

# Object-Oriented Programming in the Java language

TDD and JUnit

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# History

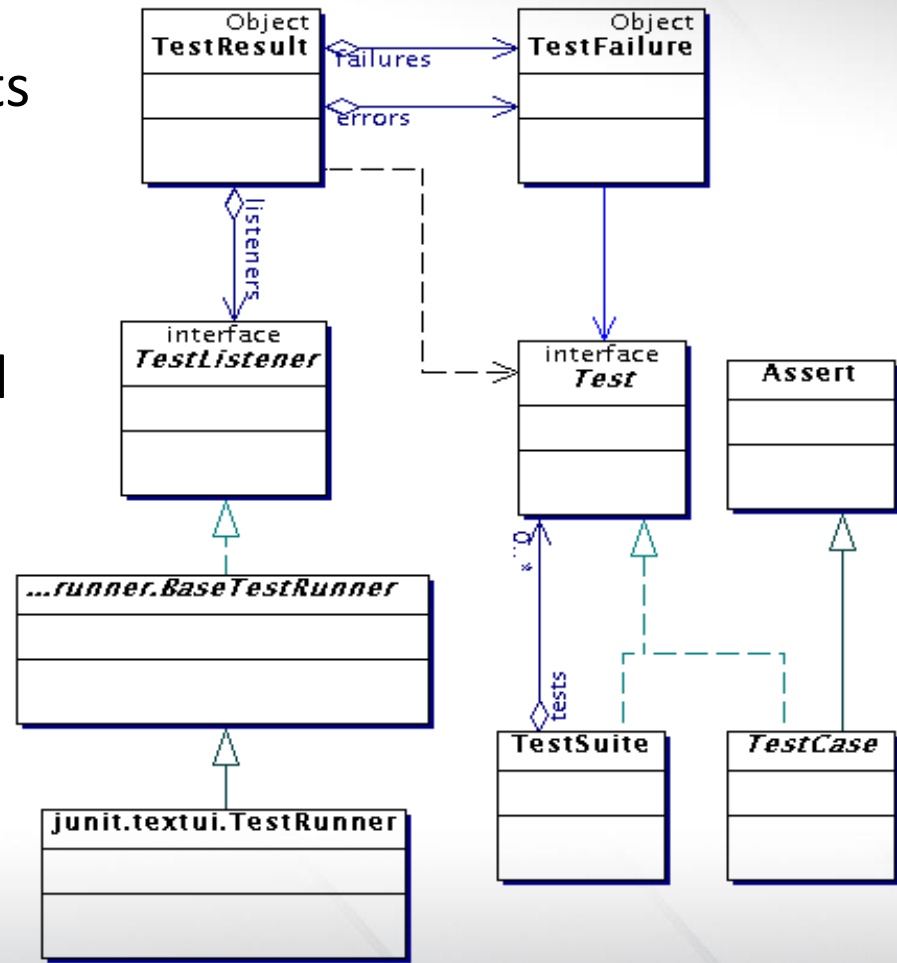
- Kent Beck developed the first xUnit automated test tool for Smalltalk in mid-90's
- Beck and Gamma (of design patterns Gang of Four) developed JUnit on a flight from Zurich to Washington, D.C.
- Martin Fowler: "Never in the field of software development was so much owed by so many to so few lines of code."
- JUnit has become the standard tool for Test-Driven Development in Java (see [junit.org](http://junit.org))
- JUnit test generators now part of many Java IDEs (IntelliJ IDEA, NetBeans, Eclipse, BlueJ, ...)

# Why create a test suite?

- Obviously you have to test your code—right?
  - You can do *ad hoc* testing (running whatever tests occur to you at the moment), or
  - You can build a test suite (a thorough set of tests that can be run at any time)
- Disadvantages of a test suite
  - It's a lot of extra programming
    - True, but use of a good test framework can help quite a bit
  - You don't have time to do all that extra work
    - *False!* Experiments repeatedly show that test suites reduce debugging time more than the amount spent building the test suite
- Advantages of a test suite
  - Reduces total number of bugs in delivered code
  - Makes code much more maintainable and refactorable

# Architectural overview

- JUnit test framework is a package of classes that lets you write tests for each method, then easily run those tests
- **TestRunner** runs tests and reports **TestResults**
- You test your class by extending abstract class **TestCase** (optional)
- To write test cases, you need to know and understand the **Assert** class



# Writing a TestCase

- To start using JUnit, create a subclass of *TestCase*, (optional in JUnit 4 and 5) to which you add test methods
- Name of class is important – should be of the form **MyClass***Test*
- This naming convention lets TestRunner automatically find your test classes

```
import org.junit.jupiter.api.BeforeEach;
```

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

```
class MainTest {  
    @BeforeEach  
    void setUp() {  
  
    }  
}
```

# Writing methods in TestCase

- Pattern follows *programming by contract* paradigm:
  - Set up **preconditions**
  - Exercise functionality being tested
  - Check **postconditions**
- Example:

```
public void testEmptyList() {  
    Bowl emptyBowl = new Bowl();  
    assertEquals(0, emptyList.size(),  
        "Size of an empty list should be zero.");  
    assertTrue(emptyBowl.isEmpty(),  
        "An empty bowl should report empty.");  
}
```
- Things to notice:
  - Specific method signature – public void **test**Whatever()
  - Coding follows pattern
  - Notice the assert-type calls...

# Assert methods

- Each assert method has parameters like these:  
*expected-value, actual-value, message*
- Assert methods dealing with floating point numbers get an additional argument, a tolerance
- Each assert method has an equivalent version that does not take a message – however, this use is not recommended because:
  - messages helps documents the tests
  - messages provide additional information when reading failure logs

# Assert methods

- `assertTrue(Boolean test, String message)`
- `assertFalse(Boolean test, String message)`
- `assertNull(Object object, String message)`
- `assertNotNull(Object object, String message)`
- `assertEquals(Object expected, Object actual, String message)`  
    *// uses equals method*
- `assertSame(Object expected, Object actual, String message)`  
    *// uses == operator*
- `assertNotSame(Object expected, Object actual, String message)`



# More stuff in test classes

- Suppose you want to test a class **Counter**
- **public class CounterTest {**
  - This is the unit test for the **Counter** class
- **public CounterTest() { } //Default constructor**
- **protected void setUp()**
  - Test *fixture* creates and initializes instance variables, etc.
- **protected void tearDown()**
  - Releases any system resources used by the test fixture
- **public void testIncrement(), public void testDecrement()**
  - These methods contain tests for the **Counter** methods **increment()**, **decrement()**, etc.
  - Note capitalization convention

# JUnit tests for Counter

```
public class CounterTest {  
    Counter counter1;  
    @BeforeEach  
    protected void setUp() { // creates a test fixture  
        counter1 = new Counter();  
    }  
    @Test  
    public void testIncrement() {  
        assertTrue(counter1.increment() == 1);  
        assertTrue(counter1.increment() == 2);  
    }  
    @Test  
    public void testDecrement() {  
        assertTrue(counter1.decrement() == -1);  
    }  
}
```

Note that each test begins with a *brand new* counter

This means you don't have to worry about the order in which the tests are run

# TestSuites

- TestSuites collect a selection of tests to run them as a unit
- Collections automatically use TestSuites, however to specify the order in which tests are run, write your own:

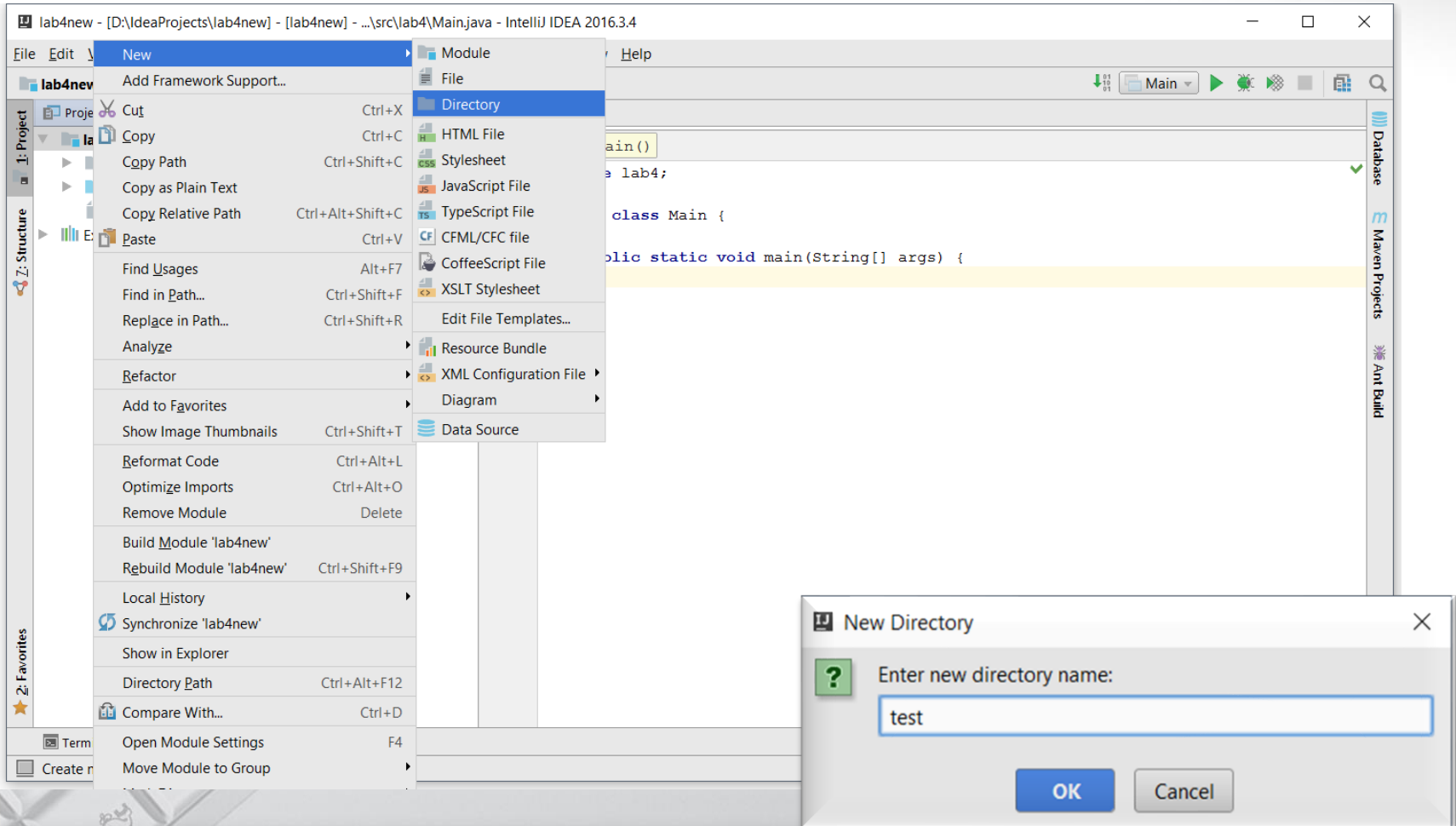
```
public static Test suite() {  
    suite.addTest(new TestBowl("testBowl"));  
    suite.addTest(new TestBowl("testAdding"));  
    return suite;  
}
```

- Should seldom have to write your own TestSuites as each method in your TestCase should be independent of all others
- Can create TestSuites that test a whole package:

```
public static Test suite() {  
    TestSuite suite = new TestSuite();  
    suite.addTestSuite(TestBowl.class);  
    suite.addTestSuite(TestFruit.class);  
    return suite;  
}
```

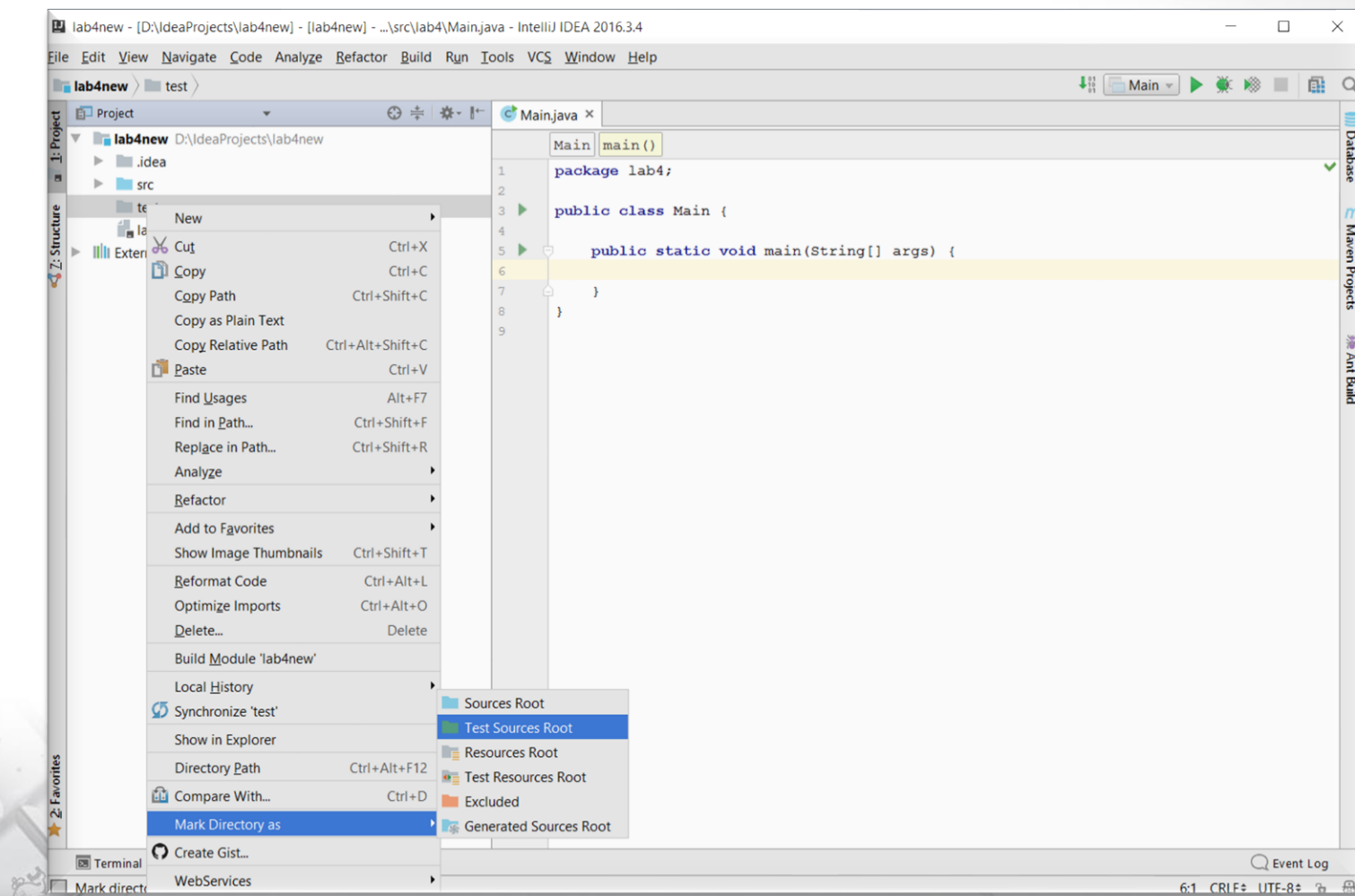
# JUnit in IntelliJ IDEA

At first you have to create a directory for your tests



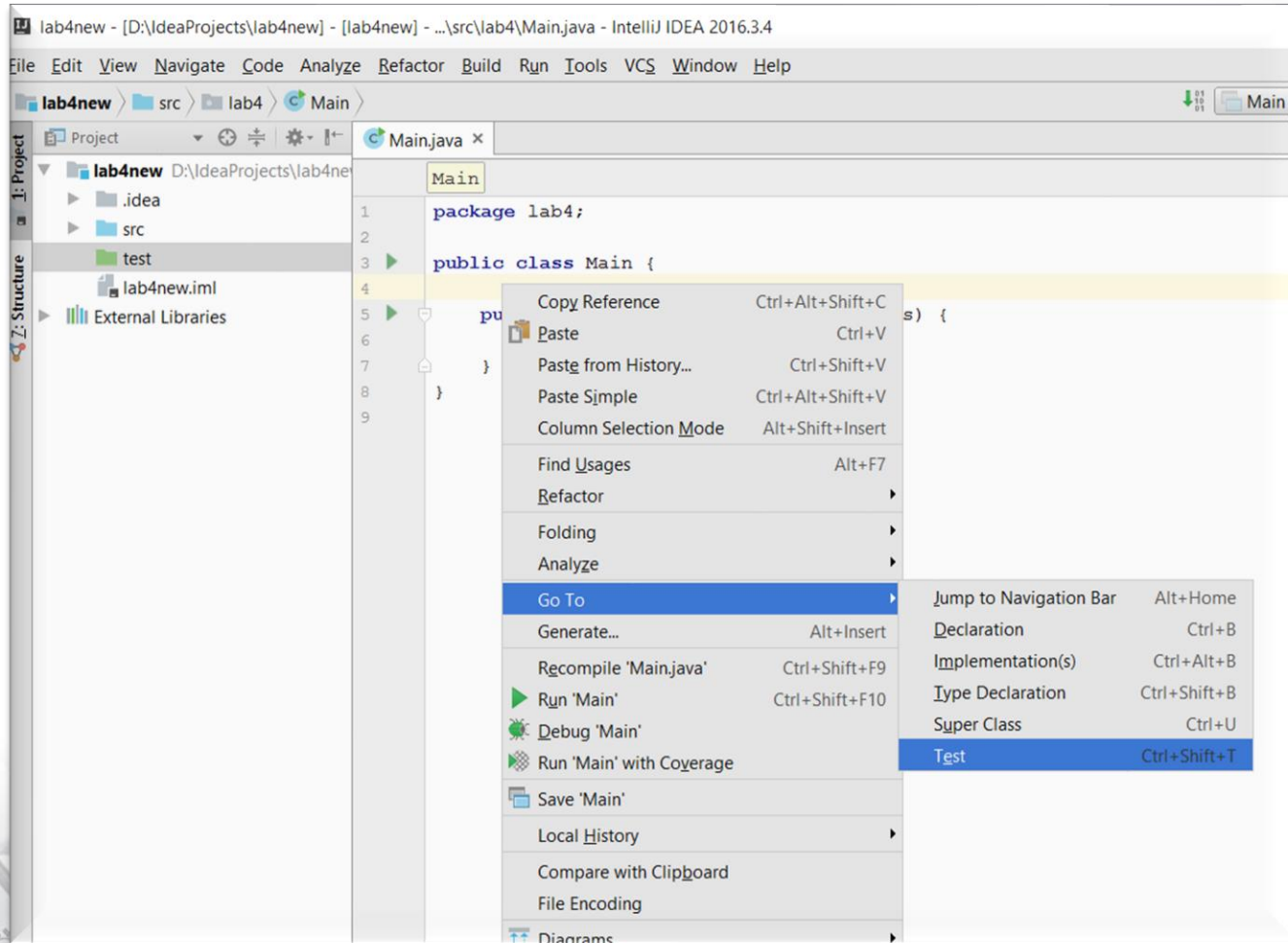
# JUnit in IntelliJ IDEA

Then, mark it as Test Sources Root

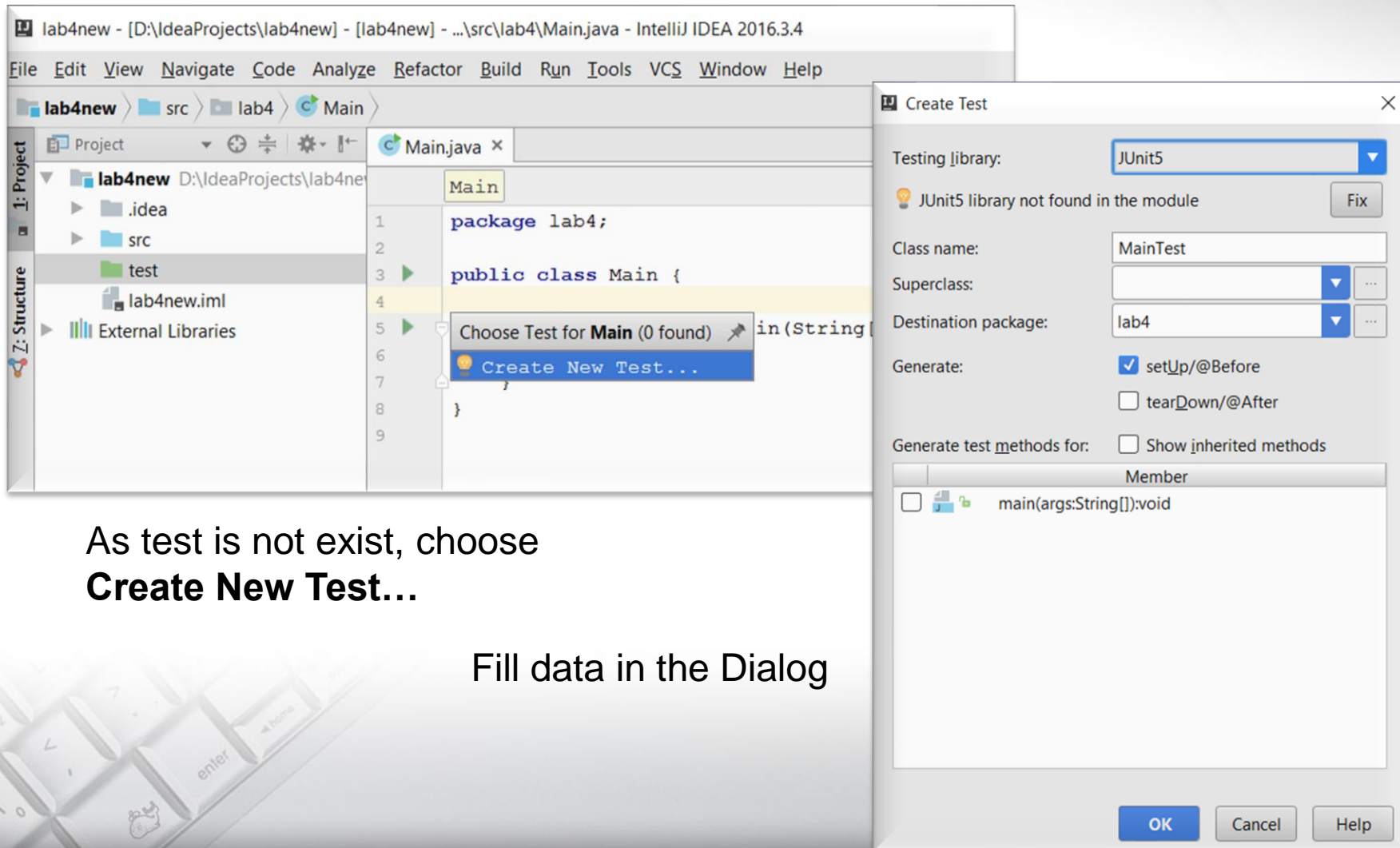


# JUnit in IntelliJ IDEA

In your class choose “Go To ► Test



# JUnit in IntelliJ IDEA



The screenshot shows the IntelliJ IDEA 2016.3.4 interface. The 'Main.java' file is open, showing the following code:

```
1 package lab4;  
2  
3 public class Main {  
4  
5     in (String  
6  
7  
8  
9 }
```

A context menu is open over the code, with the option 'Create New Test...' selected. The 'Create Test' dialog is also open, showing the following configuration:

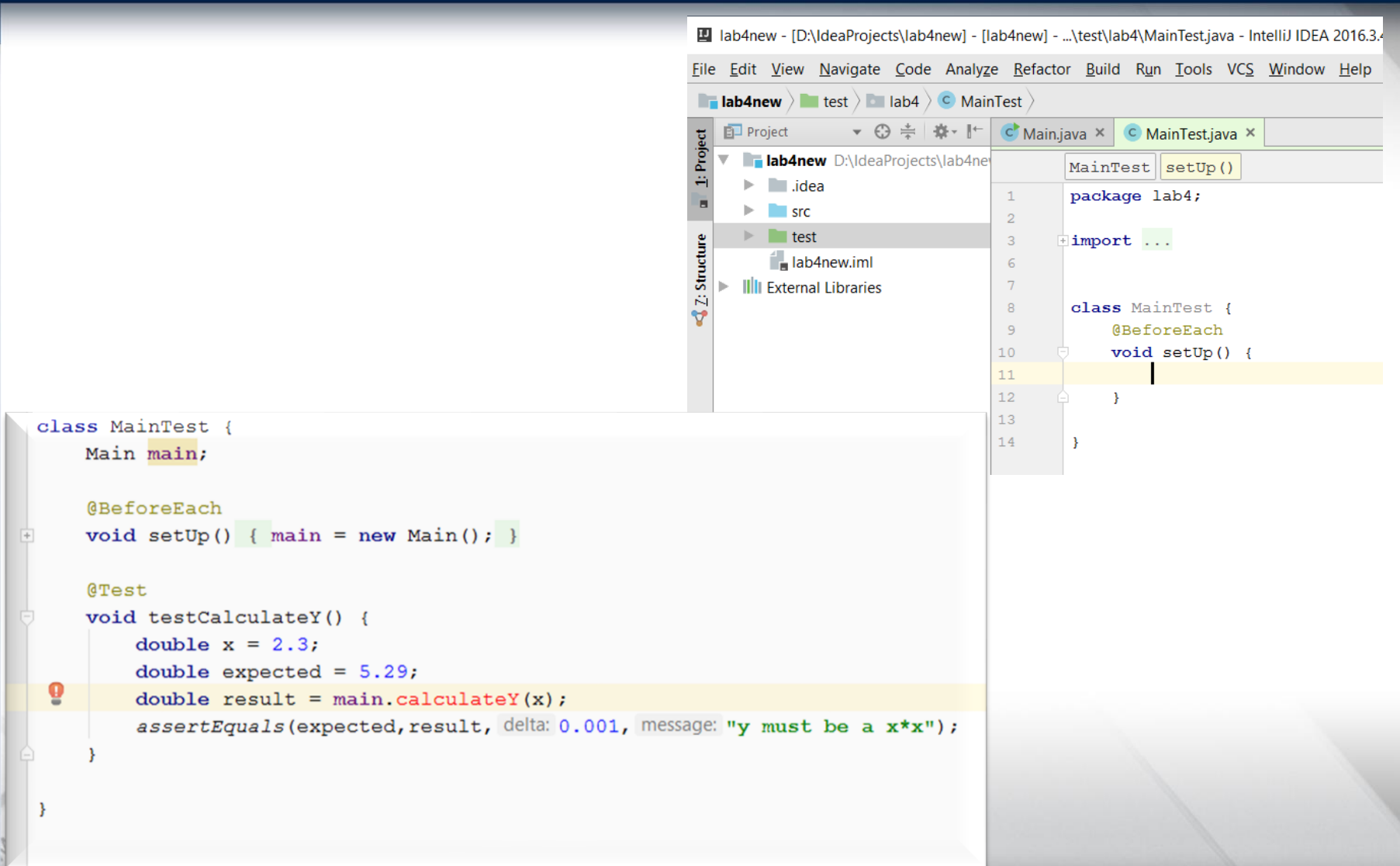
- Testing library: JUnit5
- JUnit5 library not found in the module (Fix button)
- Class name: MainTest
- Superclass: (empty)
- Destination package: lab4
- Generate: ☒ setUp/@Before, ☐ tearDown/@After
- Generate test methods for: ☐ Show inherited methods
- Member list: ☐ main(args:String[]):void

As test is not exist, choose **Create New Test...**

Fill data in the Dialog



# JUnit in IntelliJ IDEA



lab4new - [D:\IdeaProjects\lab4new] - [lab4new] - ...test\lab4\MainTest.java - IntelliJ IDEA 2016.3.4

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

lab4new > test > lab4 > MainTest

Project D:\IdeaProjects\lab4new

- lab4new
  - .idea
  - src
  - test
  - lab4new.iml
  - External Libraries

MainTest setUp()

```
1 package lab4;
2
3 import ...
4
5
6
7
8 class MainTest {
9     @BeforeEach
10    void setUp() {
11
12    }
13
14 }
```

```
class MainTest {
    Main main;

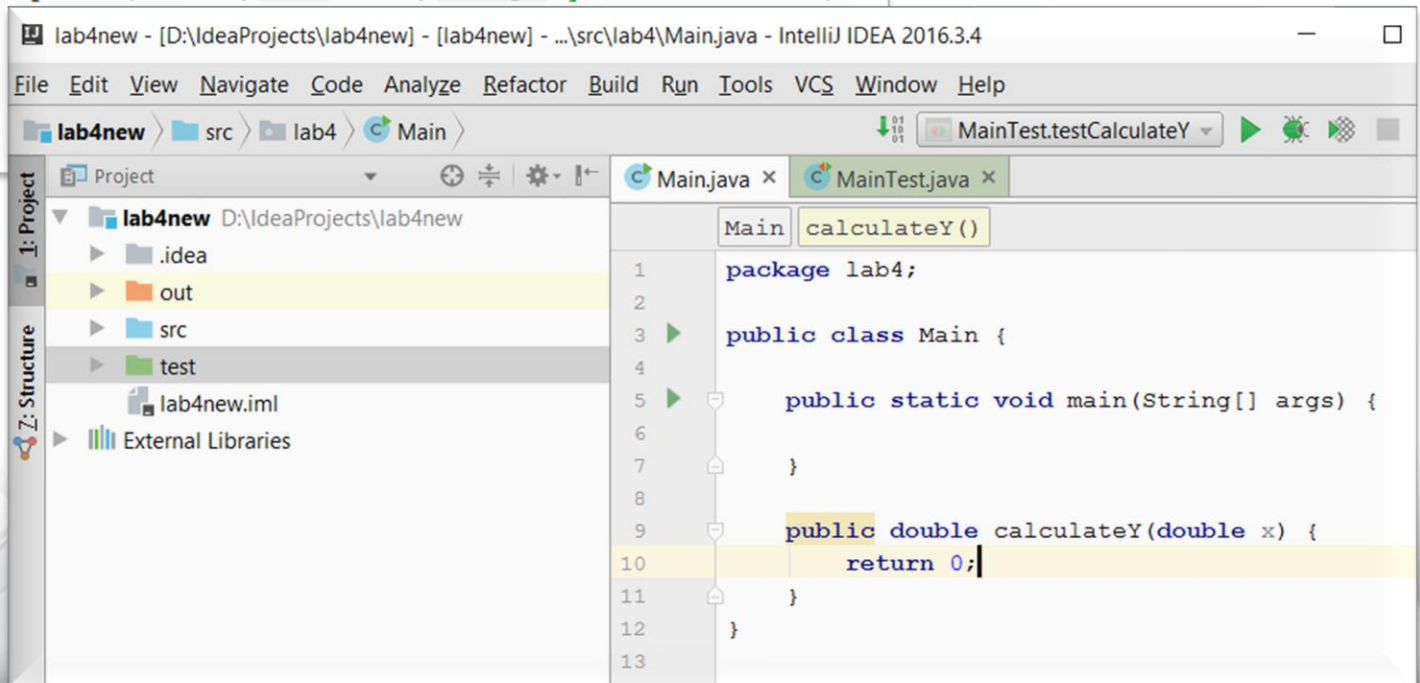
    @BeforeEach
    void setUp() { main = new Main(); }

    @Test
    void testCalculateY() {
        double x = 2.3;
        double expected = 5.29;
        double result = main.calculateY(x);
        assertEquals(expected, result, delta: 0.001, message: "y must be a x*x");
    }
}
```



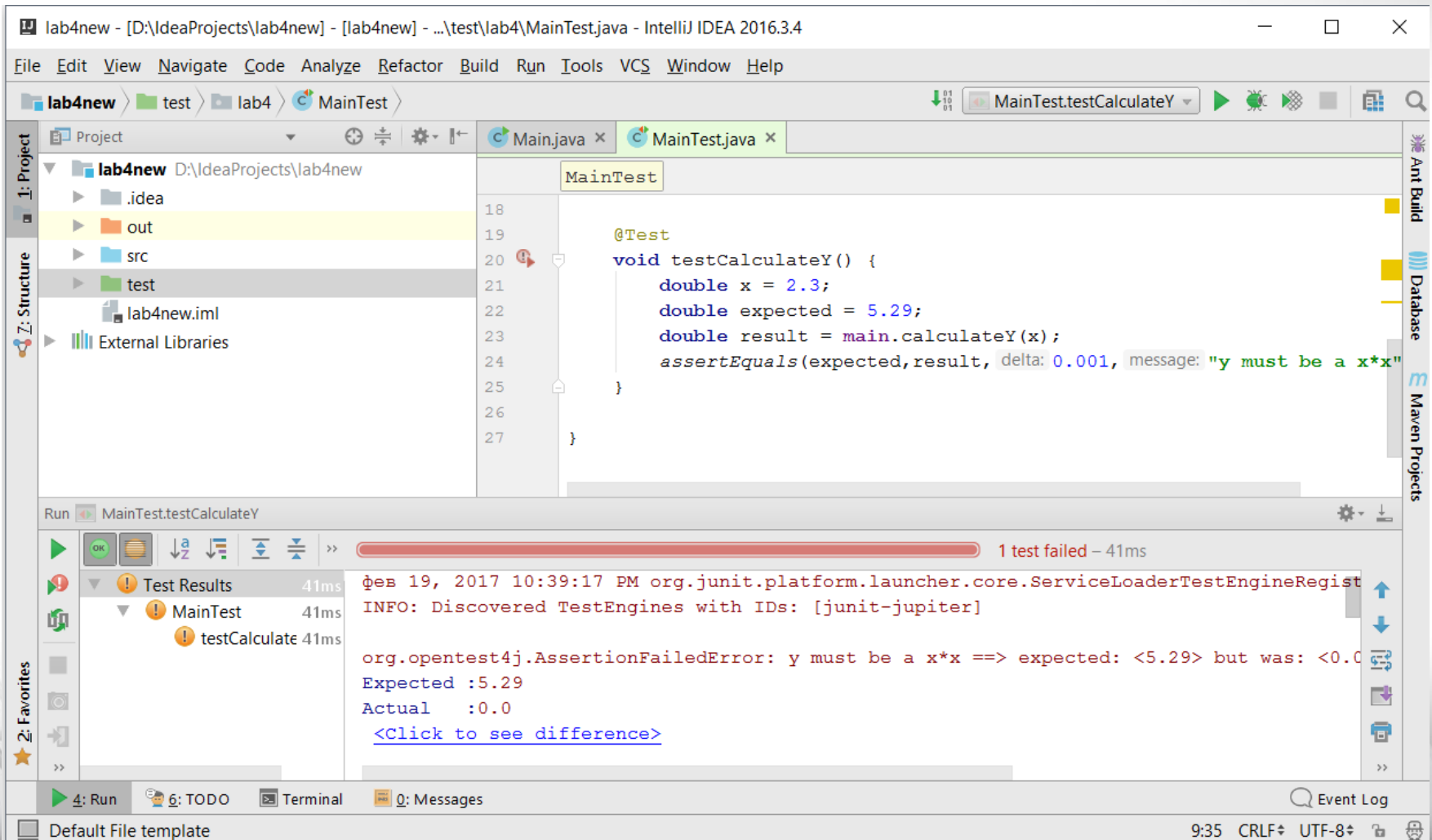
# JUnit in IntelliJ IDEA

```
class MainTest {  
    Main main;  
  
    @BeforeEach  
    void setUp() { main = new Main(); }  
  
    @Test  
    void testCalculateY() {  
        double x = 2.3;  
        double expected = 5.29;  
        double result = main.calculateY(x);  
        assertEquals(expected, result, delta: 0.001, message: "y must be a x*x");  
    }  
}
```



# JUnit in IntelliJ IDEA

Run test of the generated method. It fails



The screenshot shows the IntelliJ IDEA interface with a project named 'lab4new'. The 'Project' view on the left shows the directory structure: 'lab4new' (D:\IdeaProjects\lab4new) containing '.idea', 'out', 'src', 'test', 'lab4new.iml', and 'External Libraries'. The 'test' directory is selected. The 'MainTest.java' file is open in the editor, showing a JUnit test method:

```
18  
19  
20 @Test  
21 void testCalculateY() {  
22     double x = 2.3;  
23     double expected = 5.29;  
24     double result = main.calculateY(x);  
25     assertEquals(expected, result, delta: 0.001, message: "y must be a x*x")  
26 }  
27
```

The 'Run' button is highlighted, and the 'Run' toolbar shows the test execution progress. The 'Run' window at the bottom shows the test results:

Run MainTest.testCalculateY

1 test failed – 41ms

Test Results 41ms

- MainTest 41ms
  - testCalculate 41ms

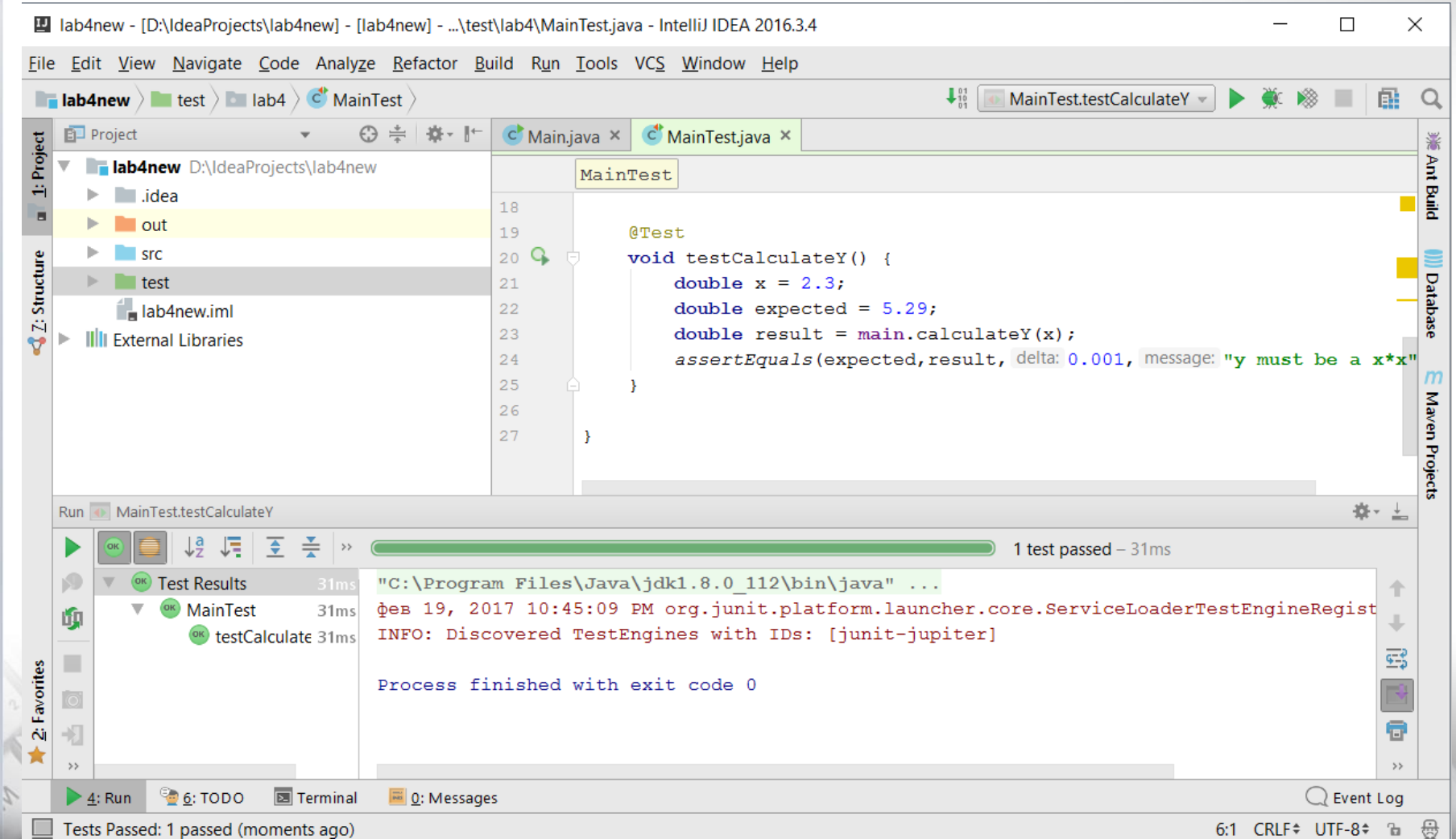
The test failure message is displayed in the 'Run' window:

```
фев 19, 2017 10:39:17 PM org.junit.platform.launcher.core.ServiceLoaderTestEngineRegist  
INFO: Discovered TestEngines with IDs: [junit-jupiter]  
  
org.opentest4j.AssertionFailedError: y must be a x*x ==> expected: <5.29> but was: <0.0  
Expected :5.29  
Actual   :0.0  
<Click to see difference>
```

The status bar at the bottom shows '4: Run', '6: TODO', 'Terminal', '0: Messages', and 'Event Log'. The system clock shows '9:35 CRLF UTF-8'.

# JUnit in IntelliJ IDEA

Write correct method body. Run test of the generated method. It should be OK



The screenshot shows the IntelliJ IDEA 2016.3.4 interface. The top toolbar has a green play button icon. The main editor displays the `MainTest.java` file with the following code:

```
18  
19  
20 @Test  
21 void testCalculateY() {  
22     double x = 2.3;  
23     double expected = 5.29;  
24     double result = main.calculateY(x);  
25     assertEquals(expected, result, delta: 0.001, message: "y must be a x*x")  
26 }  
27
```

The left sidebar shows the Project Structure with the `test` directory selected. The bottom panel shows the Run configuration for `MainTest.testCalculateY` and the Test Results window. The Test Results window shows that the test `testCalculate` passed in 31ms. The Run console shows the following output:

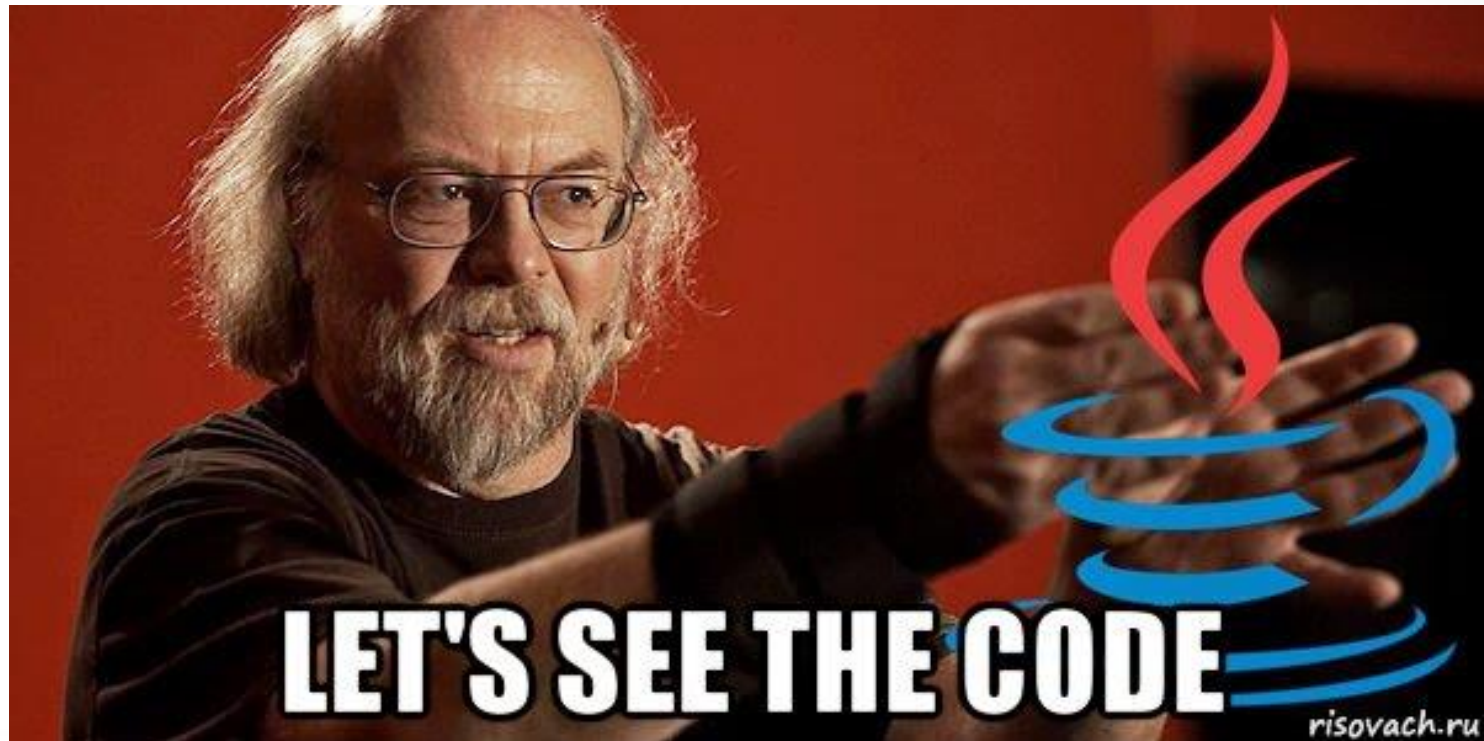
```
"C:\Program Files\Java\jdk1.8.0_112\bin\java" ...  
фев 19, 2017 10:45:09 PM org.junit.platform.launcher.core.ServiceLoaderTestEngineRegist  
INFO: Discovered TestEngines with IDs: [junit-jupiter]  
  
Process finished with exit code 0
```

The bottom status bar indicates "Tests Passed: 1 passed (moments ago)".

# More Information

- <http://www.junit.org>
  - Download of JUnit
  - Lots of information on using JUnit
- <http://sourceforge.net/projects/cppunit>
  - C++ port of Junit
- <http://www.thecoadletter.com>
  - Information on Test-Driven Development

# Example





НАЦІОНАЛЬНИЙ  
УНІВЕРСИТЕТ  
КОРАБЛЕБУДУВАННЯ  
ІМЕНІ АДМІРАЛА МАКАРОВА

# Questions?





# Object-Oriented Programming in the Java language

Part 2. TDD and JUnit



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