

Transition of automated feedback into student's learning environment

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INTRODUCTION

Programming is a key skill for a computer scientist

Many Computer Science (CS) students struggle with programming

Studies have shown that constrained lab times and insufficient feedback is an issue

AIM

To develop technology that provides automated feedback which will help first year CS students to become independent learners

We wished to

Liberate staff from low-level and repetitive questions enabling them to focus on deeper learning problems.

Provide automatic feedback and students could make meaningful progress inside and outside lab hours.

Enhance existing tools with feedback so students do not need to learn yet another tool.

OUR APPROACH

Analysed existing labs to understand which parts could potentially provide automated feedback.

Developed a plug-in for the Eclipse tool (which is used in the labs) based around code analysis and testing that could provide feedback for one lab.

Applied the tool in a lab and asked students to fill in a questionnaire.

Analysed results and improved our tool based on it.

ONGOING & FURTHER WORK

Combine labs and tests to automatically provide feedback for more complex problems

Re-factor the code to make it easier to add create, combine and configure new labs and tests.

Investigate how the work can be extended to automated marking.

INITIAL DEVELOPMENT & ANALYSIS

An initial tool was developed and applied in a lab.

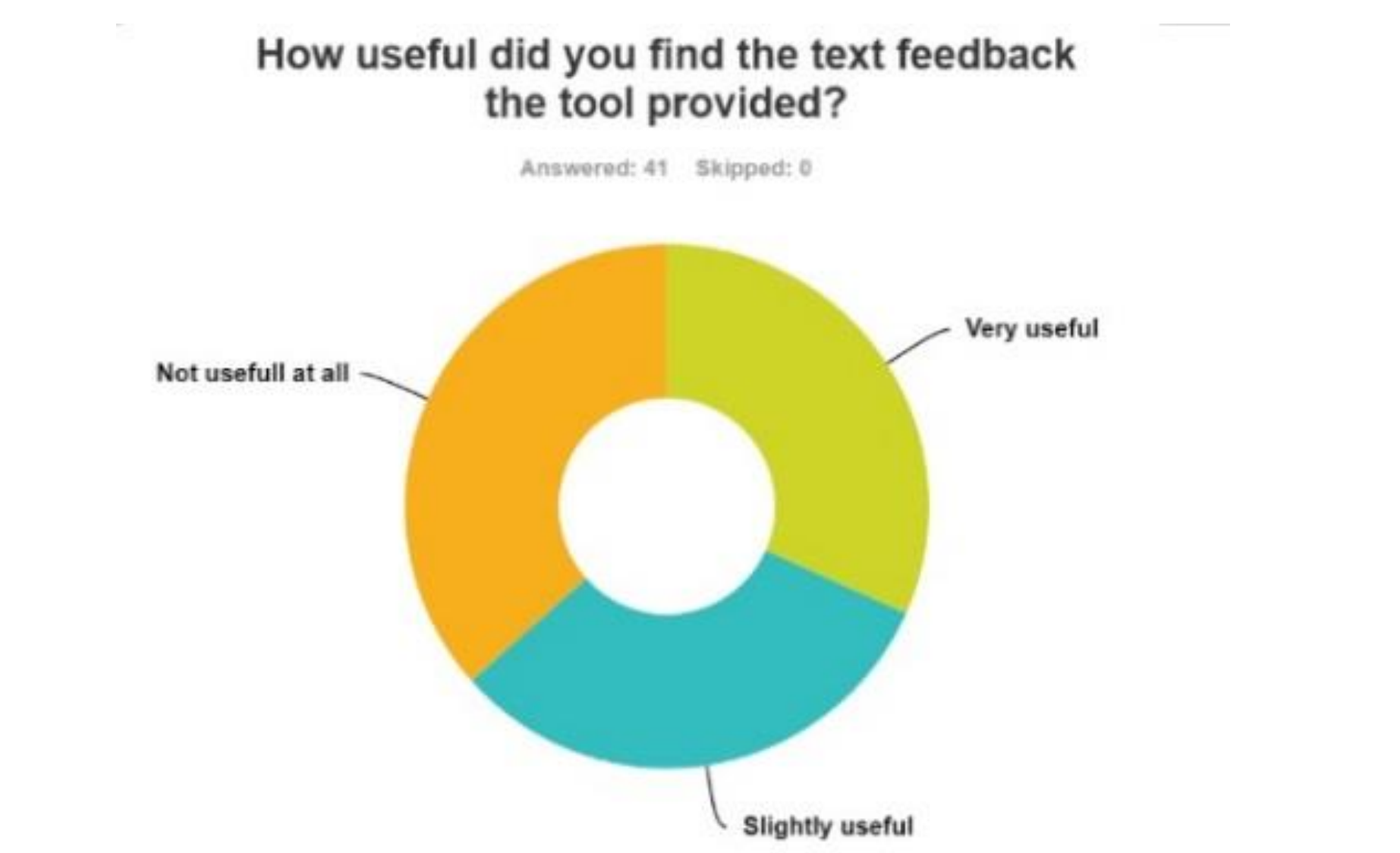
Sample lab questions

Recursive sum of numbers
Write a recursive method `sum`, which given a number `n`, returns the sum of all positive numbers up to `n` - that is, it computes:
 $sum(n) = 1 + 2 + \dots + n$

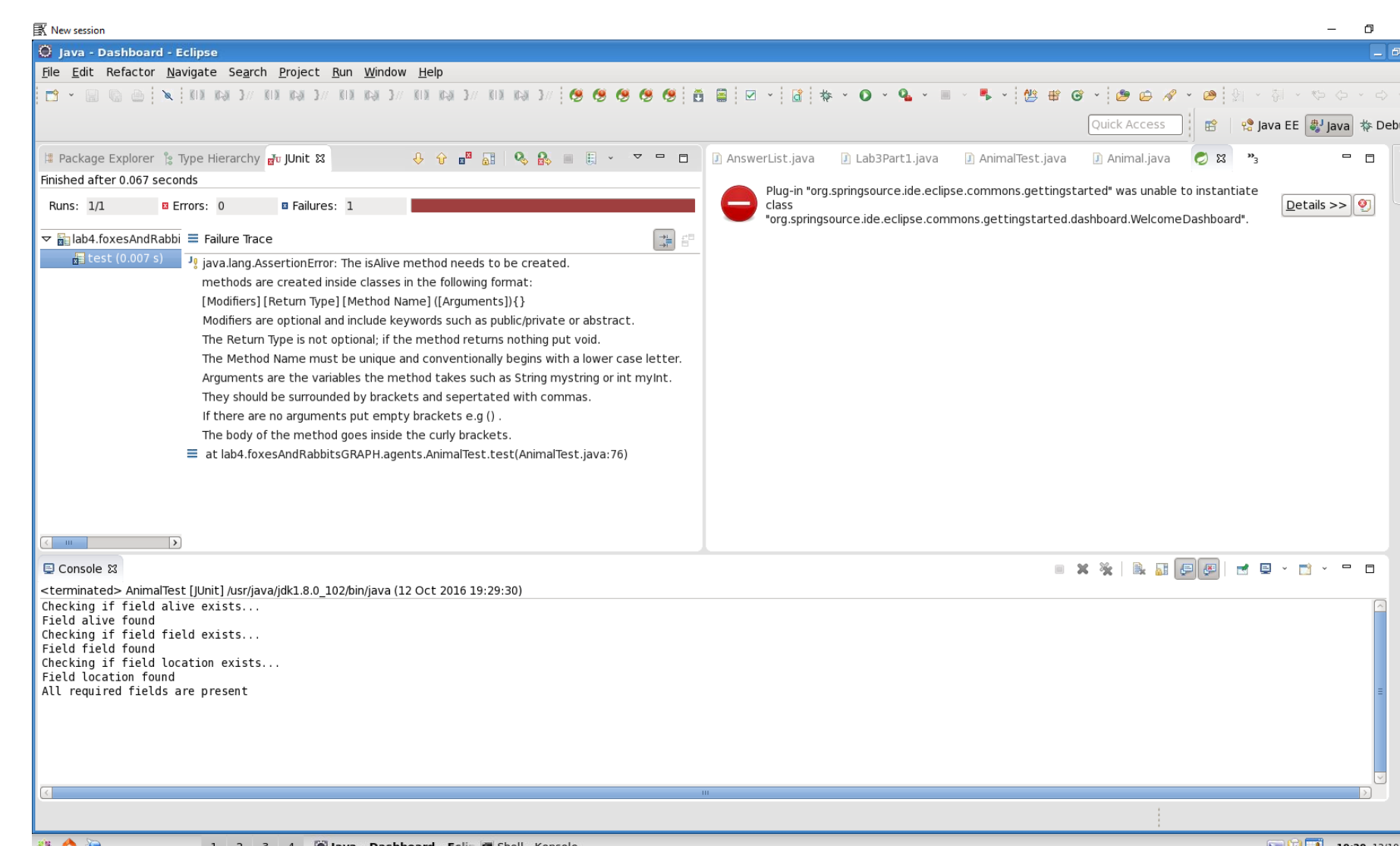
Recursive multiplication using only addition
Write a recursive method `multiply` which given two (positive) integers `m` and `n` as arguments, computes $m \times n$ using only addition (and recursion).

Computes a Fibonacci number
The Fibonacci sequence is 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, ... You should write a method `Fibonacci` which given `n` as an argument, returns the `n`th Fibonacci number using recursion, that is
`Fibonacci(0) = 0, Fibonacci(1) = 1, Fibonacci(2) = 1, Fibonacci(3) = 2, Fibonacci(4) = 4, Fibonacci(5) = 5, Fibonacci(6) = 8, Fibonacci(7) = 13, Fibonacci(8) = 21, Fibonacci(9) = 34` and so on.

Main result: Students liked it and value its potential but struggled to understand the feedback as it was too verbose and generic.



Previous method of providing feedback



Having the feedback appear in multiple places was not ideal

The console display could be shrunk, moved or closed by users of Eclipse, meaning the size and location of the feedback could vary.

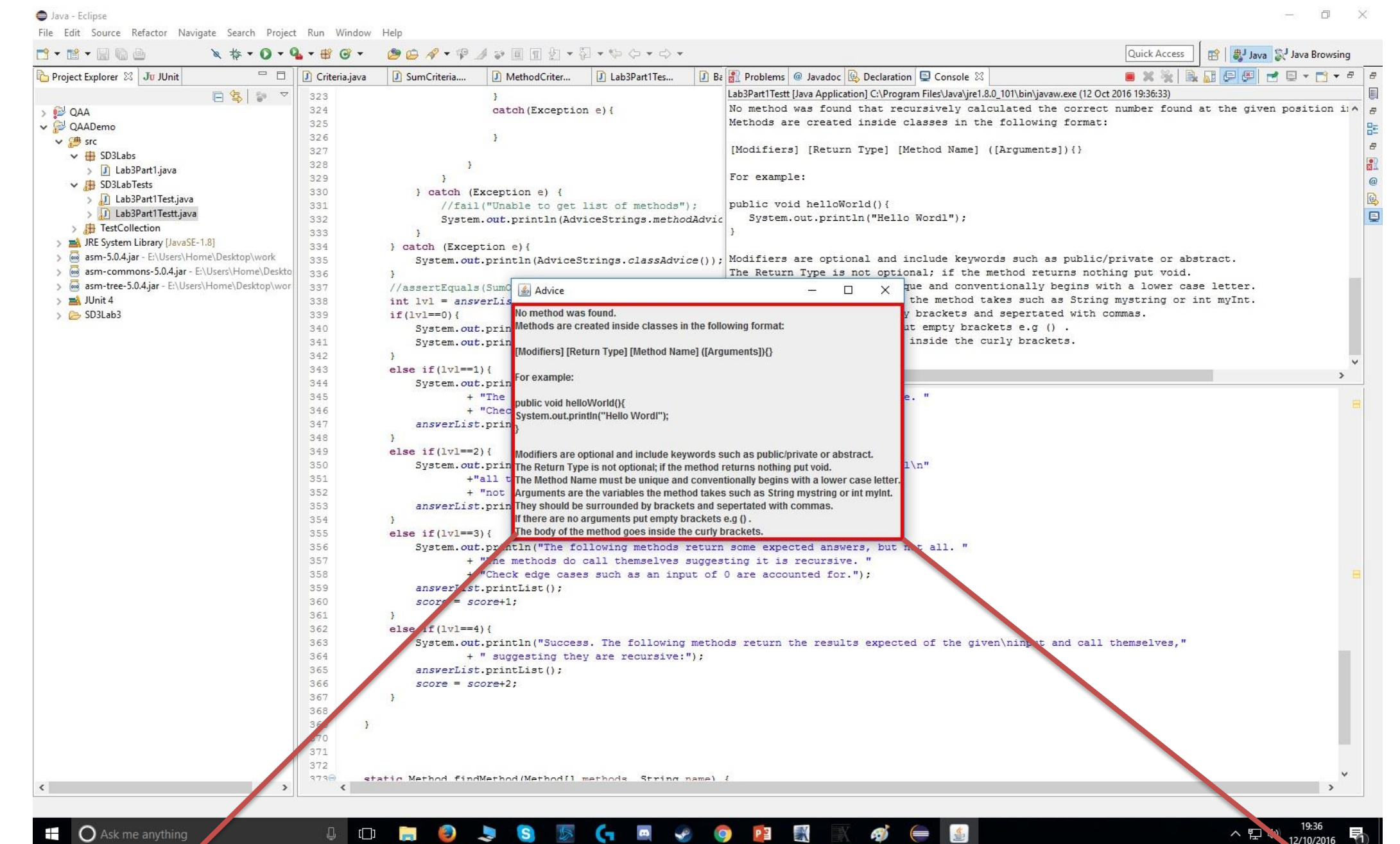
Requirements for updated tool

Use pop-up windows to deliver targeted advice closer to code.

Pop-up window should be able to be repositioned and kept open for reference as the student continues to work.

AN UPDATED FEEDBACK TOOL

An example of new automated feedback



Advice

No method was found.
Methods are created inside classes in the following format:
`[Modifiers] [Return Type] [Method Name] ([Arguments])`

For example:
`public void helloWorld(){
 System.out.println("Hello World");
}`

Modifiers are optional and include keywords such as `public/private` or `abstract`.
The Return Type is not optional; if the method returns nothing put `void`.
The Method Name must be unique and conventionally begins with a lower case letter.
Arguments are the variables the method takes such as `String mystring` or `int myInt`.
They should be surrounded by brackets and separated with commas.
If there are no arguments put empty brackets e.g `()`.
The body of the method goes inside the curly brackets.

In the new version the advice is more tailored to specific circumstances and shown as pop-up closer to the problem.

A feature requested in the feedback was to show the answers that the test was expecting and the answers that it had received from the output of the students program.

Feedback with expected & actual results

Advice

The following methods return some expected answers, but not all:
testsum1

```
input was: 5
Expected outcome was: 15
Actual outcome was: 15
input was: 1
Expected outcome was: 1
Actual outcome was: 15
input was: 0
Expected outcome was: 0
Actual outcome was: 15
```

The method does not call itself so does not appear to be recursive.
Try starting with a base case. Ask yourself what the final state is that will make the recursive method stop calling itself. Without a base case the method will call itself forever. Also be cautious of using `while` or `for` loops. Using recursion should prevent the need for these and having them may be an indication that your solution is not recursive.
Check edge cases such as an input of 0 are accounted for.

testsum1

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