌄

💡 JUnit5 library not found in the module   [Fix]

Class name: DVDTest

Superclass: [⌄] [...]

Destination package: [⌄] [...]

Generate: ☐ setUp/@Before
                        ☐ tearDown/@After

Generate test methods for: ☐ Show inherited methods

Member
☐ Ⓜ 🔓 setTitle(title:String):void
☐ Ⓜ 🔓 getTitle():String
☐ Ⓜ 🔓 ⊙ toString():String

❓   [OK]   [Cancel]
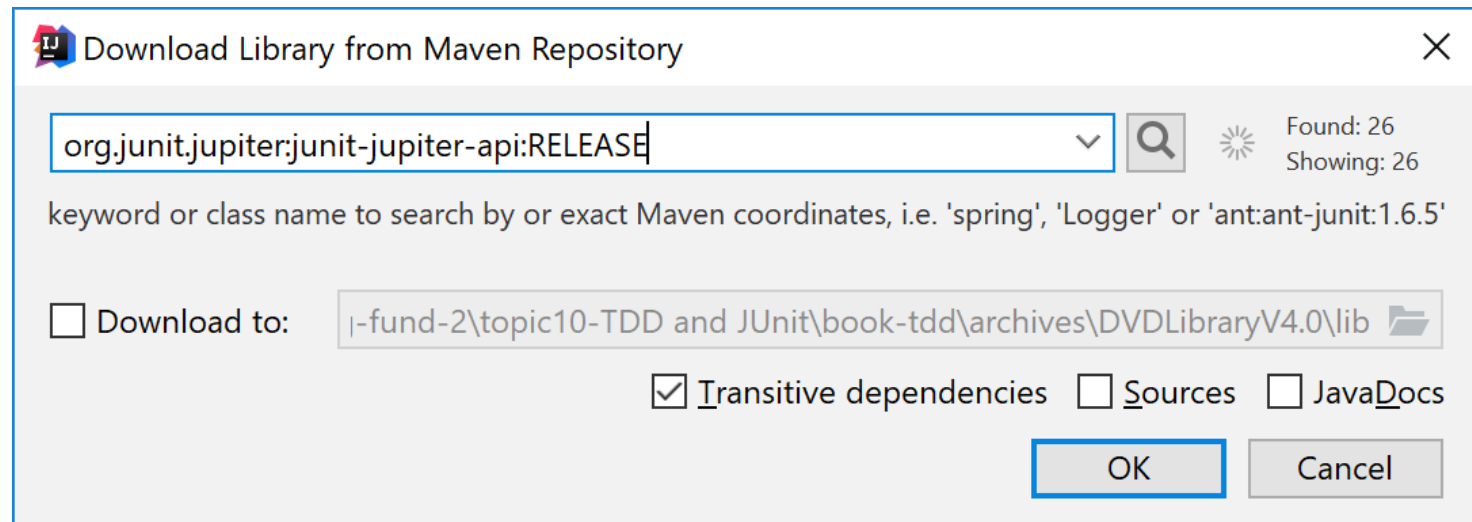
② Choose JUnit5

③ Click the Fix button…

...and click the OK button do download JUnit5 from Maven

Create Test

Testing library: JUnit5

Class name: DVDTest

Superclass:

Destination package:

Generate:
- ☑ setUp/@Before
- ☑ tearDown/@After

Generate test methods for: ☐ Show inherited methods

Member
☑ m 🔒 setTitle(title:String):void
☑ m 🔒 getTitle():String
☑ m 🔒 toString():String

OK   Cancel

---

5 Now that JUnit5 is downloaded...select the checkboxes as shown to generate test methods.

Note the class name is set to DVDTest.

DVDLibraryV4.0 [C:\Users\Siobhan\Documents\2018-2019\prog-fund-2\topic10-TDD and JUnit\book-tdd\archives\DVDLibraryV4.0] - ...\test\DVDTest.

File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
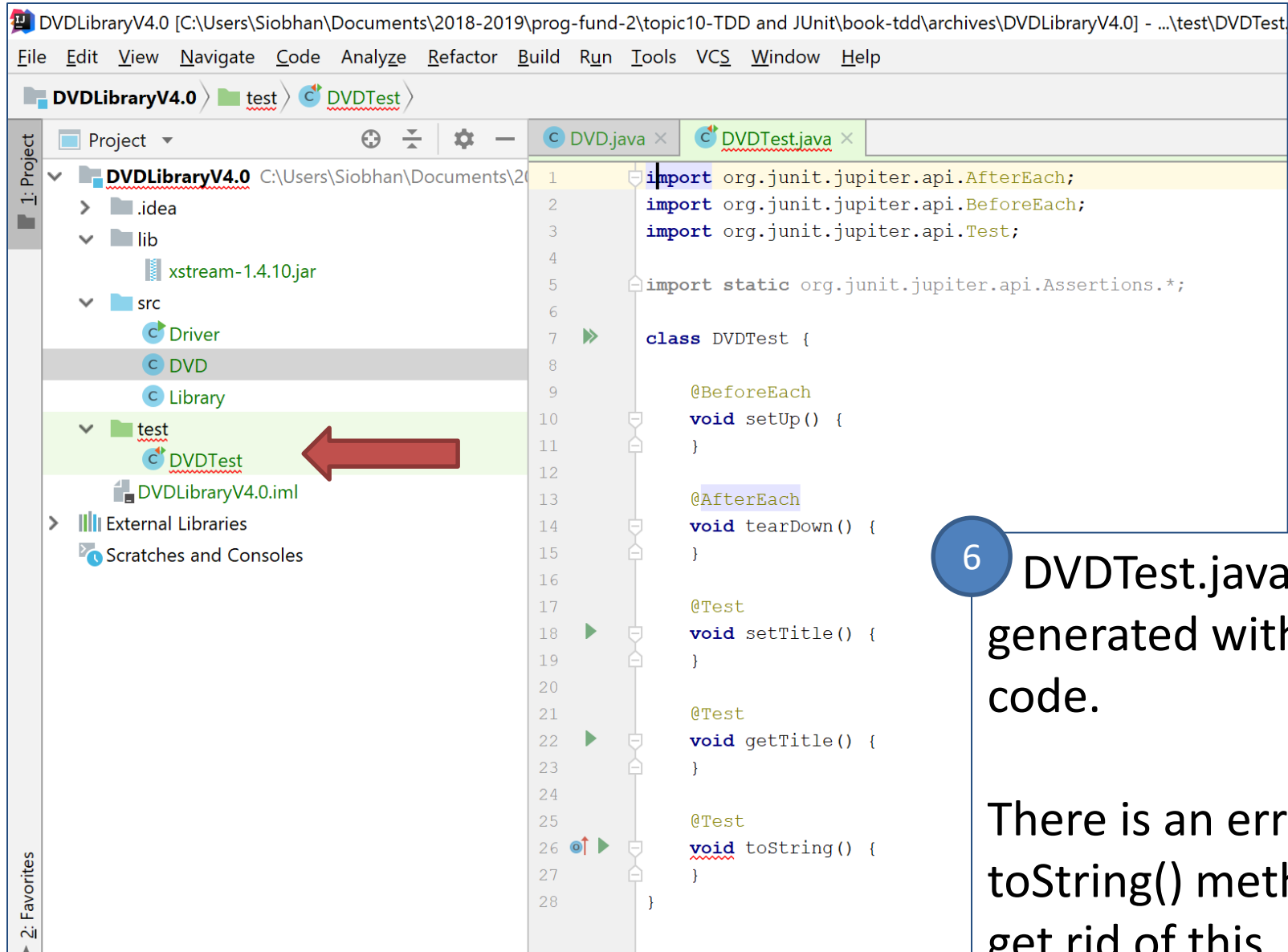
DVDLibraryV4.0 > test > DVDTest

Project

- DVDLibraryV4.0 C:\Users\Siobhan\Documents\2(
  - .idea
  - lib
    - xstream-1.4.10.jar
  - src
    - Driver
    - DVD
    - Library
  - test
    - DVDTest ←
  - DVDLibraryV4.0.iml
- External Libraries
- Scratches and Consoles

```java
import org.junit.jupiter.api.AfterEach;
import org.junit.jupiter.api.BeforeEach;
import org.junit.jupiter.api.Test;

import static org.junit.jupiter.api.Assertions.*;

class DVDTest {

    @BeforeEach
    void setUp() {
    }

    @AfterEach
    void tearDown() {
    }

    @Test
    void setTitle() {
    }

    @Test
    void getTitle() {
    }

    @Test
    void toString() {
    }
}
```

6 DVDTest.java is generated with starting code.

There is an error on the toString() method...to get rid of this, just rename it e.g. testToString().

DVDTest.Java
Writing and running tests…

Recap of DVD.java

```java
public class DVD
{
    private String title;

    public DVD(String title){
        setTitle(title);
    }

    public DVD(){
    }

    public String getTitle(){
        return title;
    }
```

```java
    public void setTitle(String title){
        if (title.length() <= 20){
            this.title = title
        }
        else{
            this.title = title.substring(0,20);
        }
    }

    public String toString(){
        return "DVD Title is: " + title;
    }
}
```

```java
import org.junit.jupiter.api.AfterEach;
import org.junit.jupiter.api.BeforeEach;
import org.junit.jupiter.api.Test;

import static org.junit.jupiter.api.Assertions.*;

class DVDTest {

    private DVD dvd1, dvd2, dvd3;

    @BeforeEach
    void setUp() {
        dvd1 = new DVD("The Hobbit(Director)");  //title with 20 characters
        dvd2 = new DVD("The Steve Jobs Film");   //title with 19 characters
        dvd3 = new DVD("Avatar: Directors Cut"); //title with 21 characters
    }

    @AfterEach
    void tearDown() {
        dvd1 = dvd2 = dvd3 = null;
    }

    @Test
    void setTitle() {
    }

    @Test
    void getTitle() {
    }

    @Test
    void testToString() {
    }
}
```

7 DVDTest.java

Add three DVD objects and instantiate them with titles 19, 20 and 21 characters long (boundary test).

```java
class DVDTest {

    private DVD dvd1, dvd2, dvd3;

    @BeforeEach
    void setUp() {
        dvd1 = new DVD("The Hobbit(Director)");  //title with 20 characters
        dvd2 = new DVD("The Steve Jobs Film");   //title with 19 characters
        dvd3 = new DVD("Avatar: Directors Cut"); //title with 21 characters
    }

    @AfterEach
    void tearDown() {
        dvd1 = dvd2 = dvd3 = null;
    }

    @Test
    void setTitle() {
    }

    @Test
    void getTitle() {
        assertEquals("The Hobbit(Director)", dvd1.getTitle());
        assertEquals("The Steve Jobs Film", dvd2.getTitle());
        assertEquals("Avatar: Directors Cu", dvd3.getTitle());
    }

    @Test
    void testToString() {
    }
}
```

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DVDTest.java

Include three assertions to test the getTitle() method (note: the constructor would have set up the object state).
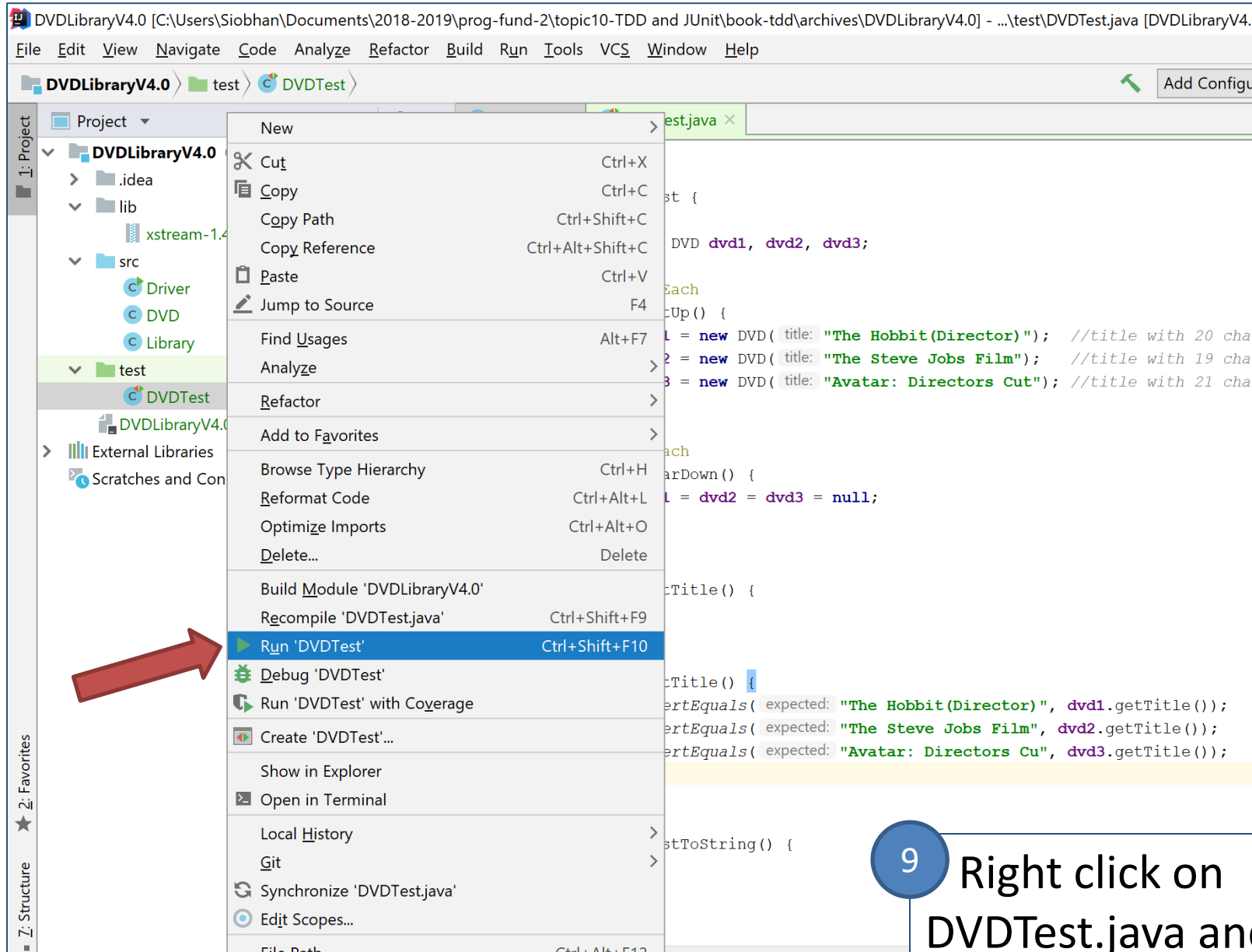
9 Right click on DVDTest.java and select "Run DVDTest" from the context menu.

Run: DVDTest ×

▶ ⊘ ⬭ ⬇ᵃ ⬇ᶻ ⮝ ⮟ » ⊘ Tests passed: 3 of 3 tests – 30 ms

⊘ Test Results   30 ms   "C:\Program Files\Java\jdk-10.0.2\bin\java.exe" ...
  ⊘ DVDTest   30 ms
    ⊘ testToString()   19 ms   Process finished with exit code 0
    ⊘ setTitle()   1 ms
    ⊘ getTitle()   10 ms

≥_ Terminal   ≡ 0: Messages   ▶ 4: Run   ≔ 6: TODO

Itemised tests and their individual result.
Green = Pass

10

The results of the tests!

DVDTest.Java

Generating a test failure…

```java
class DVDTest {

    private DVD dvd1, dvd2, dvd3;

    @BeforeEach
    void setUp() {
        dvd1 = new DVD("The Hobbit(Director)");  //title with 20 characters
        dvd2 = new DVD("The Steve Jobs Film");   //title with 19 characters
        dvd3 = new DVD("Avatar: Directors Cut"); //title with 21 characters
    }

    @AfterEach
    void tearDown() {
        dvd1 = dvd2 = dvd3 = null;
    }

    @Test
    void setTitle() {
    }

    @Test
    void getTitle() {
        assertEquals("The Hobbit(Director)", dvd1.getTitle());
        assertEquals("The Steve Jobs Film", dvd2.getTitle());
        //assertEquals("Avatar: Directors Cu", dvd3.getTitle());
        assertEquals("Avatar: Directors", dvd3.getTitle());
    }

    @Test
    void testToString() {
    }
}
```

1 Change the "expected" portion of the assertEquals to something invalid…

2 The results of the tests...we now have a failing test!

Number of tests that failed, passed and ran.

Run: ▶ DVDTest ✕

▶ ⊘ ⊜ ↓ᵃ ↓ᶻ ⊼ ⊽ ↑ ↓ » ⚠ Tests failed: 1, passed: 2 of 3 tests – 71 ms

⚠ Test Results   71 ms
  ⚠ DVDTest   71 ms
    ⊘ testToString()   46 ms
    ⊘ setTitle()
    ⚠ getTitle()   25 ms

```
"C:\Program Files\Java\jdk-10.0.2\bin\java.exe" ..

org.opentest4j.AssertionFailedError:
Expected :Avatar: Directors
Actual   :Avatar: Directors Cu
  <Click to see difference>

⊞ <5 internal calls>
    at DVDTest.getTitle(DVDTest.java:32)
```

Itemised tests and their individual result.
Green = Pass
Orange = Fail

Detail of the test failure

DVDTest.Java

Testing the setters…
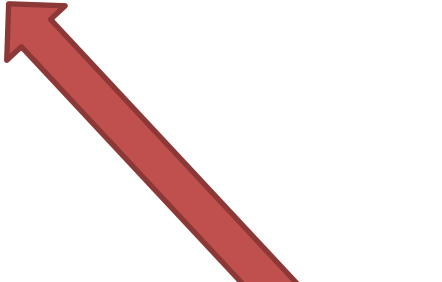
```java
@Test
void setTitle() {
    dvd1.setTitle("The Hobbit");
    assertEquals ("The Hobbit", dvd1.getTitle());

    dvd1.setTitle("The Hobbit (Director)");   //attempting to set title to 21 characters
    assertEquals ("The Hobbit (Director", dvd1.getTitle());

    dvd1.setTitle("The Hobbit(Director)");   //attempting to set title to 20 characters
    assertEquals ("The Hobbit(Director)", dvd1.getTitle());

    dvd1.setTitle("The Hobbit:Director");   //attempting to set title to 19 characters
    assertEquals ("The Hobbit:Director", dvd1.getTitle());
}

@Test
void getTitle() {
    assertEquals("The Hobbit(Director)", dvd1.getTitle());
    assertEquals("The Steve Jobs Film", dvd2.getTitle());
    assertEquals("Avatar: Directors Cu", dvd3.getTitle());
}
```

1

DVDTest.java

Attempting to set the title to 19, 20 and 21 characters long (boundary test).

Run: DVDTest ×

Tests passed: 3 of 3 tests – 33 ms

Test Results	33 ms	`"C:\Program Files\Java\jdk-10.0.2\bin\java.exe" ...`
DVDTest	33 ms	
testToString()	19 ms	`Process finished with exit code 0`
setTitle()	13 ms	
getTitle()	1 ms	
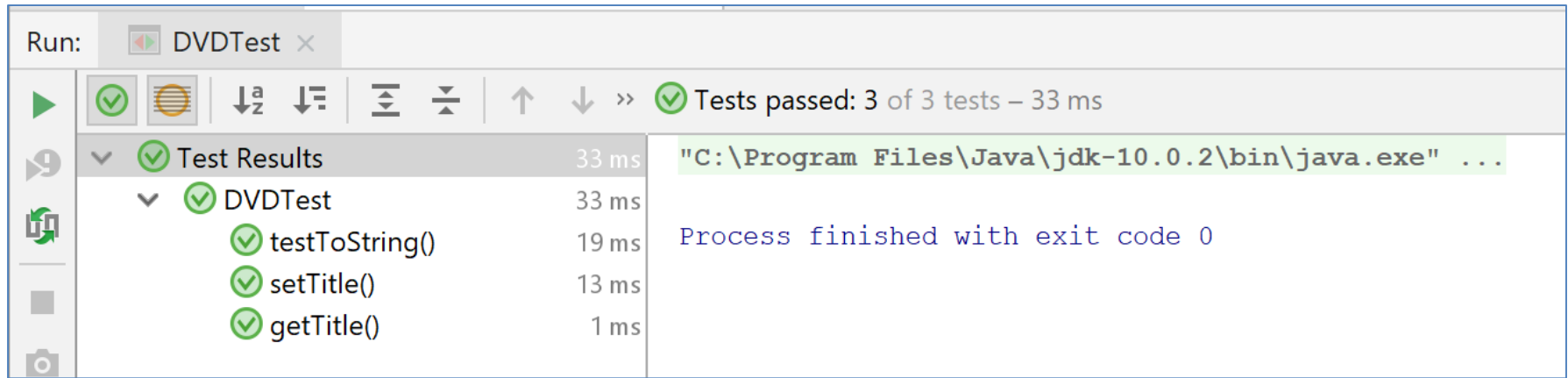
② All tests are passing

DVDTest.Java

Testing the toString…

```java
class DVDTest {

    private DVD dvd1, dvd2, dvd3;

    @BeforeEach
    void setUp() {
        dvd1 = new DVD("The Hobbit(Director)"); //title with 20 characters
        dvd2 = new DVD("The Steve Jobs Film");  //title with 19 characters
        dvd3 = new DVD("Avatar: Directors Cut"); //title with 21 characters
    }

    @AfterEach
    void tearDown() {
        dvd1 = dvd2 = dvd3 = null;
    }

    @Test
    void setTitle() {
        //code omitted
    }

    @Test
    void getTitle() {
        //code omitted
    }

    @Test
    void testToString() {
        assertEquals("DVD Title is: The Hobbit(Director)", dvd1.toString());
        assertEquals("DVD Title is: The Steve Jobs Film", dvd1.toString());
        assertEquals("DVD Title is: Avatar: Directors Cu", dvd1.toString());
    }
}
```

1 DVDTest.java

Asserting that the toString is returning the contents of the title field. **Does this look right? Will it run successfully?**

Run: DVDTest ×

(!) Tests failed: 1, passed: 2 of 3 tests – 34 ms

⌄ (!) Test Results	34 ms	
⌄ (!) DVDTest	34 ms	
(!) testToString()	32 ms	
✓ setTitle()	1 ms	
✓ getTitle()	1 ms	

```
org.opentest4j.AssertionFailedError:
Expected :DVD Title is: The Steve Jobs Film
Actual   :DVD Title is: The Hobbit(Director)
 <Click to see difference>


⊞  <5 internal calls>
     at DVDTest.testToString(DVDTest.java:48)
```

```java
class DVDTest {

    private DVD dvd1, dvd2, dvd3;

    @BeforeEach
    void setUp() {
        dvd1 = new DVD("The Hobbit(Director)");  //title with 20 characters
        dvd2 = new DVD("The Steve Jobs Film");   //title with 19 characters
        dvd3 = new DVD("Avatar: Directors Cut"); //title with 21 characters
    }

    @AfterEach
    void tearDown() {
        dvd1 = dvd2 = dvd3 = null;
    }

    @Test
    void setTitle() {
        //code omitted
    }

    @Test
    void getTitle() {
        //code omitted
    }

    @Test
    void testToString() {
        assertEquals("DVD Title is: The Hobbit(Director)", dvd1.toString());
        assertEquals("DVD Title is: The Steve Jobs Film", dvd1.toString());
        assertEquals("DVD Title is: Avatar: Directors Cut", dvd1.toString());
    }
}
```

We are referencing the wrong dvd objects in the last two method calls.

```java
    @Test
    void testToString() {
        assertEquals("DVD Title is: The Hobbit(Director)", dvd1.toString());
        assertEquals("DVD Title is: The Steve Jobs Film", dvd2.toString());
        assertEquals("DVD Title is: Avatar: Directors Cu", dvd3.toString());
    }
}
```

We are now referencing the correct dvd objects, so our test is now successful.

Run: DVDTest ✕

▶ ✓ ◉ ↓ᵃ ↓₌ ⤒ ⤓ ↑ ↓ » ✓ Tests passed: 3 of 3 tests – 27 ms

Test Results	27 ms
DVDTest	27 ms
testToString()	24 ms
setTitle()	1 ms
getTitle()	2 ms

"C:\Program Files\Java\jdk-10.0.2\bin\java.exe" ...

Process finished with exit code 0

DVDTest.Java

Have we tested everything in DVD.java?

DVD.java

```java
public class DVD
{
    private String title;

    public DVD(String title){
        setTitle(title);
    }


    public DVD(){
    }


    public String getTitle(){
        return title;
    }
}
```
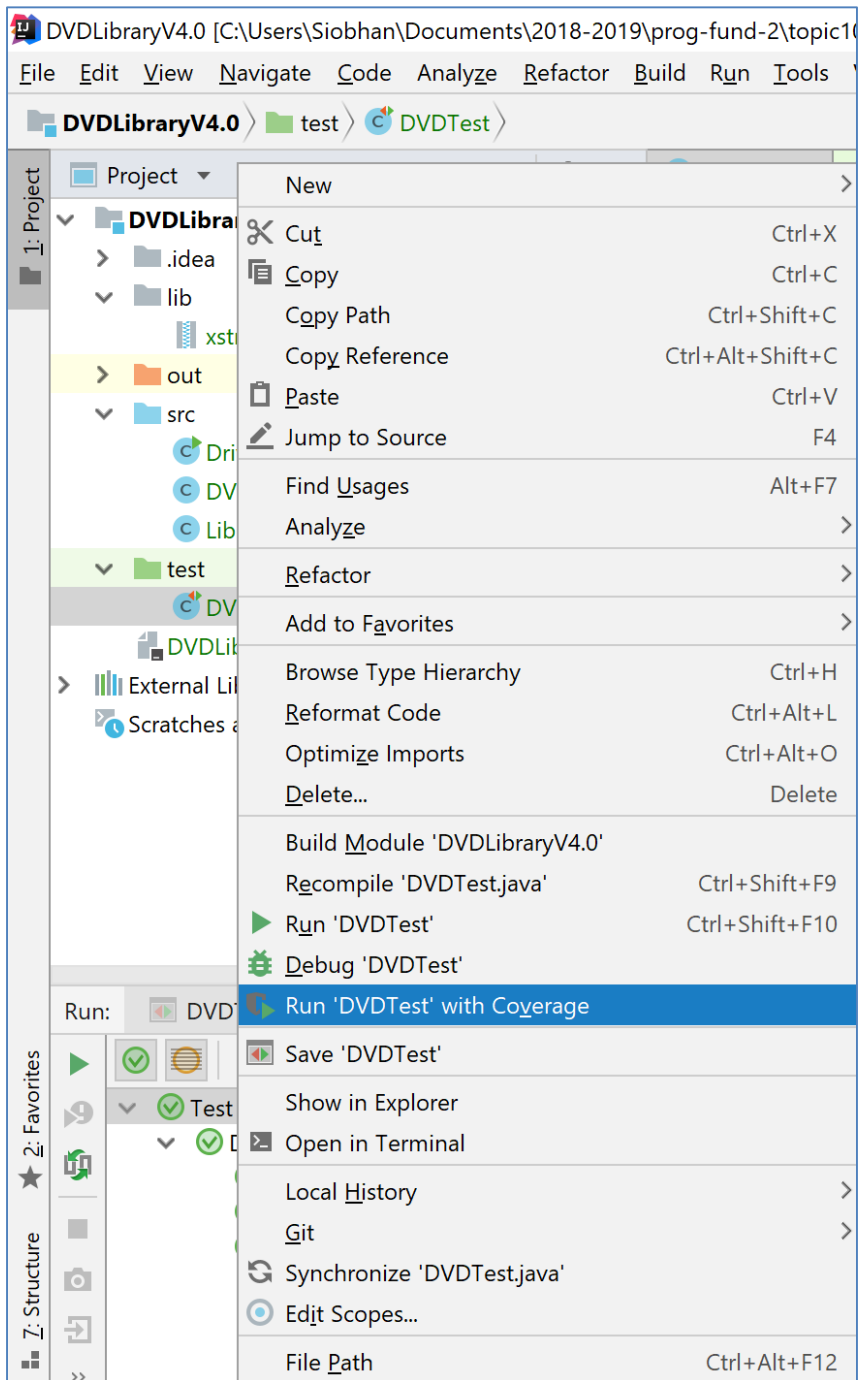
```java
    public void setTitle(String title){
        if (title.length() <= 20){
            this.title = title
        }
        else{
            this.title = title.substring(0,20);
        }
    }

    public String toString(){
        return "DVD Title is: " + title;
    }
}
```

DVDLibraryV4.0 [C:\Users\Siobhan\Documents\2018-2019\prog-fund-2\topic1(

File   Edit   View   Navigate   Code   Analyze   Refactor   Build   Run   Tools

DVDLibraryV4.0 ⟩ test ⟩ DVDTest ⟩

Project ▾

DVDLibra
> .idea
∨ lib
   xst
> out
∨ src
   Dri
   DV
   Lib
∨ test
   DV
   DVDLib
> External Lil
   Scratches

New		⟩
✂ Cut	Ctrl+X	
▤ Copy	Ctrl+C	
Copy Path	Ctrl+Shift+C	
Copy Reference	Ctrl+Alt+Shift+C	
📋 Paste	Ctrl+V	
✎ Jump to Source	F4	
Find Usages	Alt+F7	
Analyze		⟩
Refactor		⟩
Add to Favorites		⟩
Browse Type Hierarchy	Ctrl+H	
Reformat Code	Ctrl+Alt+L	
Optimize Imports	Ctrl+Alt+O	
Delete...	Delete	
Build Module 'DVDLibraryV4.0'		
Recompile 'DVDTest.java'	Ctrl+Shift+F9	
▶ Run 'DVDTest'	Ctrl+Shift+F10	
🐞 Debug 'DVDTest'		
▶ Run 'DVDTest' with Coverage		
◀ Save 'DVDTest'		
Show in Explorer		
▶ Open in Terminal		
Local History		⟩
Git		⟩
🔄 Synchronize 'DVDTest.java'		
⊙ Edit Scopes...		
File Path	Ctrl+Alt+F12	

Run: DVD

▶ ⊘ ≡
Test
D

1

DVDTest.java

We can get IntelliJ to highlight the code in DVD.java that hasn't been tested by DVDTest.java

....code coverage of tests!

Coverage: DVDTest

33% classes, 8% lines covered in 'all classes in scope'

Element	Class, %	Method, %	Line, %
com			
images			
java			
javafx			
javax			
jdk			
META-INF			
netscape			
oracle			
org			
sun			
toolbarButtonGraphics			
Driver	0% (0/1)	0% (0/7)	0% (0/73)
DVD	100% (1/1)	80% (4/5)	81% (9/11)
Library	0% (0/1)	0% (0/7)	0% (0/24)

DVD.java

```
6    */
7    public class DVD
8    {
9        private String title;
10
11       /**
12        * Constructors for objects of class DVD
13        */
14       public DVD(String title)
15       {
16           setTitle(title);
17       }
18
19       public DVD() {
20       }
21
22       /**
23        * setTitle() - This mutator method sets the title of the DV
24        * the value passed.
25        *
26        * @param title   the new title of the DVD
27        */
```

2 Test Coverage of DVD.java is 80% at method level...we missed something!

3 DVD.java is colour coded after the coverage...green for fully tested and red for not tested.

```java
class DVDTest {

    private DVD dvd1, dvd2, dvd3, dvd4;

    @BeforeEach
    void setUp() {
        dvd1 = new DVD("The Hobbit(Director)");  //title with 20 characters
        dvd2 = new DVD("The Steve Jobs Film");   //title with 19 characters
        dvd3 = new DVD("Avatar: Directors Cut"); //title with 21 characters
        dvd4 = new DVD();
    }

    @AfterEach
    void tearDown() {
        dvd1 = dvd2 = dvd3 = dvd4 = null;
    }

    @Test
    void setTitle() {
        //code omitted
    }

    @Test
    void getTitle() {
        assertEquals("The Hobbit(Director)", dvd1.getTitle());
        assertEquals("The Steve Jobs Film", dvd2.getTitle());
        assertEquals("Avatar: Directors Cu", dvd3.getTitle());
        assertEquals(null, dvd4.getTitle());
    }

    @Test
    void testToString() {
        //code omitted
    }
}
```

4 We have added a new fixture, dvd4 and tested it in getTitle().

Coverage of DVD.java is now 100%