ISMRM 27TH ANNUAL MEETING & EXHIBITION

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Secret Session: Master coding in your research environment

Testing your code

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INSTITUT DE CARDIOLOGIE DE MONTRÉAL

AxonDeepSeg

qMR Lab

Quantitative MRI. Under one umbrella.

POLYTECHNIQUE MONTRÉAL

NeuroPoly

What are tests?

A way to reproduce and automate an evaluation of the expected behaviour of your code.

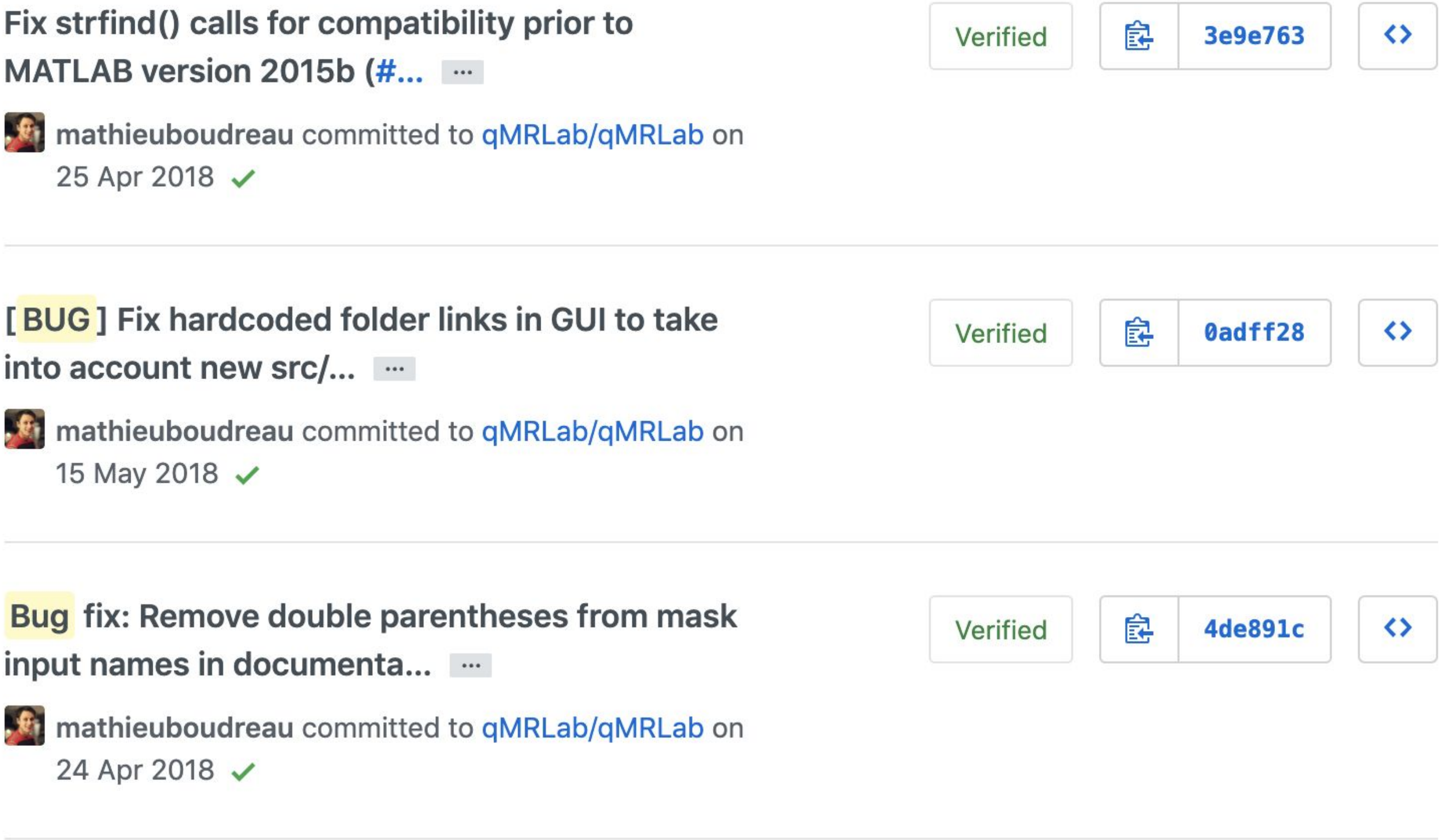
Tests will...

- inform you of where your code is behaving unexpectedly
- inform you of the expected behaviour and the actual behaviour

What tests are not.

A tool guaranteeing bug-free code.

- Just because your tests pass, does not mean your code is bug free!



Fix strfind() calls for compatibility prior to MATLAB version 2015b (#... …

mathieuboudreau committed to qMRLab/qMRLab on 25 Apr 2018 ✓

[BUG] Fix hardcoded folder links in GUI to take into account new src/... …

mathieuboudreau committed to qMRLab/qMRLab on 15 May 2018 ✓

Bug fix: Remove double parentheses from mask input names in documenta... …

mathieuboudreau committed to qMRLab/qMRLab on 24 Apr 2018 ✓

Broad types of tests

Unit tests

- For individual pieces of code (e.g. one function/file in isolation)

Integration Tests

- Interaction between multiple functions/files (i.e. a user experience)

How do I start?

Most coding languages have testing frameworks!

MATLAB → *MATLAB Unit Test Framework* and *MOxUnit*

Python → *PyTest* and *unittest*

Octave → *MOxUnit*

R → *testthat* and *RUnit*

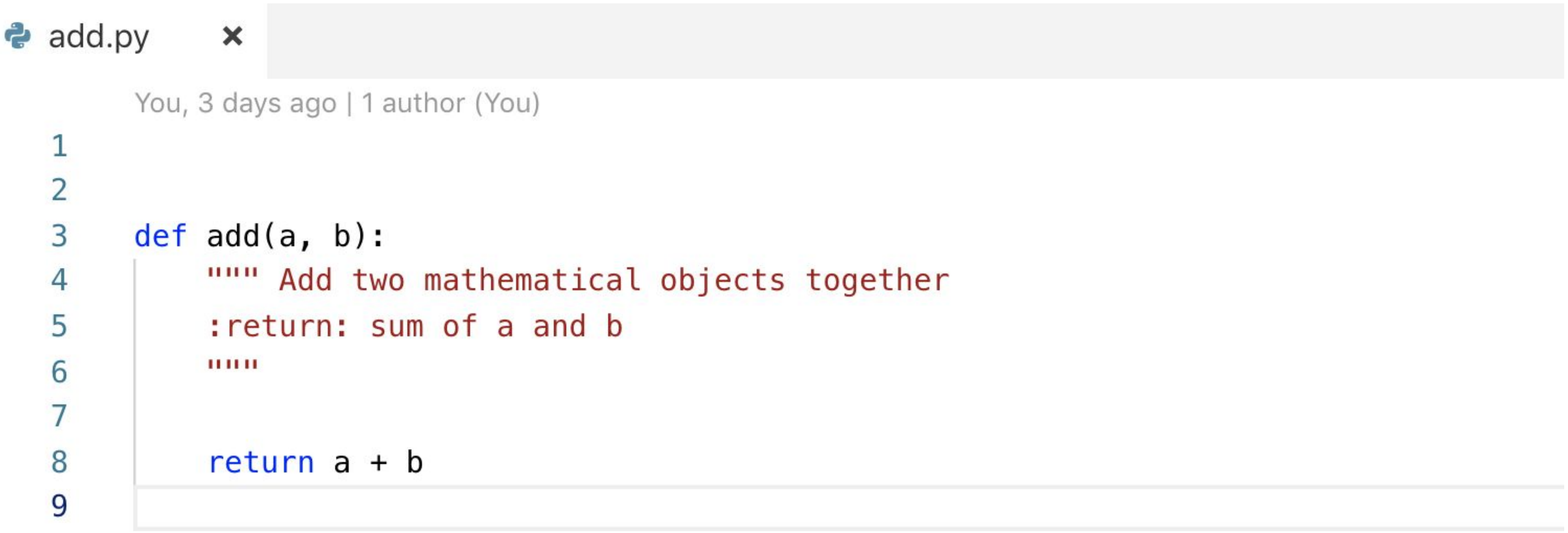
C++ → *Catch2* and *Googletest*

C → *Check* and *Unity*

… and many more!

Simple example

Example function

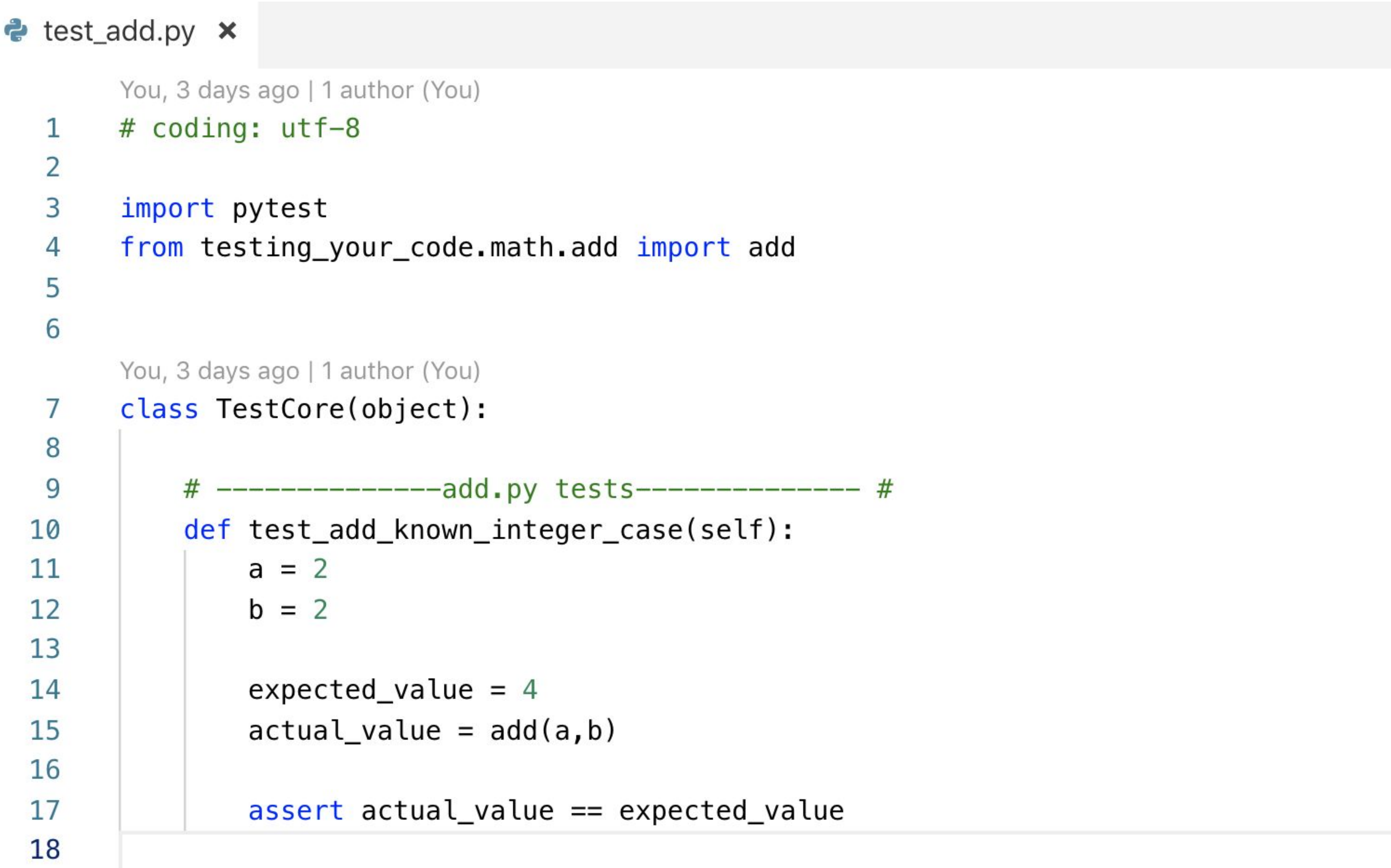


You, 3 days ago | 1 author (You)

```python


def add(a, b):
    """ Add two mathematical objects together
    :return: sum of a and b
    """

    return a + b

```

Simple example

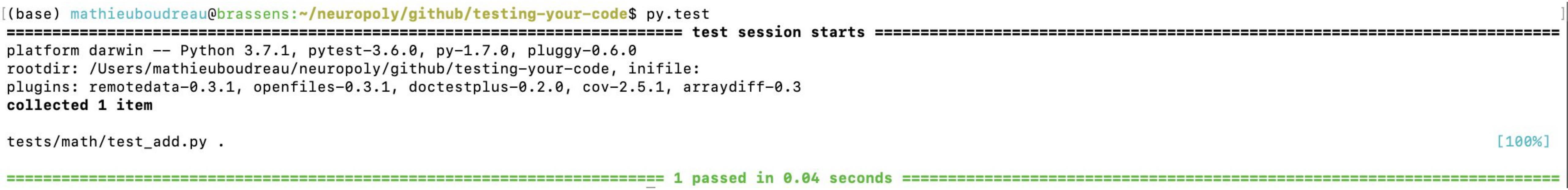
Example test


test_add.py ×
You, 3 days ago | 1 author (You)
You, 3 days ago | 1 author (You)

```python
# coding: utf-8

import pytest
from testing_your_code.math.add import add


class TestCore(object):

    # --------------add.py tests-------------- #
    def test_add_known_integer_case(self):
        a = 2
        b = 2

        expected_value = 4
        actual_value = add(a,b)

        assert actual_value == expected_value

```

Simple example

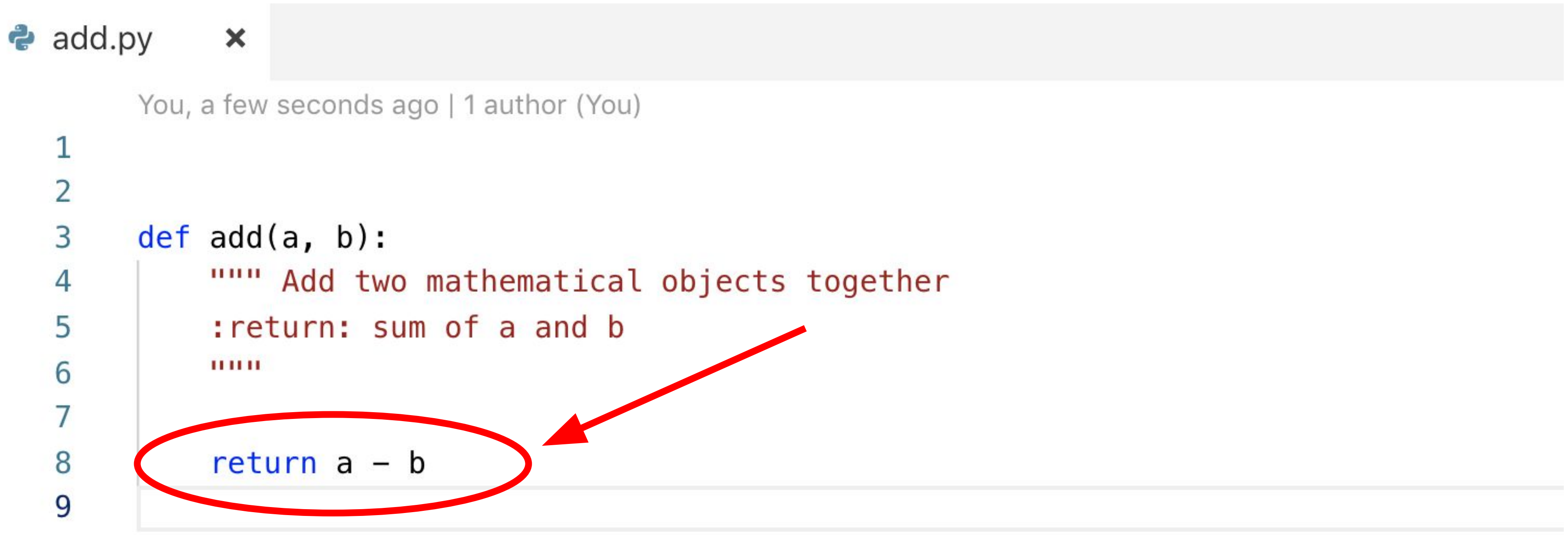
Run the tests!



```
[(base) mathieuboudreau@brassens:~/neuropoly/github/testing-your-code$ py.test
========================================================================== test session starts ==========================================================================
platform darwin -- Python 3.7.1, pytest-3.6.0, py-1.7.0, pluggy-0.6.0
rootdir: /Users/mathieuboudreau/neuropoly/github/testing-your-code, inifile:
plugins: remotedata-0.3.1, openfiles-0.3.1, doctestplus-0.2.0, cov-2.5.1, arraydiff-0.3
collected 1 item

tests/math/test_add.py .                                                                                                                                          [100%]

======================================================================== 1 passed in 0.04 seconds ========================================================================
```

Simple example

Without realizing, while developing a “substract” function, you accidentally save this...

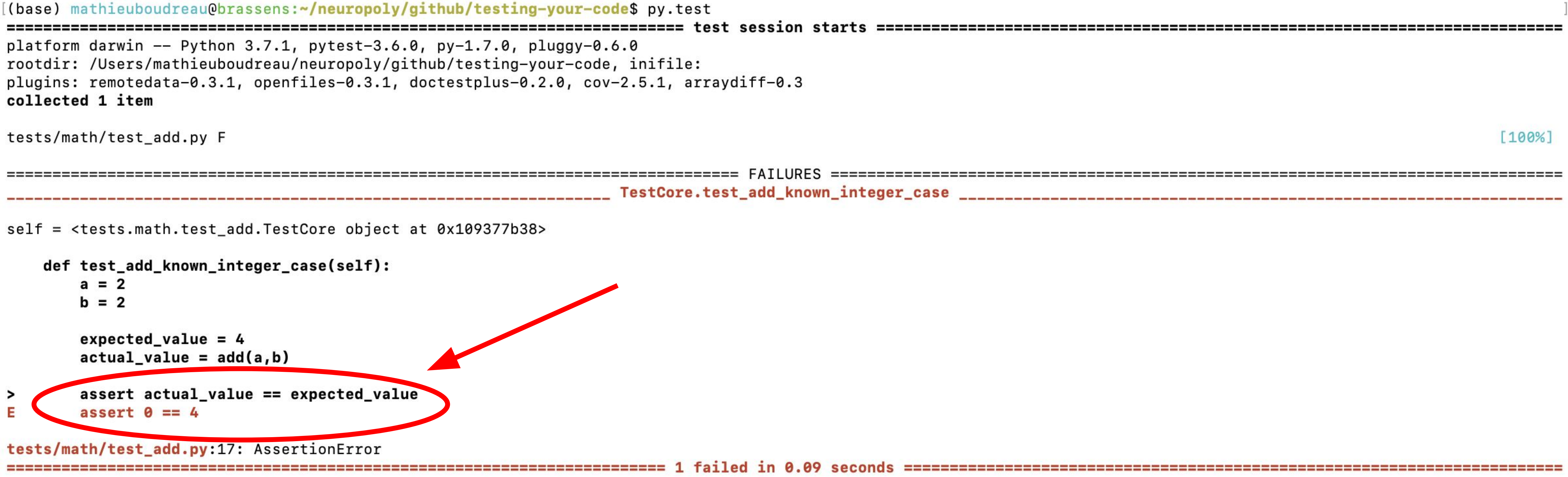


You, a few seconds ago | 1 author (You)

```python


def add(a, b):
    """ Add two mathematical objects together
    :return: sum of a and b
    """

    return a - b

```

Simple example

Run the test again, and...

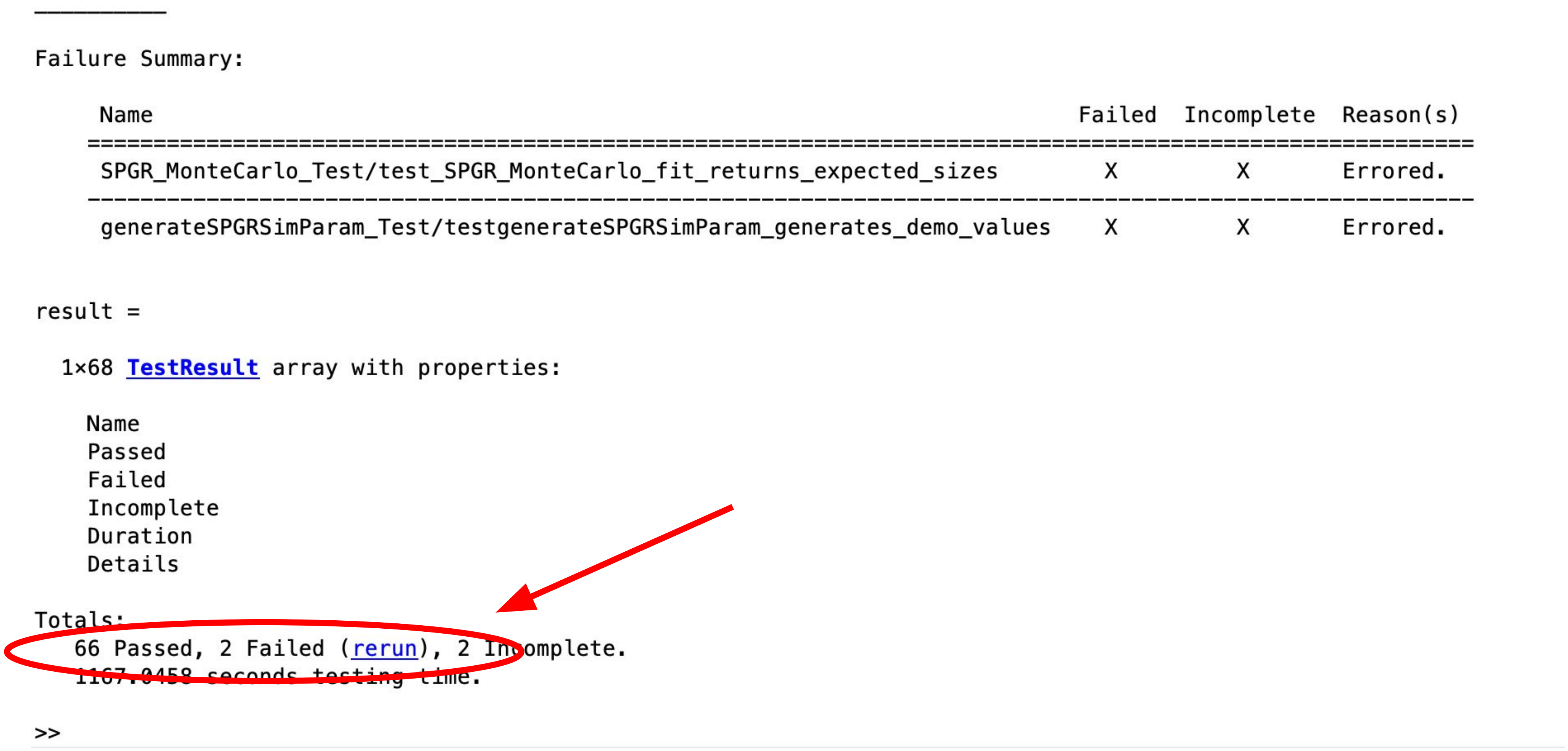


```
(base) mathieuboudreau@brassens:~/neuropoly/github/testing-your-code$ py.test
========================================================================= test session starts ==========================================================================
platform darwin -- Python 3.7.1, pytest-3.6.0, py-1.7.0, pluggy-0.6.0
rootdir: /Users/mathieuboudreau/neuropoly/github/testing-your-code, inifile:
plugins: remotedata-0.3.1, openfiles-0.3.1, doctestplus-0.2.0, cov-2.5.1, arraydiff-0.3
collected 1 item

tests/math/test_add.py F                                                                                                                                        [100%]

=============================================================================== FAILURES ===============================================================================
_________________________________________________________________ TestCore.test_add_known_integer_case _________________________________________________________________

self = <tests.math.test_add.TestCore object at 0x109377b38>

    def test_add_known_integer_case(self):
        a = 2
        b = 2

        expected_value = 4
        actual_value = add(a,b)

>       assert actual_value == expected_value
E       assert 0 == 4

tests/math/test_add.py:17: AssertionError
======================================================================= 1 failed in 0.09 seconds =======================================================================
```

Real-world example

2 year old PhD code: https://github.com/mathieuboudreau/qmt-optimization

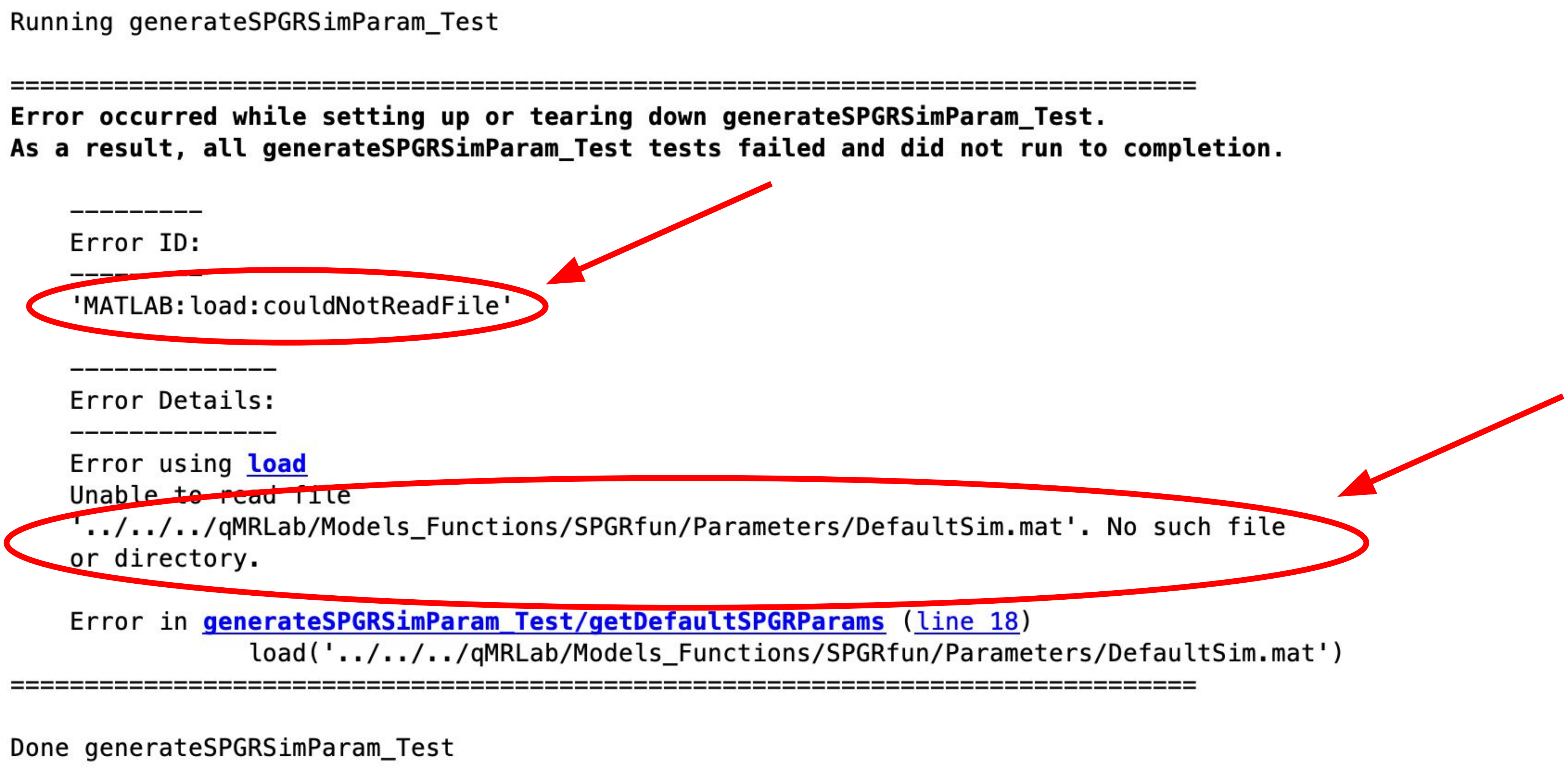
Updated a software dependency (qMRLab)



```
__________

Failure Summary:

     Name                                                                      Failed  Incomplete  Reason(s)
    =========================================================================================================
     SPGR_MonteCarlo_Test/test_SPGR_MonteCarlo_fit_returns_expected_sizes        X         X       Errored.
    ---------------------------------------------------------------------------------------------------------
     generateSPGRSimParam_Test/testgenerateSPGRSimParam_generates_demo_values    X         X       Errored.


result =

  1×68 TestResult array with properties:

    Name
    Passed
    Failed
    Incomplete
    Duration
    Details

Totals:
   66 Passed, 2 Failed (rerun), 2 Incomplete.
   1167.0458 seconds testing time.

>>
```

Real-world example

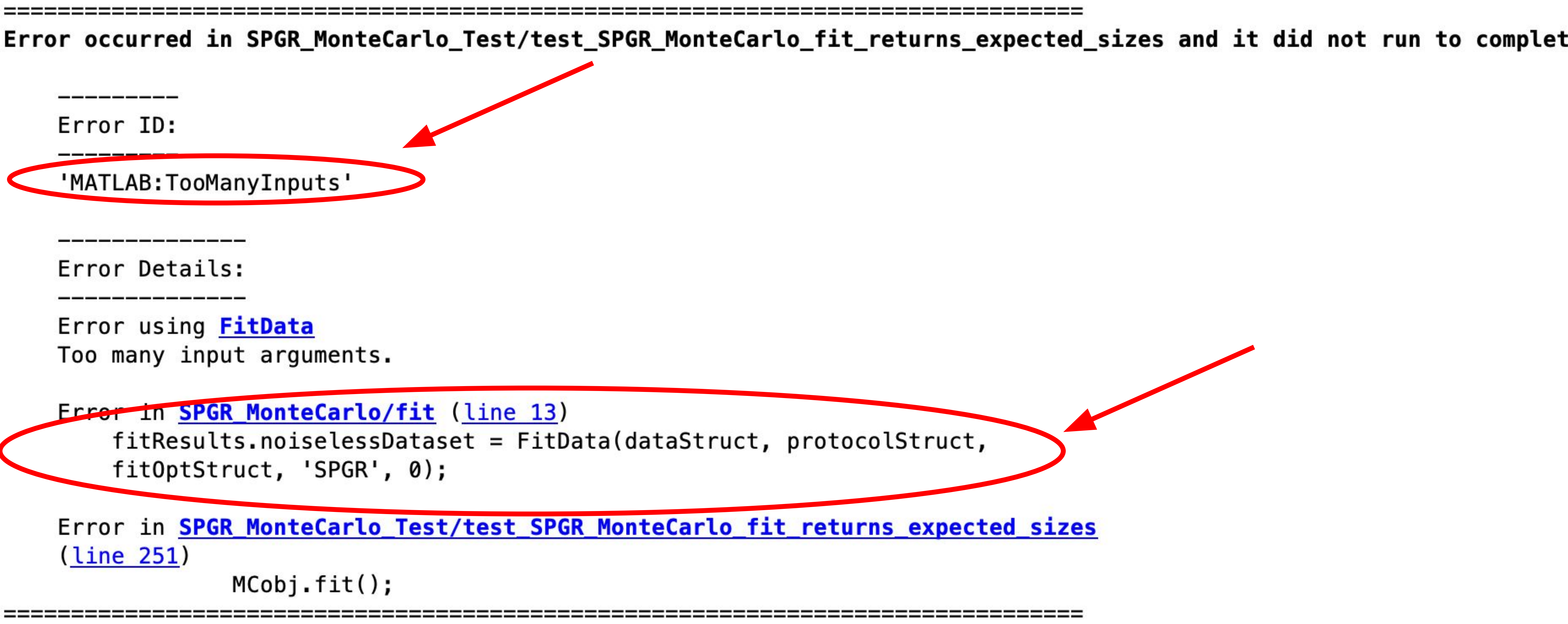
Where and why did they fail?



```
Running generateSPGRSimParam_Test

================================================================================
Error occurred while setting up or tearing down generateSPGRSimParam_Test.
As a result, all generateSPGRSimParam_Test tests failed and did not run to completion.

    ---------
    Error ID:
    ---------
    'MATLAB:load:couldNotReadFile'

    --------------
    Error Details:
    --------------
    Error using load
    Unable to read file
    '../../../qMRLab/Models_Functions/SPGRfun/Parameters/DefaultSim.mat'. No such file
    or directory.

    Error in generateSPGRSimParam_Test/getDefaultSPGRParams (line 18)
                load('../../../qMRLab/Models_Functions/SPGRfun/Parameters/DefaultSim.mat')
================================================================================

Done generateSPGRSimParam_Test
```

Real-world example

Where and why did they fail?



```
================================================================================
Error occurred in SPGR_MonteCarlo_Test/test_SPGR_MonteCarlo_fit_returns_expected_sizes and it did not run to complet

    ---------
    Error ID:
    ---------
    'MATLAB:TooManyInputs'

    --------------
    Error Details:
    --------------
    Error using FitData
    Too many input arguments.

    Error in SPGR_MonteCarlo/fit (line 13)
        fitResults.noiselessDataset = FitData(dataStruct, protocolStruct,
        fitOptStruct, 'SPGR', 0);

    Error in SPGR_MonteCarlo_Test/test_SPGR_MonteCarlo_fit_returns_expected_sizes
    (line 251)
                MCobj.fit();
================================================================================
```

If you there’s a possibility that you encounter one of these situations, tests are for you!

- A software, library, or operating system upgrade
  - MATLAB 2015a → MATLAB 2019a, numpy 1.8.0 → 1.16.2
- A change in operating system or hardware (new computer)
  - MacOS Mojave → Windows 10
- You have a bad memory
  - How do I use this function again…?
- Plan on using your code in the future
  - (in the year 2023) Why won’t this work anymore..?
- You make mistakes writing code
  - **i.e. everyone should write tests!**

Awesome features that having tests open up

Continuous Integration

- Automatically runs your tests when you commit to GitHub

Travis CI

Jenkins

Code Coverage (e.g. Coveralls, CodeCov)

- Informs you of which code lines your tests are evaluating, and those that missed.

COVERALLS

(CodeCov)

Example repositories containing tests

Simple examples

- https://github.com/ismrm-coding-secret-session/testing-your-code

Real-world examples

- Python: https://github.com/neuropoly/axondeepseg
- Octave/MATLAB: https://github.com/qmrlab/qmrlab
- MATLAB: https://github.com/mathieuboudreau/qmt-optimization