JAVA / UNIT TESTING

EXERCISES

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#exercises #java #unit-testing #oop

JAVA / UNIT TESTING

1. SETUP PROJECT

- Download and unzip the following project into a suitable folder on your computer.
- Open IntelliJ and import the project:
  - Step 1: Import Project;
  - Step 2: Select Folder;
  - Step 3: Import from external model (Gradle);
  - Step 4: Select "Gradle" and click "Finish".
- Run all tests by selecting "src/test/java", right-clicking and selecting "Run All Tests".
- Verify that all tests pass (you might need to turn on showing tests that are passing by selecting the checkmark icon).

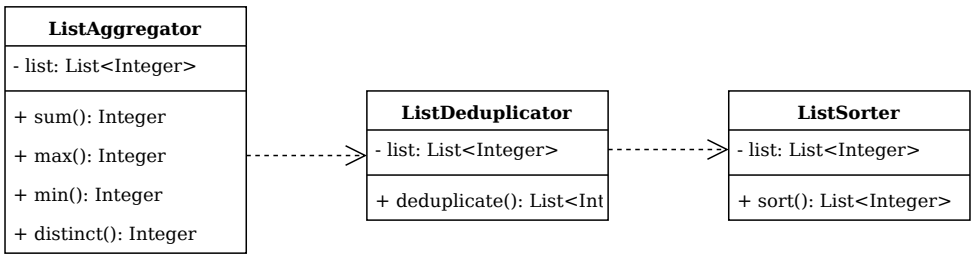
2. ANALYZE PROJECT

The project contains three classes:

- ListAggregator: Contains several methods that calculate values from lists

of integers (sum, min, max and distinct). The distinct() method returns the number of distinct numbers in the list.

- ListDeduplicator: Is capable of removing duplicates from a list of integers.
- ListSorter: Is capable of sorting a list of integers.



As you can see, the distinct() method in the ListAggregator class, depends on the ListDeduplicator class in order to calculate the number of unique elements in a list.

Also, the ListDeduplicator class depends on the ListSorter class as it is much easier to remove duplicates in an already sorted list.

3. SIMPLIFY TEST SETUP

Take a moment to notice that our test methods are organized along three different phases (the 3 As):

- Arrange - Where the test is setup and the data is arranged.
- Act - Where the the actual method under test is invoked.
- Assert - Where a single logical assert is used to test the outcome.

Notice that the setup for the ListAggregator tests is always the same:

```
List<Integer> list = new ArrayList<>();
list.add(1);
```

```
list.add(2);
list.add(4);
list.add(2);
list.add(5);
```

Do one of two things:

- Create a helper method, that gets called from each one of the tests, setting up the list.
- Create a helper method, having a @Before annotation, setting up the list as an attribute. Methods with a @Before annotation are called before each test.

Do the same for the other test classes making sure that all tests still pass.

4. CORNER CASES

You received a bug report:

> Bug report #7263
>
> Created a list with values "-1, -4 and -5".
>
> Tried to calculate the maximum of these values but got 0 instead of -1.

- Create a test that confirms the bug.
- Observe that the test fails.
- Fix the code so the test passes.

5. DISTINCT

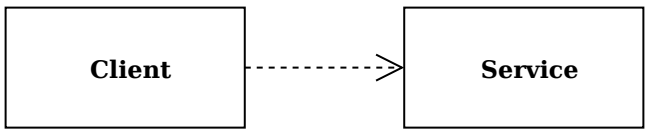
You received a bug report:

> Bug report #8726
>
> Created a list with values "1, 2, 4 and 2".
>
> Tried to calculate the number of distinct values in the list but got 4 instead of 3.

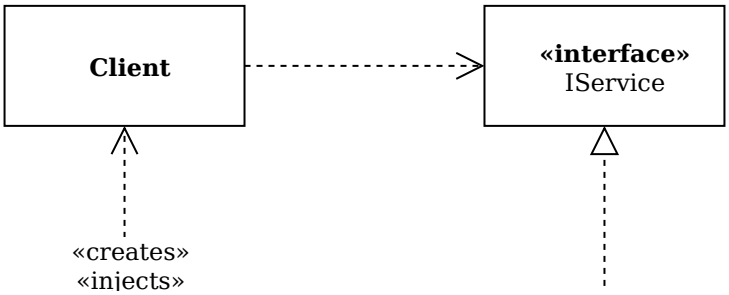
- Start by creating a test that confirms the bug.
- Observe that the test fails.
- Then, look into the ListAggregator.distinct() method code. Spoiler alert: you won't find anything wrong...

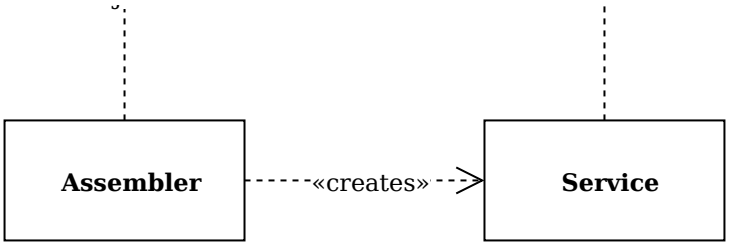
The problem is that when we are testing the distinct() method, we are also testing the ListDeduplicator.deduplicate() code. Before fixing the bug, lets fix the test.

To test the distinct() and the deduplicate() methods independently from each other, we must go from a design that looks like this:



Where our client (the ListAggregator) depends directly on its service (the ListDeduplicator). To something like this:





Where the client depends on an interface (lets call it IListDeduplicator) instead, and some Assembler class (the ListAggregatorTest) is responsible for creating the concrete service (the ListDeduplicator) and injecting it into the client (the ListAggregator).

Like this:

```
int distinct = aggregator.distinct(new ListDeduplicator(list));
```

This is what is called Dependency Injection and it allows our test to inject into the ListAggregator any list deduplicator service. Even one that always responds with the same canned answer (a Stub).

To remove the dependency between the ListAggregatorTest and the ListDeduplicator class using a stub, we first need to:

- Create a IListDeduplicator interface containing only the definition of the deduplicate() method.
- Modify the ListAggregator.distinct() method so that it can receive a class that implements this IListDeduplicator interface.
- Make ListDeduplicator implement this interface.
- Change the tests so that a ListDeduplicator is injected into the distinct method.

And then create the stub:

- Create a stub that always returns the correct answer for the data we are

testing as a inner-class inside our ListAggregatorTest.distinct() method.

- Modify both distinct() tests so that they inject this stub class. This should make both tests pass.

This did not fix any bug, we simply corrected the failing test as it should not be the one failing. To fix our code we still have to:

- Create tests for sorting and deduplicating using these same values: "1, 2, 4 and 2".
- Make sure to use Dependency Injection in the deduplicator() method as it also depends on the sort() method.
- Fix the code that needs fixing. Only one of the tests should be failing now and that should point you in the correct direction.

6. MOCKITO

Redo the previous exercise but this time use Mockito to create the stubs.

To use Mockito, you must first add this to the dependencies on your build.gradle file:

```
  testCompile group: 'org.mockito', name: 'mockito-core',
version: '2.25.0'
```

Creating a deduplicator using Mockito, should look like this:

```
IListDeduplicator deduplicator =
Mockito.mock(IListDeduplicator.class);
```

Making the stub return the correct list can then be done like this:

```
Mockito.when(deduplicator.deduplicate()).thenReturn(deduplicated);
```

Where deduplicated is the list that we want the method to return.

7. COVERAGE

- Run all tests again, but this time right-click on "src/test/java", and select "Run All Tests with Coverage".

The report should appear on the right side of the screen.

Enter inside the com package, then inside the aor and numbers packages and verify if all classes, methods and lines are covered by your tests. If not add more tests until they are.

8. FILTERS

Create a new class ListFilterer that will be capable of filtering a list of numbers. This class should have a constructor that receives a list and single method called filter with the following signature:

```
public List<Integer> filter(IListFilter filter);
```

As you can see, this method returns a list of numbers that have been filtered by a certain filter (Dependency Injection again).

The IListFilter interface, should have only one method that returns true if a certain number should be accepted for that filter and false otherwise:

```
public boolean accept(Integer number);
```

Create two classes that follow this interface: PositiveFilter (that accepts only

positive numbers) and DivisibleByFilter (that receives an integer upon construction and accepts only numbers divisible by that number).

- Create tests for all these classes (ListFilterer, PositiveFilter and DivisibleByFilter).
- Use stubs when necessary.
- Verify the test coverage again.

9. MUTATION TESTING

Test coverage allows us to access the percentage of lines covered by our tests but it doesn't verify the quality of those tests.

Mutation testing tries to mitigate this problem by creating code mutations (that should not pass the tests) and verifying if any of those mutations survive our test suite.

To use PIT (a test mutation system for Java) we must first add the following line to the plugin section of our build.gradle file:

```
id 'info.solidsoft.pitest' version '1.4.6'
```

By default, PIT runs all tests under the package with the same name as the group defined in your build.gradle file. So if all your classes and tests are under the com.aor.numbers package, no other configuration should be necessary.

PIT should have automatically created a gradle task called pitest that you can execute by doing (or using the IntelliJ gradle panel):

```
./gradlew pitest
```

This will run PIT and create a report under "build/reports/pitest/<date>". You can open this report using your browser and check if any mutations survived.

Try improving your tests so all mutations die.

10. HERO TESTING

- With your new found knowledge, create tests for the Hero code you created last class.
- Try using Dependency Injection to remove the dependency between your Element classes and the lanterna library.
- Try using Mocks, with Mockito, to test if the correct lanterna functions are being called by your code.
- Verify the coverage of your tests.
- Try mutation testing and improve the results by writing more and better tests.