How to organize a growing set of tests?

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Dibya Chakravorty
Test Automation Engineer

datacamp

What you've done so far

16

- `row_to_list()`
- `convert_to_int()`
- `get_data_as_numpy_array()`
- `split_into_training_and_testing_sets()`

What you've done so far

32

- `row_to_list()`
- `convert_to_int()`
- `get_data_as_numpy_array()`
- `split_into_training_and_testing_sets()`
- `...`

What you've done so far

64

- `row_to_list()`
- `convert_to_int()`
- `get_data_as_numpy_array()`
- `split_into_training_and_testing_sets()`
- `...`

What you've done so far

128

- `row_to_list()`
- `convert_to_int()`
- `get_data_as_numpy_array()`
- `split_into_training_and_testing_sets()`
- `...`

Need a strategy to organize tests

128

Need a strategy to organize tests

Project structure

```
src/                                    # All application code lives here
```

Project structure

```
src/                                    # All application code lives here
|-- data/                               # Package for data preprocessing
    |-- __init__.py
```

Project structure

```
src/                                    # All application code lives here
|-- data/                               # Package for data preprocessing
    |-- __init__.py
    |-- preprocessing_helpers.py        # Contains row_to_list(), convert_to_int()
```

Project structure

```
src/                                    # All application code lives here
|-- data/                               # Package for data preprocessing
|   |-- __init__.py
|   |-- preprocessing_helpers.py        # Contains row_to_list(), convert_to_int()
|-- features/                           # Package for feature generation from preprocessed data
    |-- __init__.py
```

Project structure

```
src/                                    # All application code lives here
|-- data/                               # Package for data preprocessing
|   |-- __init__.py
|   |-- preprocessing_helpers.py        # Contains row_to_list(), convert_to_int()
|-- features/                           # Package for feature generation from preprocessed data
    |-- __init__.py
    |-- as_numpy.py                     # Contains get_data_as_numpy_array()
```

Project structure

```
src/                                    # All application code lives here
|-- data/                               # Package for data preprocessing
|   |-- __init__.py
|   |-- preprocessing_helpers.py        # Contains row_to_list(), convert_to_int()
|-- features/                           # Package for feature generation from preprocessed data
|   |-- __init__.py
|   |-- as_numpy.py                     # Contains get_data_as_numpy_array()
|-- models/                             # Package for training and testing linear regression model
    |-- __init__.py
```

Project structure

```
src/                                  # All application code lives here
|-- data/                             # Package for data preprocessing
|   |-- __init__.py
|   |-- preprocessing_helpers.py      # Contains row_to_list(), convert_to_int()
|-- features/                         # Package for feature generation from preprocessed data
|   |-- __init__.py
|   |-- as_numpy.py                   # Contains get_data_as_numpy_array()
|-- models/                           # Package for training/testing linear regression model
    |-- __init__.py
    |-- train.py                      # Contains split_into_training_and_testing_sets()
```

The tests folder

```
src/                                  # All application code lives here
|-- data/                             # Package for data preprocessing
|   |-- __init__.py
|   |-- preprocessing_helpers.py      # Contains row_to_list(), convert_to_int()
|-- features/                         # Package for feature generation from preprocessed data
|   |-- __init__.py
|   |-- as_numpy.py                   # Contains get_data_as_numpy_array()
|-- models/                           # Package for training/testing linear regression model
|   |-- __init__.py
|   |-- train.py                      # Contains split_into_training_and_testing_sets()
tests/                                # Test suite: all tests live here
```

The tests folder mirrors the application folder

```
src/                                  # All application code lives here
|-- data/                             # Package for data preprocessing
|   |-- __init__.py
|   |-- preprocessing_helpers.py      # Contains row_to_list(), convert_to_int()
|-- features/                         # Package for feature generation from preprocessed data
|   |-- __init__.py
|   |-- as_numpy.py                   # Contains get_data_as_numpy_array()
|-- models/                           # Package for training/testing linear regression model
|   |-- __init__.py
|   |-- train.py                      # Contains split_into_training_and_testing_sets()
tests/                                # Test suite: all tests live here
|-- data/
|   |-- __init__.py
|-- features/
|   |-- __init__.py
|-- models/
    |-- __init__.py
```

Python module and test module correspondence

- `my_module.py` $\iff$ `test_my_module.py`.

```
src/                                    # All application code lives here
|-- data/                               # Package for data preprocessing
|   |-- __init__.py
|   |-- preprocessing_helpers.py        # Contains row_to_list(), convert_to_int()
|-- features/                           # Package for feature generation from preprocessed data
|   |-- __init__.py
|   |-- as_numpy.py                     # Contains get_data_as_numpy_array()
|-- models/                             # Package for training/testing linear regression model
|   |-- __init__.py
|   |-- train.py                        # Contains split_into_training_and_testing_sets()
tests/                                  # Test suite: all tests live here
|-- data/
|   |-- __init__.py
|   |-- test_preprocessing_helpers.py   # Corresponds to module src/data/preprocessing_helpers.py
|-- features/
|   |-- __init__.py
|-- models/
    |-- __init__.py
```

Structuring tests inside test modules

- Test module: `test_preprocessing_helpers.py`

```
import pytest
from data.preprocessing_helpers import row_to_list, convert_to_int

def test_on_no_tab_no_missing_value():    # A test for row_to_list()
    ...

def test_on_two_tabs_no_missing_value():  # Another test for row_to_list()
    ...

...

def test_with_no_comma():                 # A test for convert_to_int()
    ...

def test_with_one_comma():                # Another test for convert_to_int()
    ...

...
```

Test class

Test class is a container for a single unit's tests

Test class: theoretical structure

- Test module: `test_preprocessing_helpers.py`

```
import pytest
from data.preprocessing_helpers import row_to_list, convert_to_int

class
```

Test class: theoretical structure

- Test module: `test_preprocessing_helpers.py`

```
import pytest
from data.preprocessing_helpers import row_to_list, convert_to_int

class TestRowToList():                              # Use CamelCase
```

Test class: theoretical structure

- Test module: `test_preprocessing_helpers.py`

```
import pytest
from data.preprocessing_helpers import row_to_list, convert_to_int

class TestRowToList(object):                          # Always put the argument object
    def test_on_no_tab_no_missing_value():            # A test for row_to_list()
        ...

    def test_on_two_tabs_no_missing_value():          # Another test for row_to_list()
        ...
```

Test class: theoretical structure

- Test module: `test_preprocessing_helpers.py`

```
import pytest
from data.preprocessing_helpers import row_to_list, convert_to_int

class TestRowToList(object):                        # Always put the argument object
    def test_on_no_tab_no_missing_value(self):      # Always put the argument self
        ...

    def test_on_two_tabs_no_missing_value(self):    # Always put the argument self
        ...
```

Clean separation

- Test module: `test_preprocessing_helpers.py`

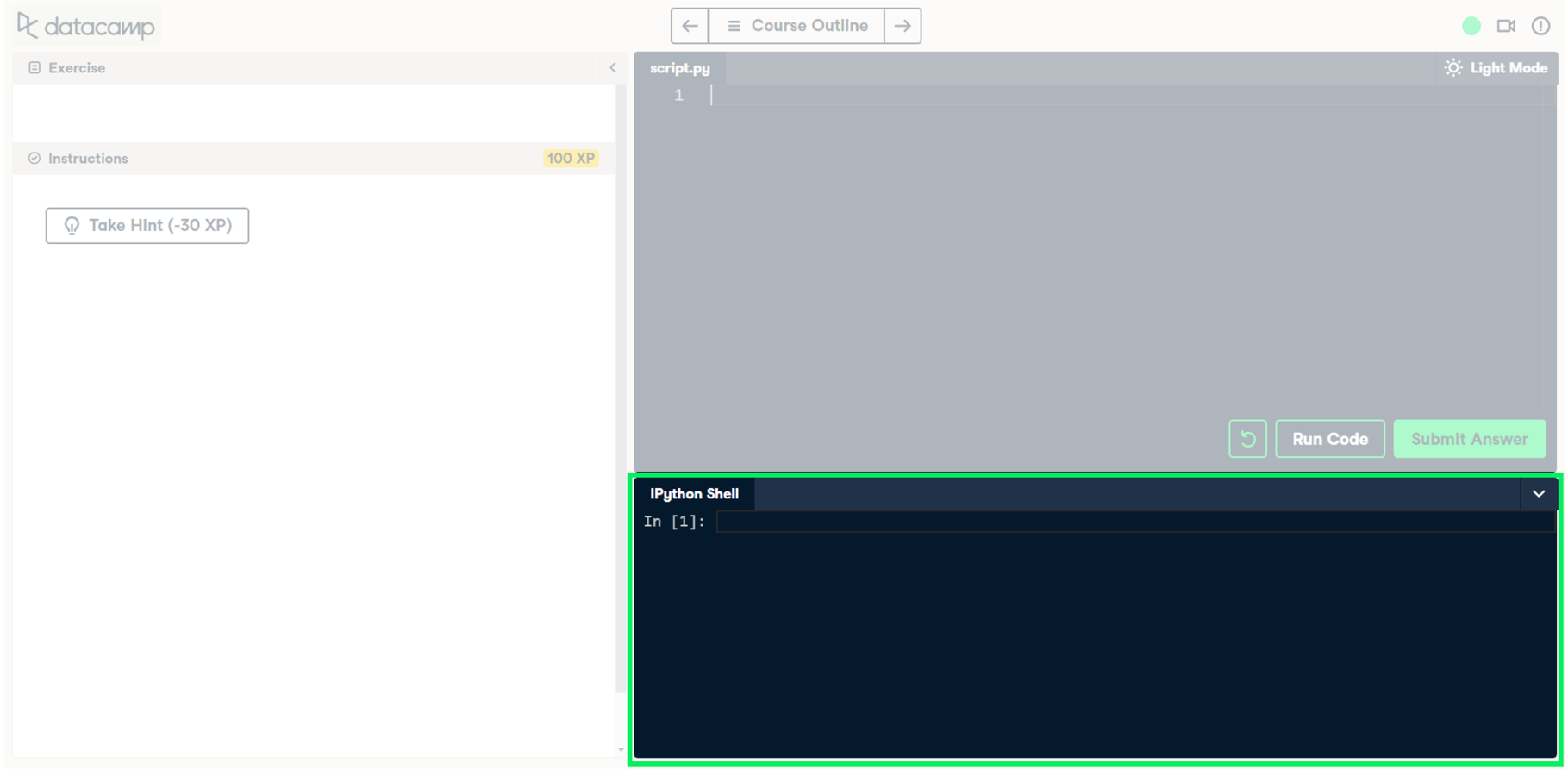
```
import pytest
from data.preprocessing_helpers import row_to_list, convert_to_int

class TestRowToList(object):                          # Always put the argument object
    def test_on_no_tab_no_missing_value(self):        # Always put the argument self
        ...

    def test_on_two_tabs_no_missing_value(self):      # Always put the argument self
        ...

class TestConvertToInt(object):                       # Test class for convert_to_int()
    def test_with_no_comma(self):                     # A test for convert_to_int()
        ...

    def test_with_one_comma(self):                    # Another test for convert_to_int()
        ...
```

Final test directory structure

```
src/                                  # All application code lives here
|-- data/                             # Package for data preprocessing
|   |-- __init__.py
|   |-- preprocessing_helpers.py      # Contains row_to_list(), convert_to_int()
|-- features/                         # Package for feature generation from preprocessed data
|   |-- __init__.py
|   |-- as_numpy.py                   # Contains get_data_as_numpy_array()
|-- models/                           # Package for training/testing linear regression model
|   |-- __init__.py
|   |-- train.py                      # Contains split_into_training_and_testing_sets()
tests/                                # Test suite: all tests live here
|-- data/
|   |-- __init__.py
|   |-- test_preprocessing_helpers.py   # Contains TestRowToList, TestConvertToInt
|-- features/
|   |-- __init__.py
|   |-- test_as_numpy.py              # Contains TestGetDataAsNumpyArray
|-- models/
    |-- __init__.py
    |-- test_train.py                 # Contains TestSplitIntoTrainingAndTestingSets
```

Test directory is well organized!

IPython console's working directory is tests



IPython console's working directory is tests

```
src/
|-- data/
|   |-- __init__.py
|   |-- preprocessing_helpers.py
|-- features/
|   |-- __init__.py
|   |-- as_numpy.py
|-- models/
|   |-- __init__.py
|   |-- train.py
tests/                                  # This is IPython console's working directory from now on
|-- data/
|   |-- __init__.py
|   |-- test_preprocessing_helpers.py
|-- features/
|   |-- __init__.py
|   |-- test_as_numpy.py
|-- models/
    |-- __init__.py
    |-- test_train.py
```

Let's practice structuring tests!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

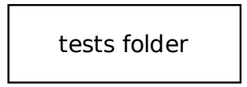
Mastering test execution

UNIT TESTING FOR DATA SCIENCE IN PYTHON

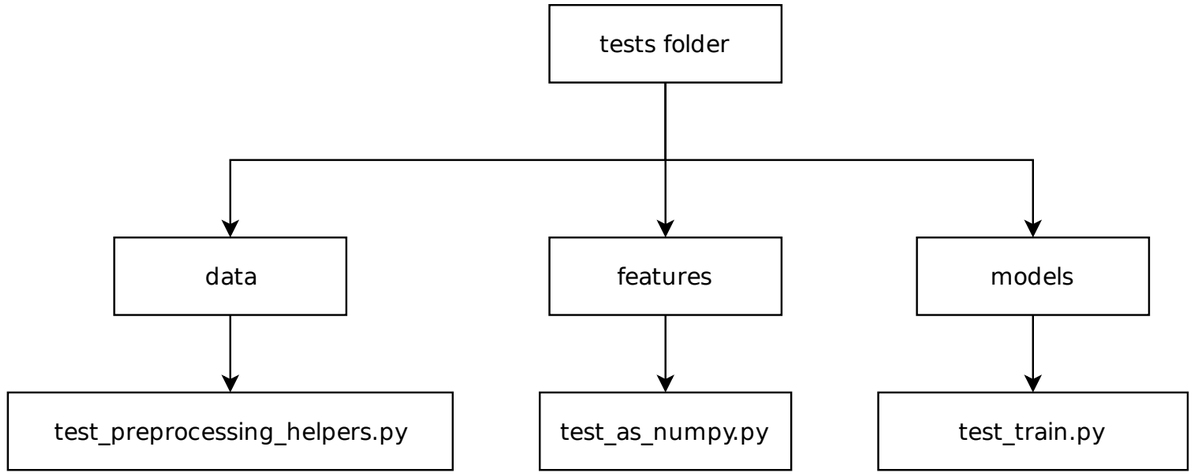
Dibya Chakravorty
Test Automation Engineer

datacamp

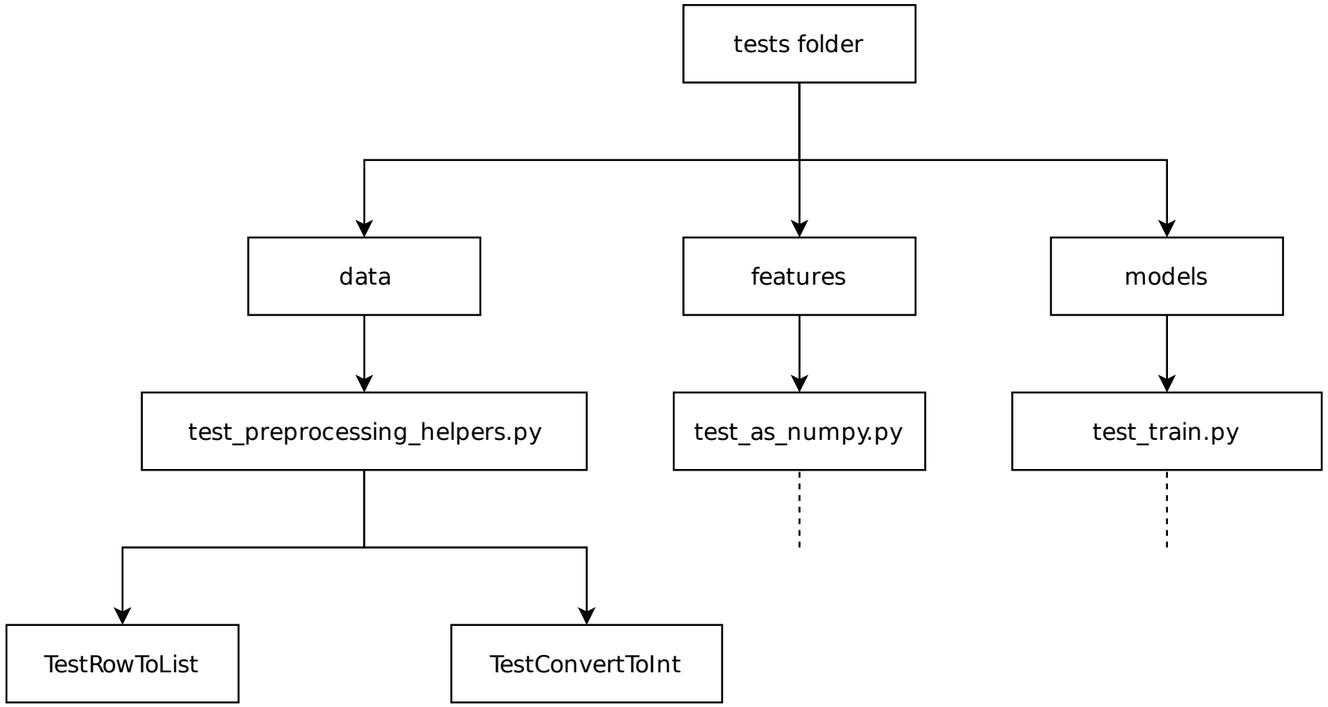
Test organization



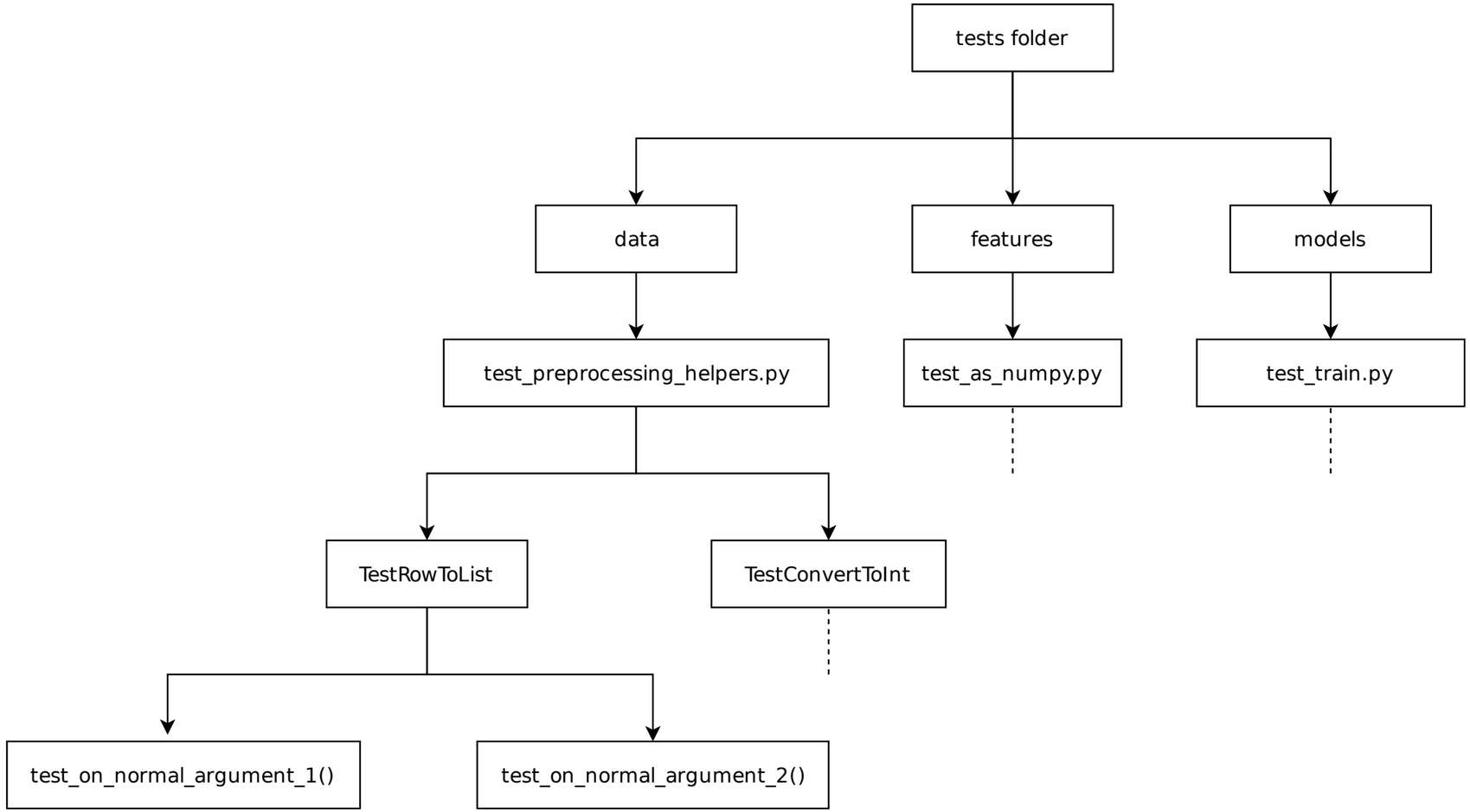
Test organization



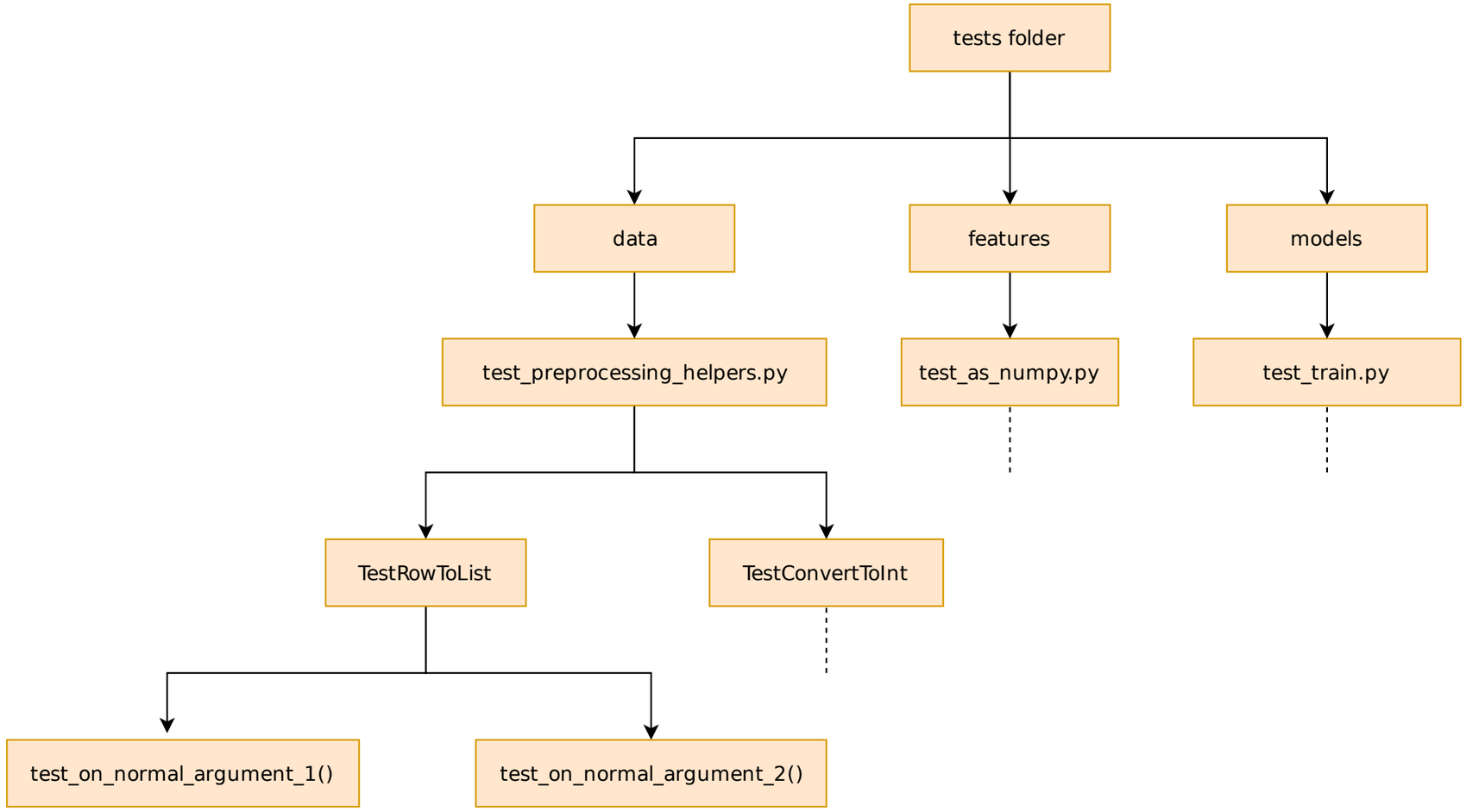
Test organization



Test organization



Running all tests



Running all tests

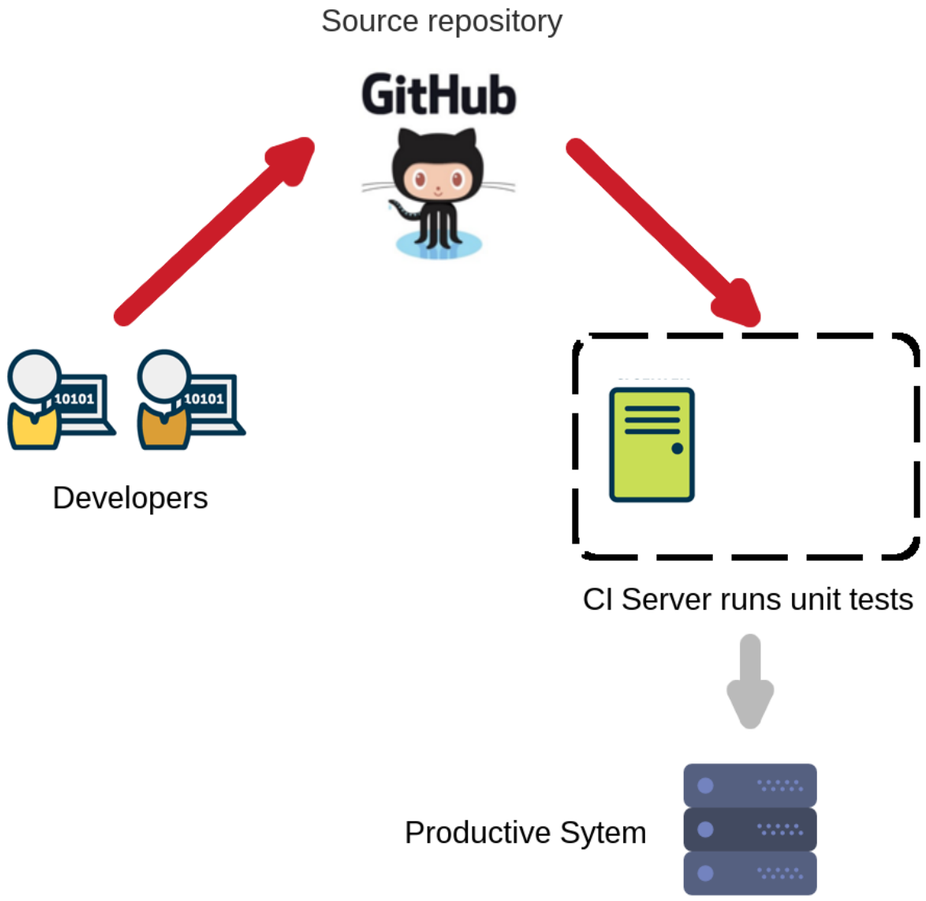
```
cd tests
pytest
```

- Recurses into directory subtree of `tests/` .
  - Filenames starting with `test_` $\rightarrow$ test module.
    - Classnames starting with `Test` $\rightarrow$ test class.
      - Function names starting with `test_` $\rightarrow$ unit test.

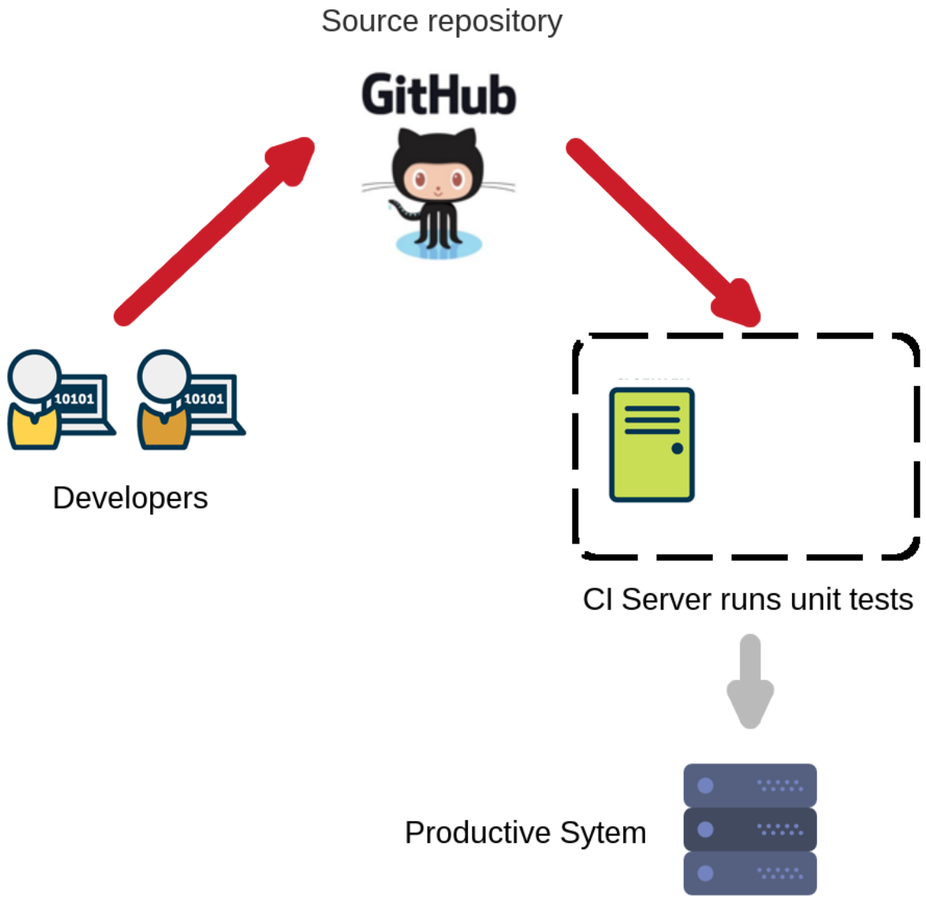
Running all tests

```
============================================================ test session starts ============================================
data/test_preprocessing_helpers.py ........F....                                                                        [ 81%]
features/test_as_numpy.py .                                                                                            [ 87%]
models/test_train.py ..                                                                                                [100%]

================================================================= FAILURES ==================================================
_____________________________________________ TestRowToList.test_on_one_tab_with_missing_value ____________________________

self = <tests.data.test_preprocessing_helpers.TestRowToList object at 0x7f6205475240>

    def test_on_one_tab_with_missing_value(self):    # (1, 1) boundary value
        actual = row_to_list("\t4,567\n")
>       assert actual is None, "Expected: None, Actual: {0}".format(actual)
E       AssertionError: Expected: None, Actual: ['', '4,567']
E       assert ['', '4,567'] is None

data/test_preprocessing_helpers.py:55: AssertionError
========================================================== 1 failed, 15 passed in 0.46 seconds ==============================
```

Typical scenario: CI server



Binary question: do all unit tests pass?

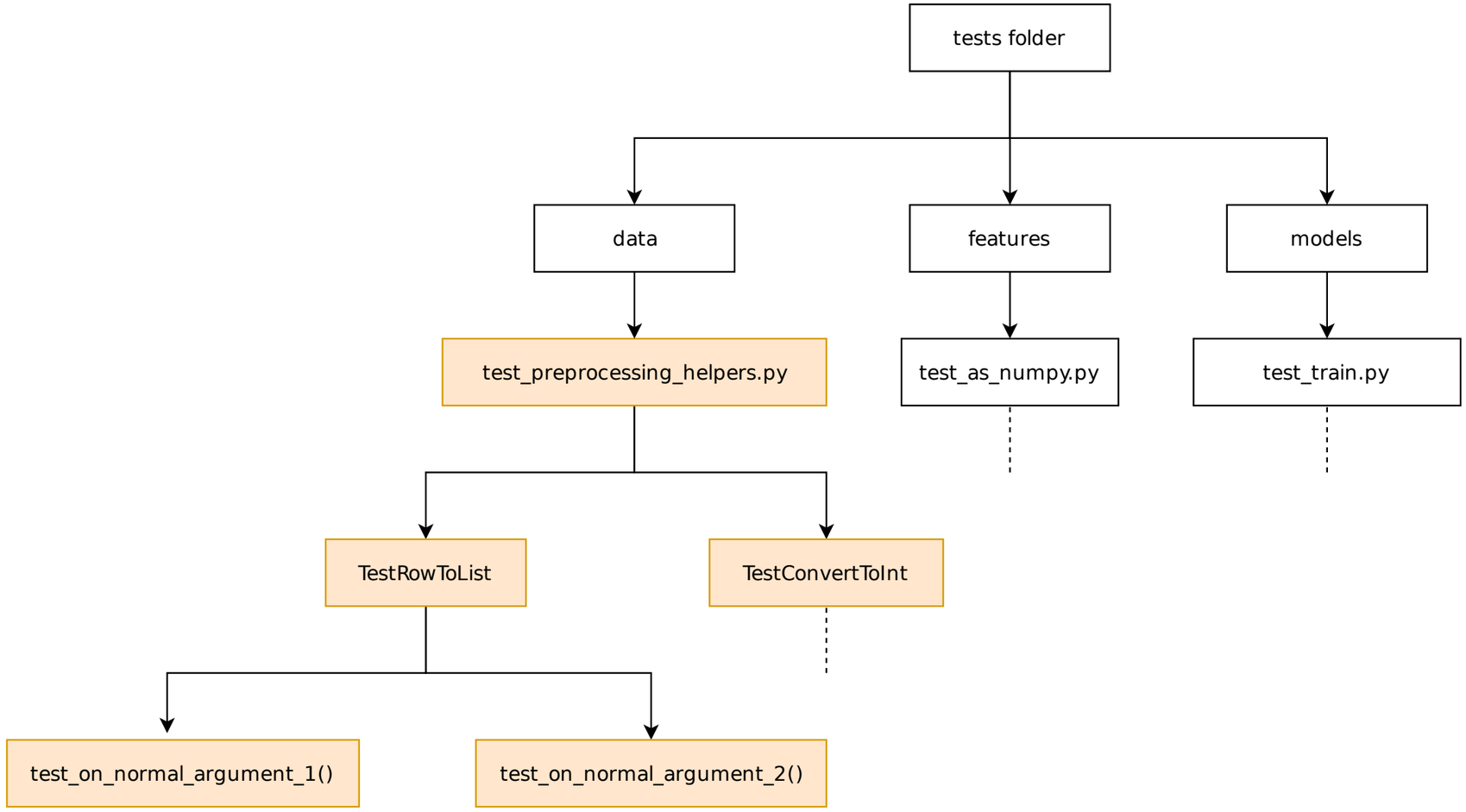


The -x flag: stop after first failure

```
pytest -x
```

```
====================================== test session starts ======================================
data/test_preprocessing_helpers.py ........F

========================================== FAILURES ==========================================
_____________________________ TestRowToList.test_on_one_tab_with_missing_value _____________________________

self = <tests.data.test_preprocessing_helpers.TestRowToList object at 0x7f6309f17198>

    def test_on_one_tab_with_missing_value(self):    # (1, 1) boundary value
        actual = row_to_list("\t4,567\n")
>       assert actual is None, "Expected: None, Actual: {0}".format(actual)
E       AssertionError: Expected: None, Actual: ['', '4,567']
E       assert ['', '4,567'] is None

data/test_preprocessing_helpers.py:55: AssertionError
================================== 1 failed, 8 passed in 0.45 seconds ==================================
```

Running tests in a test module

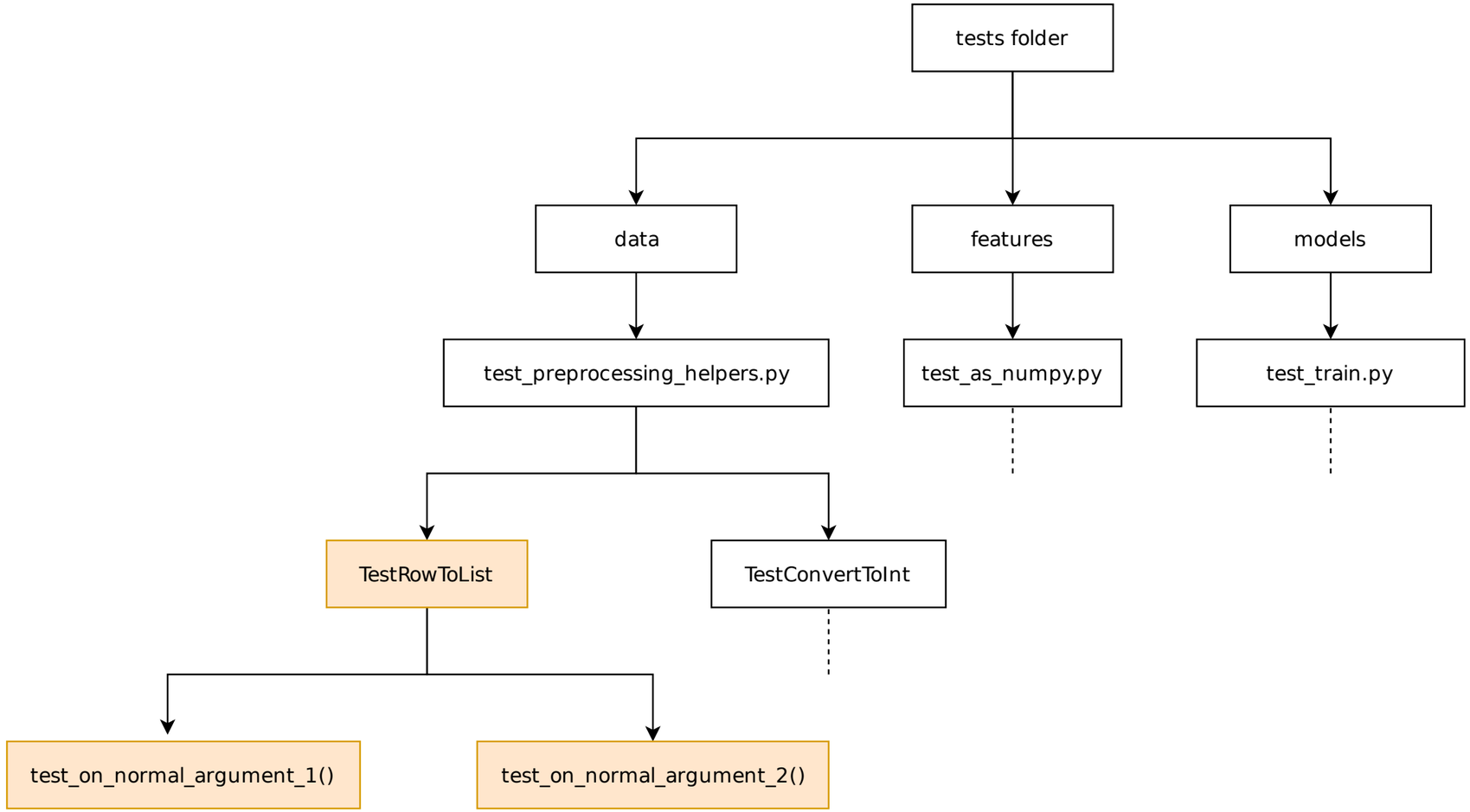


Running tests in a test module

```
pytest data/test_preprocessing_helpers.py
```

```
data/test_preprocessing_helpers.py ........F....                                    [100%]

================================================ FAILURES ================================================
____________________________ TestRowToList.test_on_one_tab_with_missing_value ____________________________

self = <tests.data.test_preprocessing_helpers.TestRowToList object at 0x7f435947f198>

    def test_on_one_tab_with_missing_value(self):    # (1, 1) boundary value
        actual = row_to_list("\t4,567\n")
>       assert actual is None, "Expected: None, Actual: {0}".format(actual)
E       AssertionError: Expected: None, Actual: ['', '4,567']
E       assert ['', '4,567'] is None

data/test_preprocessing_helpers.py:55: AssertionError
================================== 1 failed, 12 passed in 0.07 seconds ===================================
```

Running only a particular test class



Node ID

- Node ID of a test class: `<path to test module>::<test class name>`
- Node ID of an unit test: `<path to test module>::<test class name>::<unit test name>`

Running tests using node ID

- Run the test class `TestRowToList`.

```
pytest data/test_preprocessing_helpers.py::TestRowToList
```

```
data/test_preprocessing_helpers.py ..F....                                [100%]

========================================== FAILURES ==========================================
_________________________ TestRowToList.test_on_one_tab_with_missing_value __________________________

self = <tests.data.test_preprocessing_helpers.TestRowToList object at 0x7ffb3bac4da0>

    def test_on_one_tab_with_missing_value(self):    # (1, 1) boundary value
        actual = row_to_list("\t4,567\n")
>       assert actual is None, "Expected: None, Actual: {0}".format(actual)
E       AssertionError: Expected: None, Actual: ['', '4,567']
E       assert ['', '4,567'] is None

data/test_preprocessing_helpers.py:55: AssertionError
================================== 1 failed, 6 passed in 0.06 seconds ==================================
```

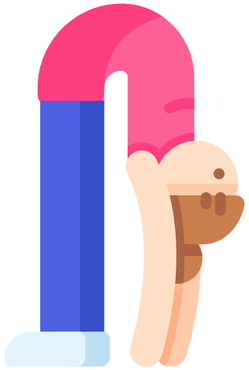
Running tests using node ID

- Run the unit test `test_on_one_tab_with_missing_value()`.

```
pytest data/test_preprocessing_helpers.py::TestRowToList::test_on_one_tab_with_missing_value
```

```
data/test_preprocessing_helpers.py F                                                [100%]

========================================== FAILURES ==========================================
_____________________________ TestRowToList.test_on_one_tab_with_missing_value _____________________________

self = <tests.data.test_preprocessing_helpers.TestRowToList object at 0x7f4eece33b00>

    def test_on_one_tab_with_missing_value(self):    # (1, 1) boundary value
        actual = row_to_list("\t4,567\n")
>       assert actual is None, "Expected: None, Actual: {0}".format(actual)
E       AssertionError: Expected: None, Actual: ['', '4,567']
E       assert ['', '4,567'] is None

data/test_preprocessing_helpers.py:55: AssertionError
====================================== 1 failed in 0.06 seconds ======================================
```

Running tests using keyword expressions



The -k option

```
pytest -k "pattern"
```

- Runs all tests whose node ID matches the pattern.

The -k option

- Run the test class `TestSplitIntoTrainingAndTestingSets`.

```
pytest -k "TestSplitIntoTrainingAndTestingSets"
```

```
models/test_train.py ..                                                  [100%

============================== 2 passed, 14 deselected in 0.36 seconds ==============================
```

```
pytest -k "TestSplit"
```

```
models/test_train.py ..                                                  [100%

============================== 2 passed, 14 deselected in 0.36 seconds ==============================
```

Supports Python logical operators

```
pytest -k "TestSplit and not test_on_one_row"
```

```
models/test_train.py .                                                  [100%]

==================== 1 passed, 15 deselected in 0.36 seconds ====================
```

Let's run some tests!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

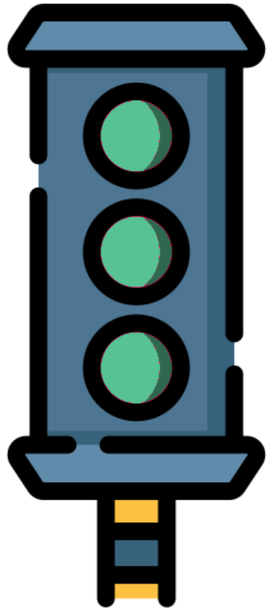
Expected failures and conditional skipping

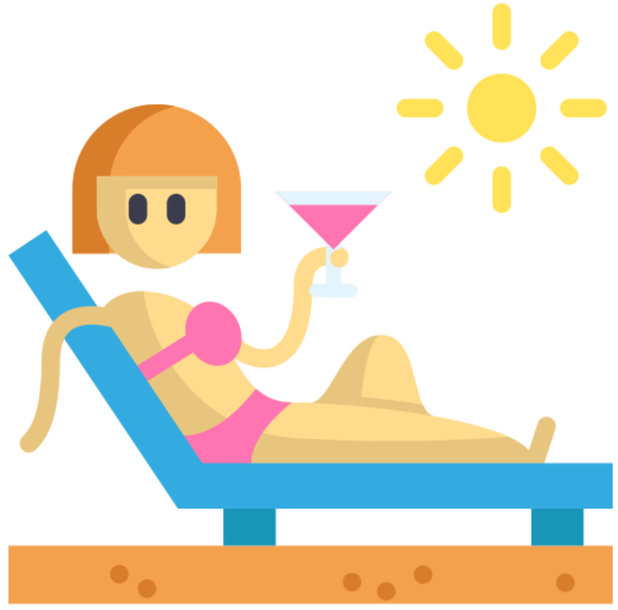
UNIT TESTING FOR DATA SCIENCE IN PYTHON

Dibya Chakravorty
Test Automation Engineer

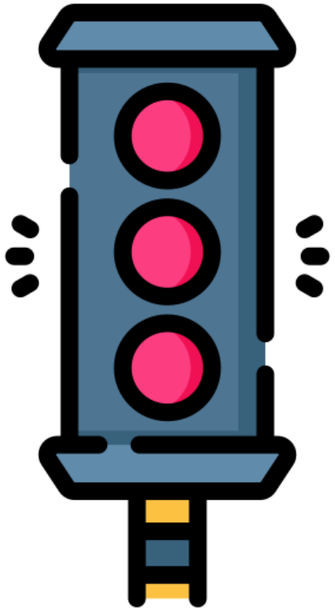
datacamp

Test suite is green when all tests pass





Test suite is red when any test fails



Implementing a function using TDD

- `train_model()` : Returns best fit line given training data.

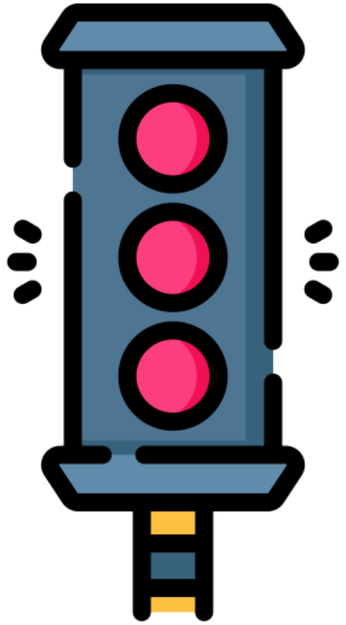
```
import pytest


class TestTrainModel(object):
    def test_on_linear_data(self):
        ...
```

The test fails, of course!

```
pytest
```

```
============================================= test session starts ==============================================
data/test_preprocessing_helpers.py .............                                                        [ 76%]
features/test_as_numpy.py .                                                                            [ 82%]
models/test_train.py ..F                                                                               [100%]

================================================== FAILURES ====================================================
_____________________________________ TestTrainModel.test_on_linear_data ______________________________________

self = <tests.models.test_train.TestTrainModel object at 0x7f5fc0f31978>

    def test_on_linear_data(self):
        test_input = np.array([[1.0, 3.0], [2.0, 5.0], [3.0, 7.0]])
        expected_slope = 2.0
        expected_intercept = 1.0
>       actual_slope, actual_intercept = train_model(test_input)
E       NameError: name 'train_model' is not defined

models/test_train.py:39: NameError
========================================== 1 failed, 16 passed in 0.22 seconds ===========================================
```

False alarm



xfail: marking tests as "expected to fail"

```
import pytest

class TestTrainModel(object):
    @
    def test_on_linear_data(self):
        ...
```

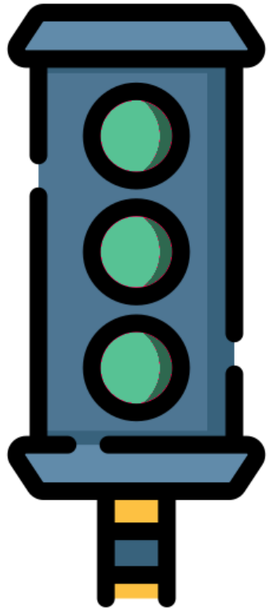
xfail: marking tests as "expected to fail"

```
import pytest

class TestTrainModel(object):
    @pytest.mark.xfail
    def test_on_linear_data(self):
        ...
```

```
pytest
```

```
====================================== test session starts ======================================
data/test_preprocessing_helpers.py ............                                          [ 76%]
features/test_as_numpy.py .                                                             [ 82%]
models/test_train.py ..x                                                                [100%]

============================== 16 passed, 1 xfailed in 0.21 seconds ==============================
```

Test suite stays green



Expected failures, but conditionally

Tests that are expected to fail

- on certain Python versions.
- on certain platforms like Windows.

```
class TestConvertToInt(object):
    def test_with_no_comma(self):
        """Only runs on Python 2.7 or lower"""
        test_argument = "756"
        expected = 756
        actual = convert_to_int(test_argument)
        message = unicode("Expected: 2081, Actual: {0}".format(actual))  # Requires Python 2.7 or low
        assert actual == expected, message
```

Test suite goes red on Python 3

```
pytest
```

```
==================================== test session starts =====================================
platform linux -- Python 3.6.8, pytest-4.3.1, py-1.8.0, pluggy-0.9.0

========================================== FAILURES ==========================================
_____________________________ TestConvertToInt.test_with_no_comma ______________________________

self = <tests.data.test_preprocessing_helpers.TestConvertToInt object at 0x7f2c479a76a0>

    def test_with_no_comma(self):
        test_argument = "756"
        expected = 756
        actual = convert_to_int(test_argument)
>       message = unicode("Expected: 2081, Actual: {0}".format(actual))
E       NameError: name 'unicode' is not defined

data/test_preprocessing_helpers.py:12: NameError
======================== 1 failed, 15 passed, 1 xfailed in 0.23 seconds ========================
```

skipif: skip tests conditionally

```
class TestConvertToInt(object):
    @pytest.mark.skipif
    def test_with_no_comma(self):
        """Only runs on Python 2.7 or lower"""
        test_argument = "756"
        expected = 756
        actual = convert_to_int(test_argument)
        message = unicode("Expected: 2081, Actual: {0}".format(actual))
        assert actual == expected, message
```

skipif: skip tests conditionally

```
class TestConvertToInt(object):
    @pytest.mark.skipif(boolean_expression)
    def test_with_no_comma(self):
        """Only runs on Python 2.7 or lower"""
        test_argument = "756"
        expected = 756
        actual = convert_to_int(test_argument)
        message = unicode("Expected: 2081, Actual: {0}".format(actual))
        assert actual == expected, message
```

- If `boolean_expression` is `True`, then test is skipped.

skipif when Python version is higher than 2.7

```
import sys


class TestConvertToInt(object):
    @pytest.mark.skipif(sys.version_info > (2, 7))
    def test_with_no_comma(self):
        """Only runs on Python 2.7 or lower"""
        test_argument = "756"
        expected = 756
        actual = convert_to_int(test_argument)
        message = unicode("Expected: 2081, Actual: {0}".format(actual))
        assert actual == expected, message
```

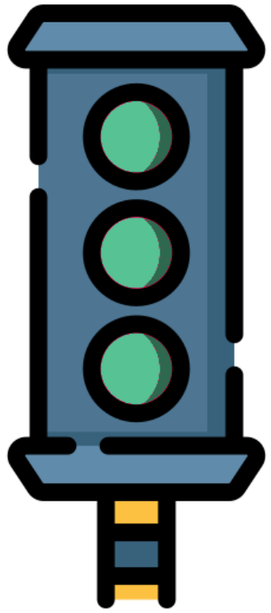
The reason argument

```
import sys


class TestConvertToInt(object):
    @pytest.mark.skipif(sys.version_info > (2, 7), reason="requires Python 2.7")
    def test_with_no_comma(self):
        """Only runs on Python 2.7 or lower"""
        test_argument = "756"
        expected = 756
        actual = convert_to_int(test_argument)
        message = unicode("Expected: 2081, Actual: {0}".format(actual))
        assert actual == expected, message
```

1 skipped, 1 xfailed

```
pytest
```

```
============================= test session starts ==============================
platform linux -- Python 3.6.8, pytest-4.3.1, py-1.8.0, pluggy-0.9.0
collected 17 items

data/test_preprocessing_helpers.py s.....                                [ 76%]
features/test_as_numpy.py .                                              [ 82%]
models/test_train.py ..x                                                 [100%]

======================== 15 passed, 1 skipped, 1 xfailed in 0.21 seconds ========================
```



Showing reason in the test result report

```
pytest -r
```

The -r option

```
pytest -r[set_of_characters]
```

Showing reason for skipping

```
pytest -rs
```

```
================================== test session starts ===================================
platform linux -- Python 3.6.8, pytest-4.3.1, py-1.8.0, pluggy-0.9.0
collected 17 items

data/test_preprocessing_helpers.py s.....                                          [ 76%]
features/test_as_numpy.py .                                                        [ 82%]
models/test_train.py ..x                                                           [100%]
================================== short test summary info ===============================
SKIPPED [1] tests/data/test_preprocessing_helpers.py:8: Requires Python 2.7 or lower

================== 15 passed, 1 skipped, 1 xfailed in 0.21 seconds ===================
```

Optional reason argument to xfail

```
import pytest


class TestTrainModel(object):
    @pytest.mark.xfail
    def test_on_linear_data(self):
        ...
```

Optional reason argument to xfail

```
import pytest


class TestTrainModel(object):
    @pytest.mark.xfail(reason=""“Using TDD, train_model() is not implemented")
    def test_on_linear_data(self):
        ...
```

Showing reason for xfail

```
pytest -rx
```

```
================================== test session starts ==================================
platform linux -- Python 3.6.8, pytest-4.3.1, py-1.8.0, pluggy-0.9.0
collected 17 items

data/test_preprocessing_helpers.py s.....                                         [ 76%]
features/test_as_numpy.py .                                                       [ 82%]
models/test_train.py ..x                                                          [100%]
================================== short test summary info ==================================
XFAIL models/test_train.py::TestTrainModel::test_on_linear_data
  Using TDD, train_model() is not implemented

==================== 15 passed, 1 skipped, 1 xfailed in 0.28 seconds ====================
```

Showing reason for both skipped and xfail

```
pytest -rsx
```

```
==================================== test session starts ====================================
platform linux -- Python 3.6.8, pytest-4.3.1, py-1.8.0, pluggy-0.9.0
rootdir: /home/dibya/startup-code/datacamp/univariate_linear_regression, inifile:
collected 17 items

data/test_preprocessing_helpers.py s...........                                        [ 76%]
features/test_as_numpy.py .                                                            [ 82%]
models/test_train.py ..x                                                               [100%]
================================== short test summary info ==================================
SKIPPED [1] tests/data/test_preprocessing_helpers.py:8: Requires Python 2.7 or lower
XFAIL models/test_train.py::TestTrainModel::test_on_linear_data
  Using TDD, train_model() is not implemented

==================== 15 passed, 1 skipped, 1 xfailed in 0.22 seconds ====================
```

Skipping/xfailing entire test classes

```
@pytest.mark.xfail(reason="“Using TDD, train_model() is not implemented")
class TestTrainModel(object):
    ...
```

```
@pytest.mark.skipif(sys.version_info > (2, 7), reason="requires Python 2.7")
class TestConvertToInt(object):
    ...
```

Let's practice xfailing and skipping!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Continuous integration and code coverage

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Dibya Chakravorty
Test Automation Engineer

datacamp

Code coverage and build status badges

NumPy is the fundamental package needed for scientific computing with Python.

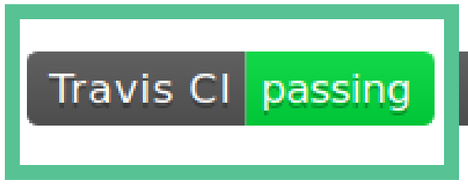
- **Website (including documentation):** https://www.numpy.org
- **Mailing list:** https://mail.python.org/mailman/listinfo/numpy-discussion
- **Source:** https://github.com/numpy/numpy

Code coverage and build status badges

NumPy is the fundamental package needed for scientific computing with Python.

- **Website (including documentation):** https://www.numpy.org
- **Mailing list:** https://mail.python.org/mailman/listinfo/numpy-discussion
- **Source:** https://github.com/numpy/numpy

Code coverage and build status badges

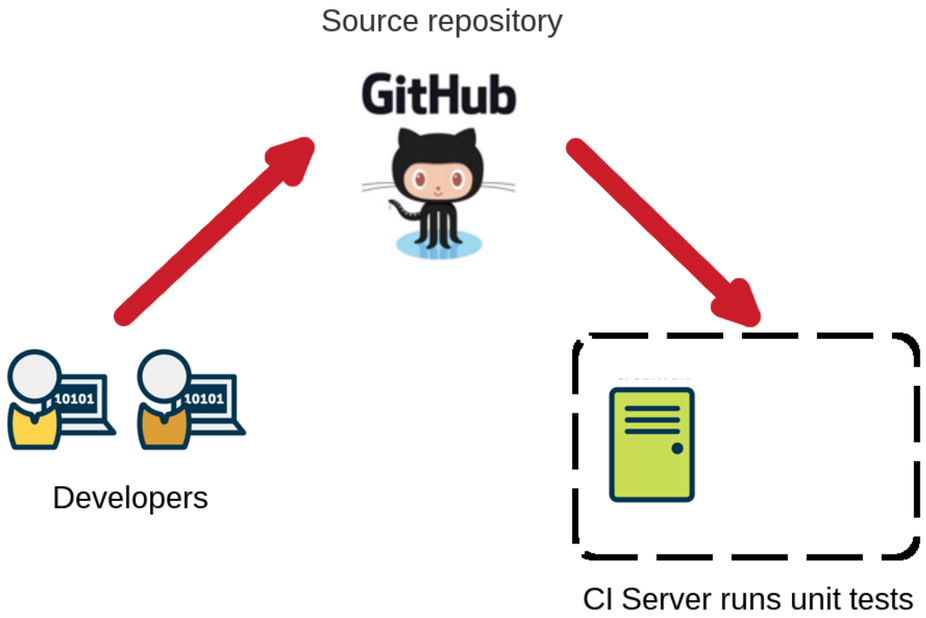


NumPy is the fundamental package needed for scientific computing with Python.

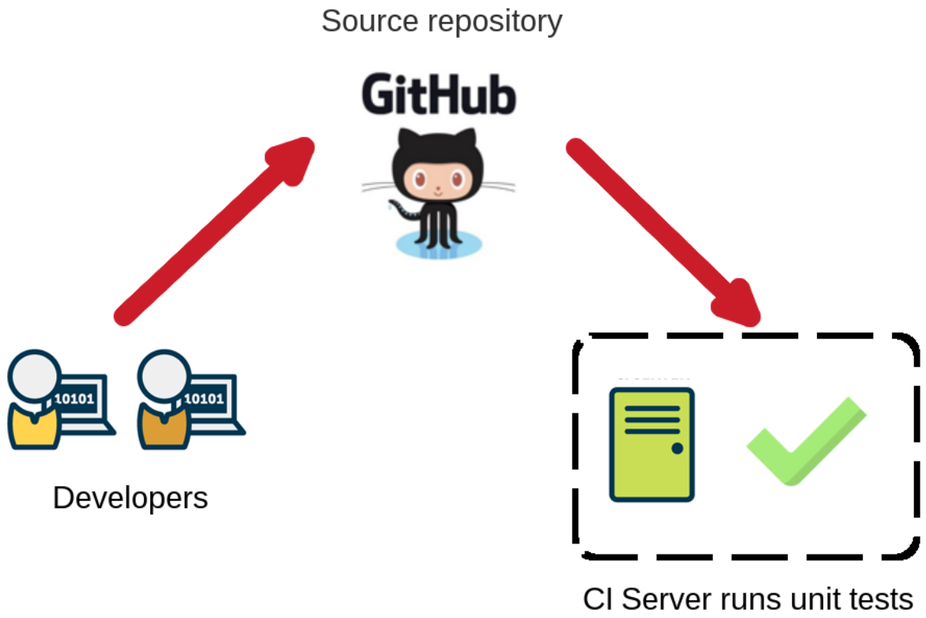
- **Website (including documentation):** https://www.numpy.org
- **Mailing list:** https://mail.python.org/mailman/listinfo/numpy-discussion
- **Source:** https://github.com/numpy/numpy

The build status badge

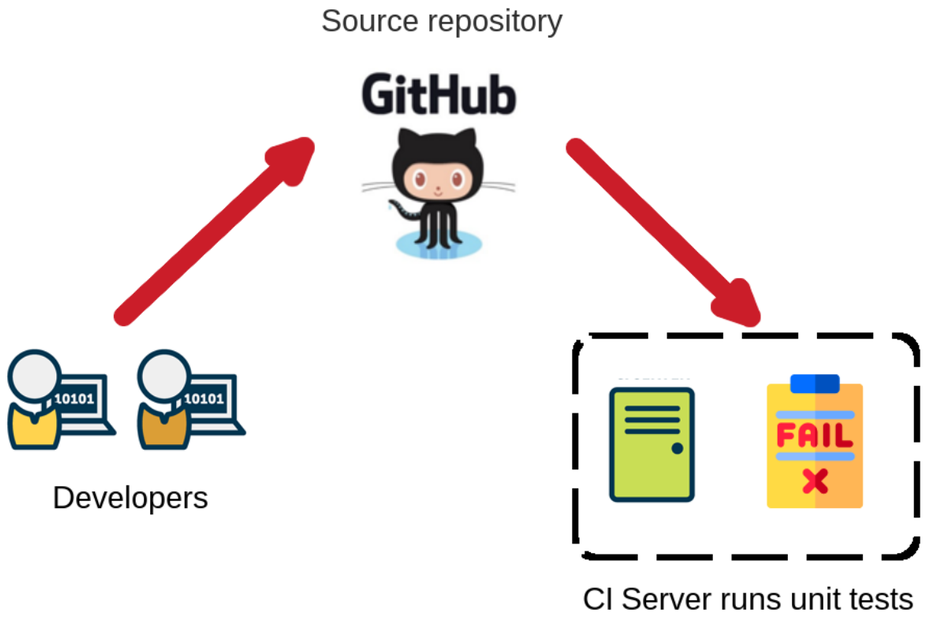
The build status badge



Build passing = Stable project



Build failing = Unstable project



CI server

Travis CI

Step 1: Create a configuration file

```
repository root
|-- src
|-- tests
|--.travis.yml
```

Step 1: Create a configuration file

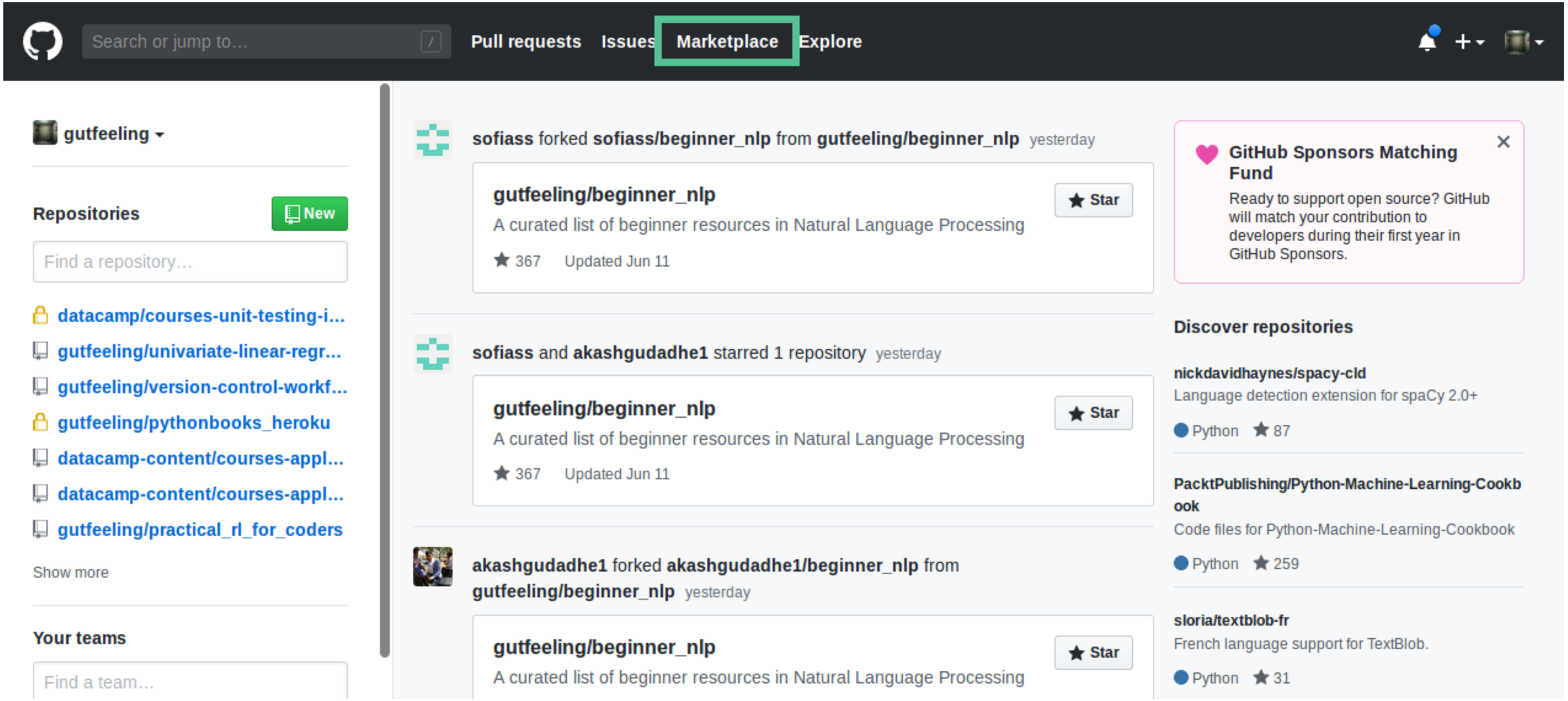
- Contents of `.travis.yml`.

```
language: python
python:
  - "3.6"
install:
  - pip install -e .
script:
  - pytest tests
```

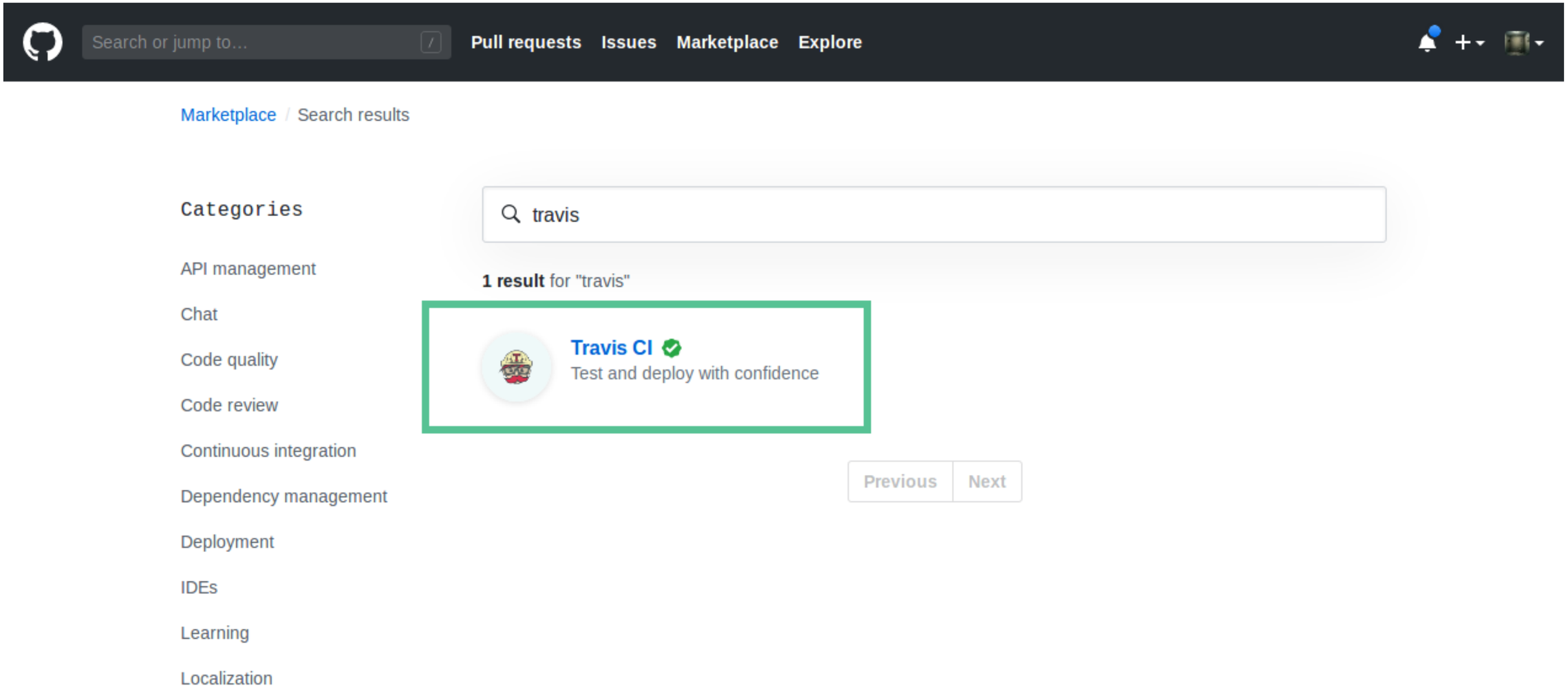
Step 2: Push the file to GitHub

```
git add .travis.yml
git push origin master
```

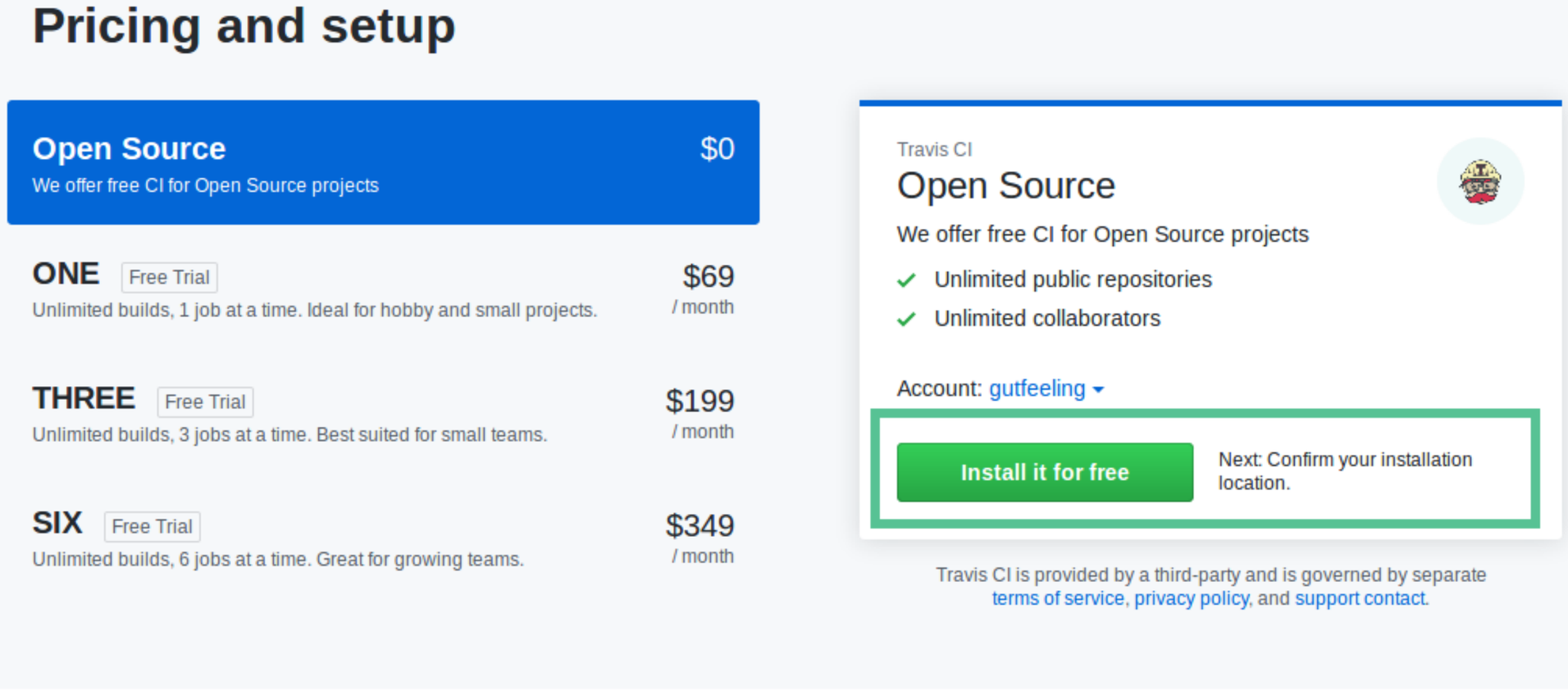
Step 3: Install the Travis CI app



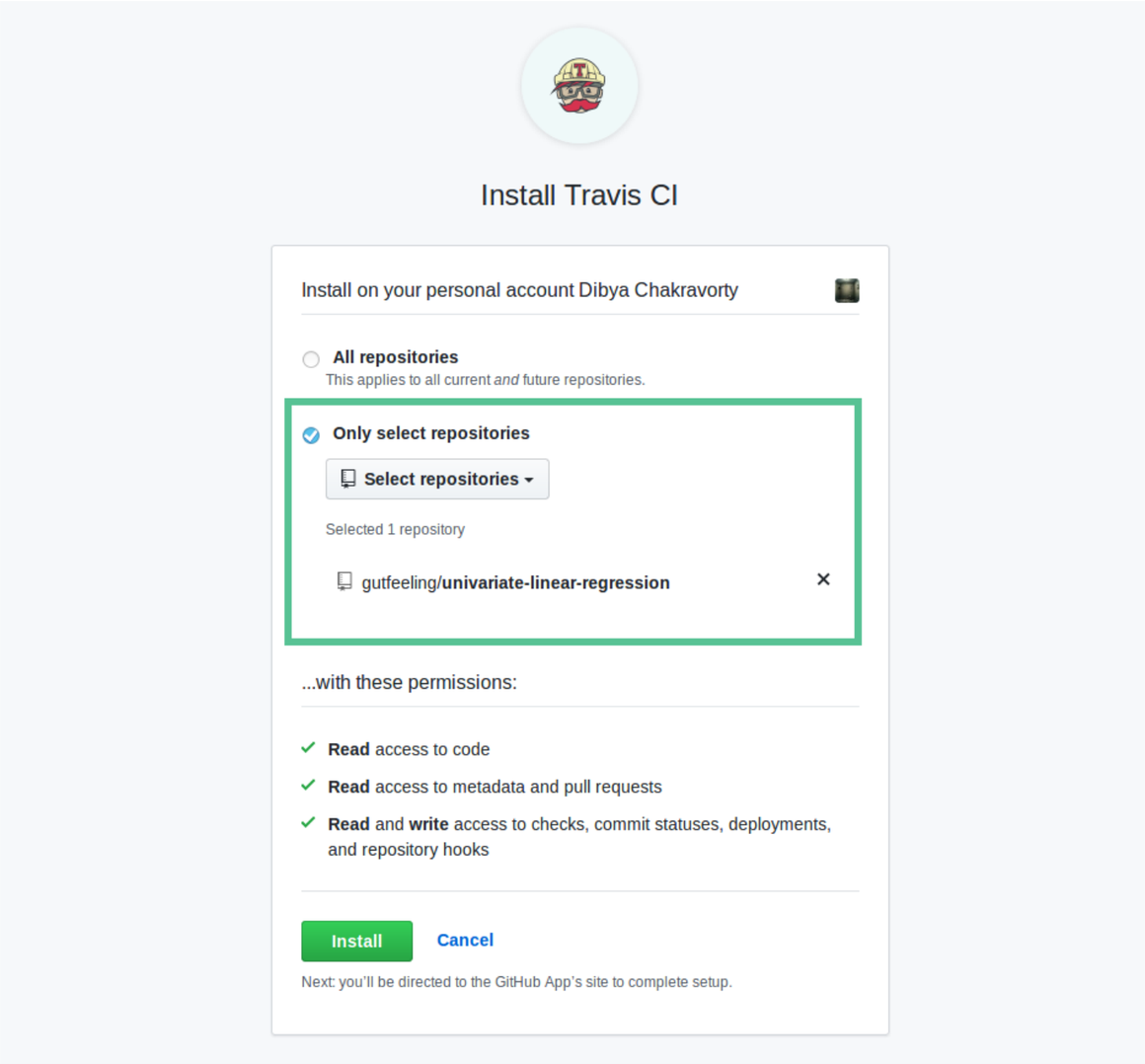
Step 3: Install the Travis CI app



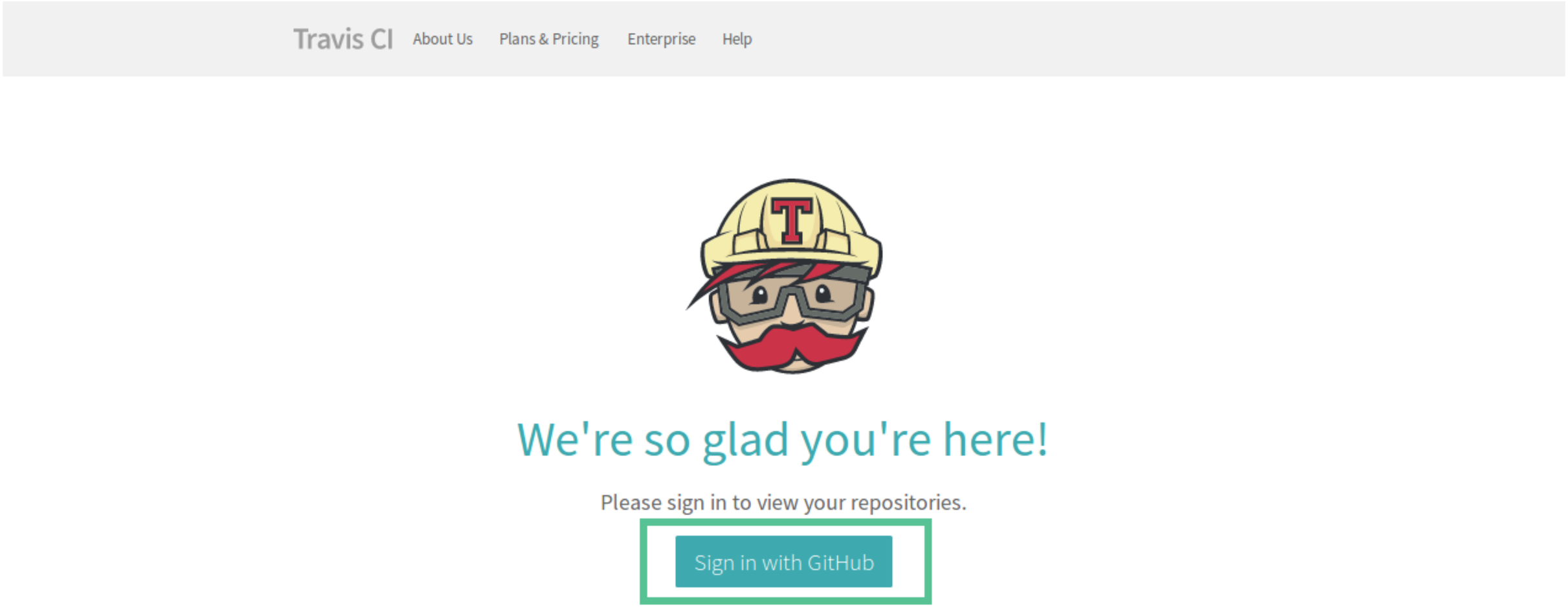
Step 3: Install the Travis CI app



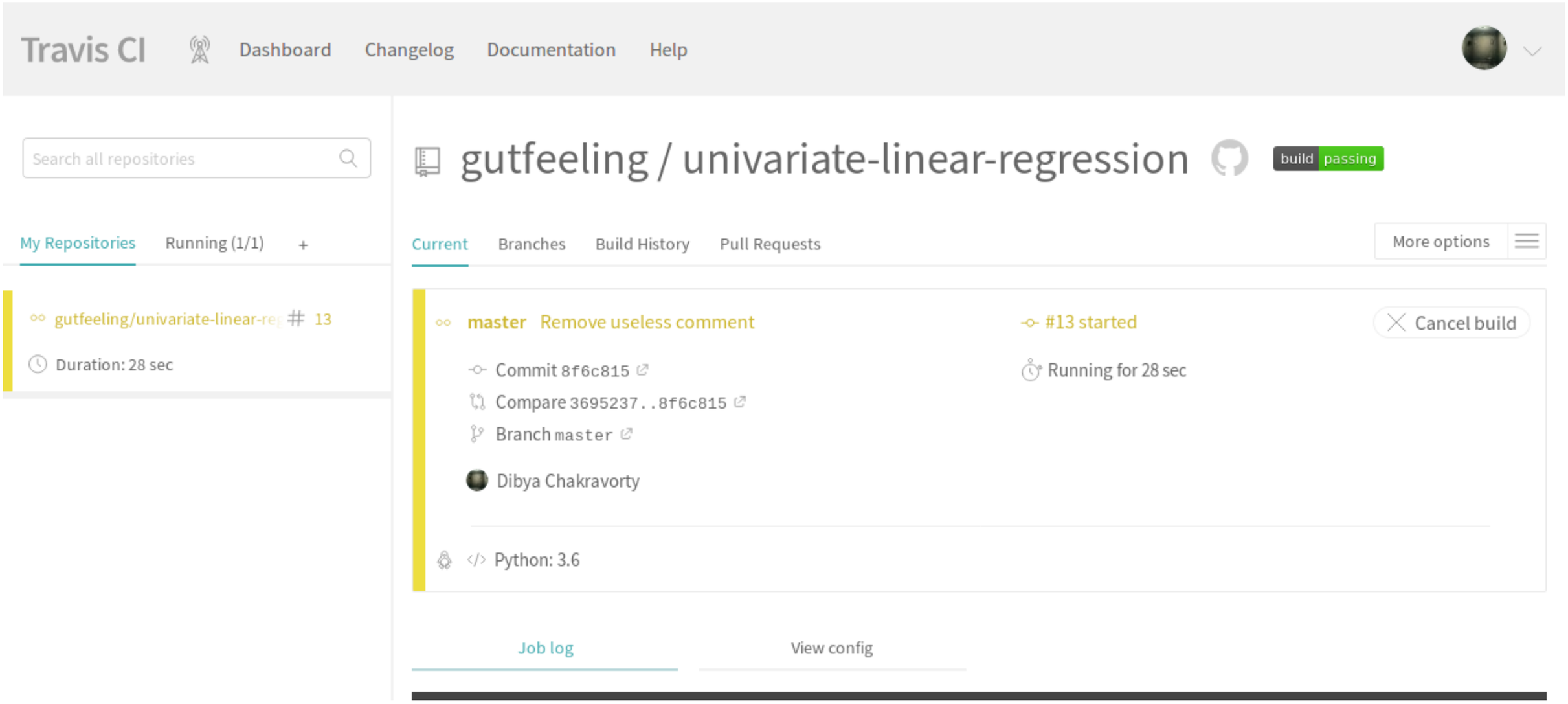
Step 3: Install the Travis CI app



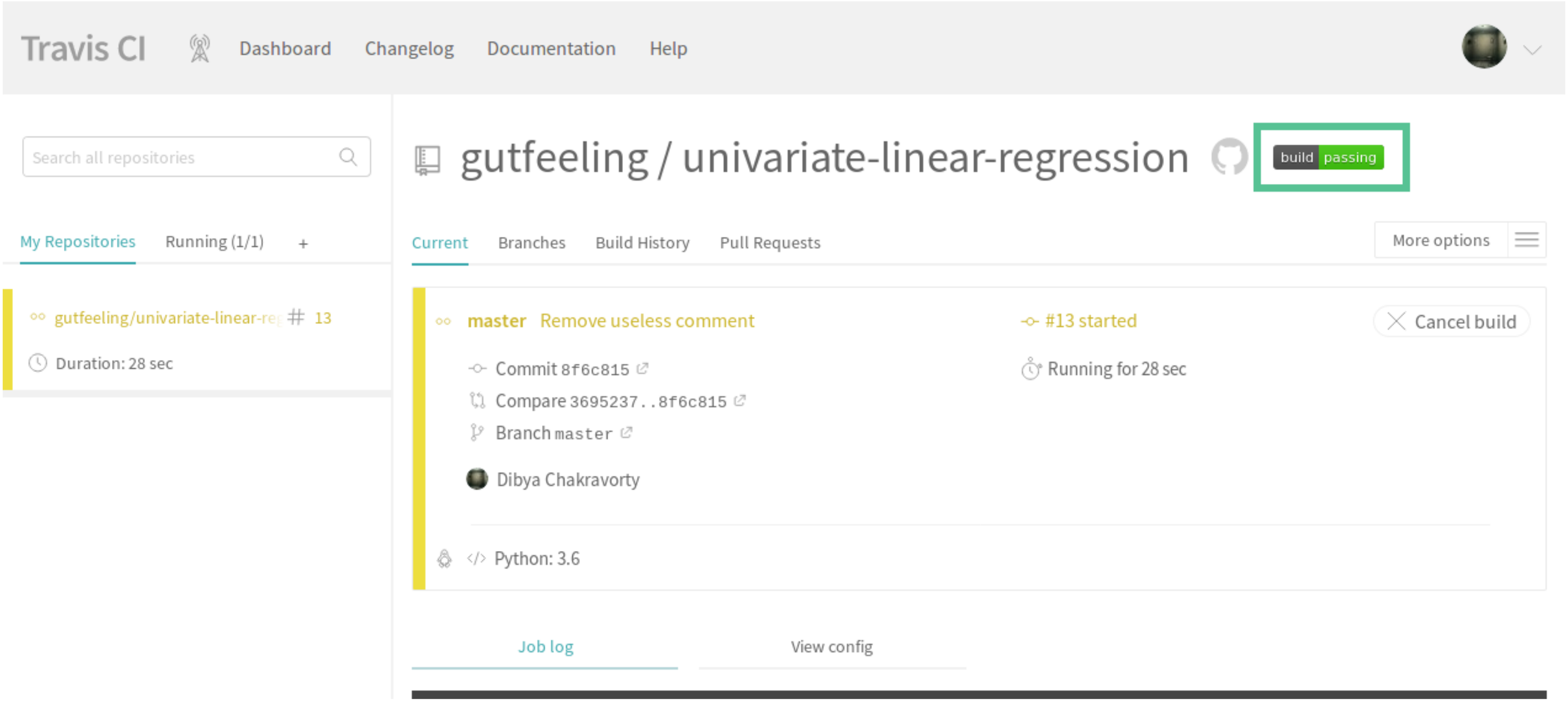
Step 3: Install the Travis CI app



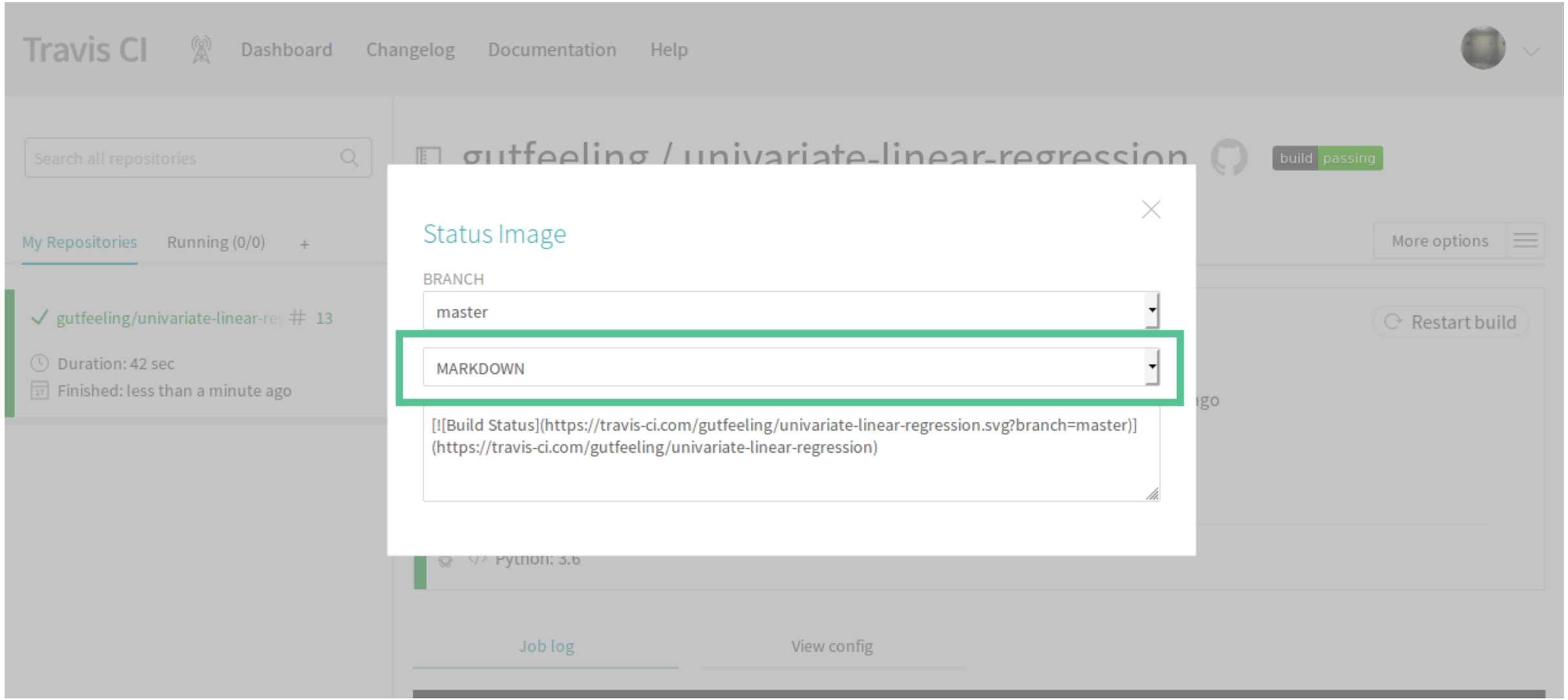
Every commit leads to a build



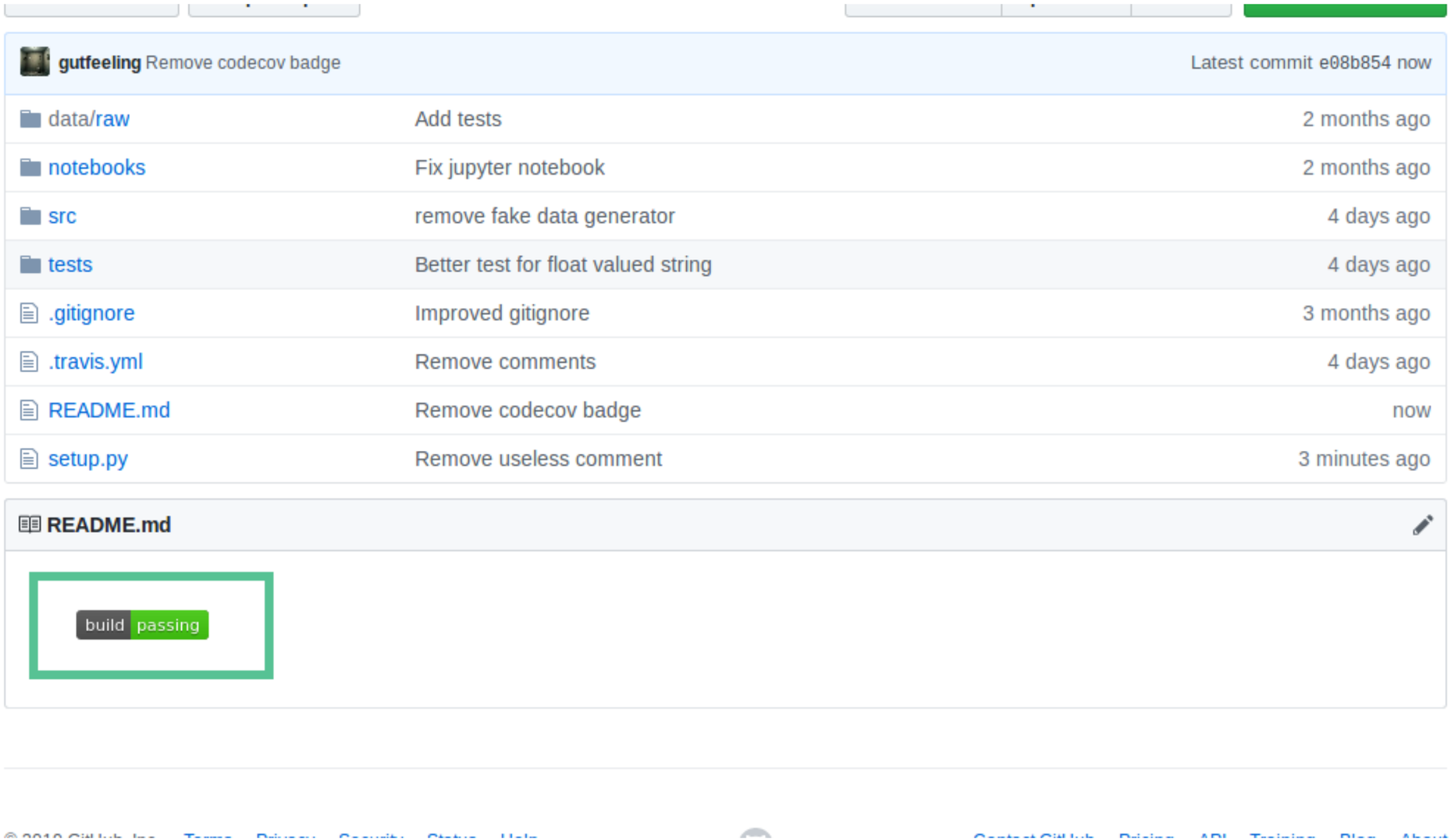
Step 4: Showing the build status badge



Step 4: Showing the build status badge



Step 4: Showing the build status badge



Code coverage

- $\text{code coverage} = \frac{\text{num lines of application code that ran during testing}}{\text{total num lines of application code}} \times 100$
- Higher percentages (75% and above) indicate well tested code.

Codecov

Step 1: Modify the Travis CI configuration file

- File: `.travis.yml`

```
language: python
python:
  - "3.6"
install:
  - pip install -e .

script:
  - pytest tests
```

Step 1: Modify the Travis CI configuration file

- File: `.travis.yml`

```
language: python
python:
  - "3.6"
install:
  - pip install -e .
  - pip install pytest-cov codecov    # Install packages for code coverage report
script:
  - pytest tests
```

Step 1: Modify the Travis CI configuration file

- File: `.travis.yml`

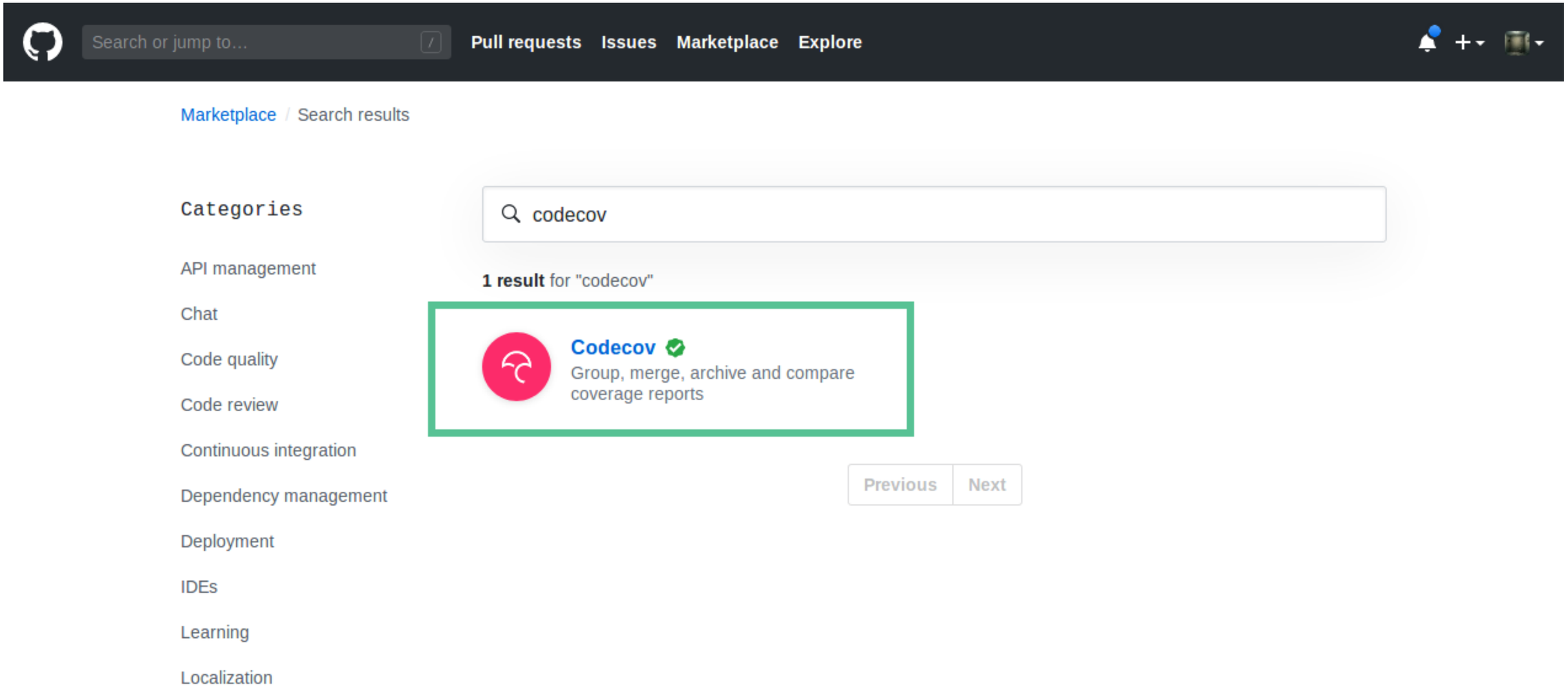
```
language: python
python:
  - "3.6"
install:
  - pip install -e .
  - pip install pytest-cov codecov    # Install packages for code coverage report
script:
  - pytest --cov=src tests            # Point to the source directory
```

Step 1: Modify the Travis CI configuration file

- File: `.travis.yml`

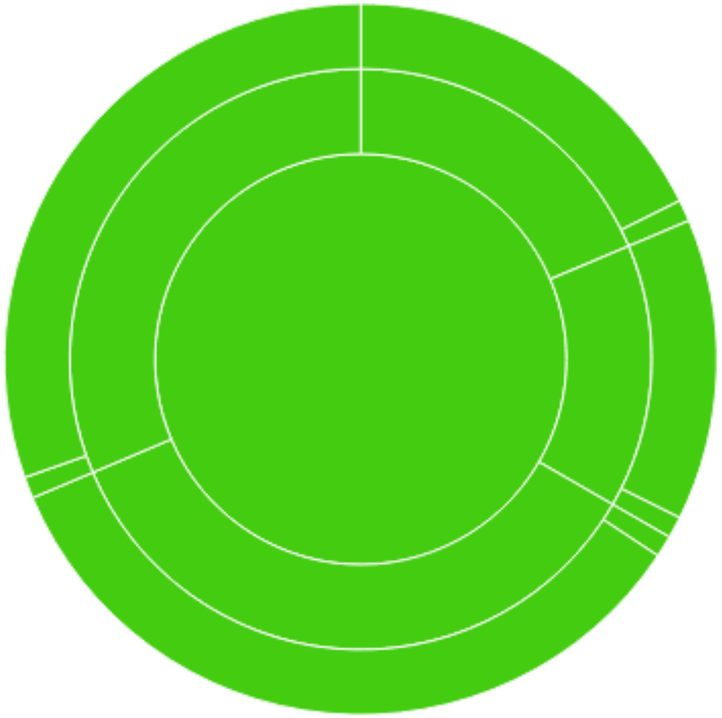
```
language: python
python:
  - "3.6"
install:
  - pip install -e .
  - pip install pytest-cov codecov    # Install packages for code coverage report
script:
  - pytest --cov=src tests            # Point to the source directory
after_success:
  - codecov                           # uploads report to codecov.io
```

Step 2: Install Codecov



Commits lead to coverage report at codecov.io

COVERAGE SUNBURST



/

ALL RECENT COMMITS

Fix side effects and call order in mocks — Browse Report

gutfeeling 7 days ago master 298091d CI Passed

Add pytest-mock — Browse Report

gutfeeling 7 days ago master 02e714a CI Passed

Add test for preprocessing function — Browse Report

gutfeeling 7 days ago master b8dfc76 CI Passed

Add baseline plots and add pytest-mpl requirement — Browse Report

gutfeeling 7 days ago master 752e0e0 CI Passed

Merge remote-tracking branch 'origin/master' — Browse Report

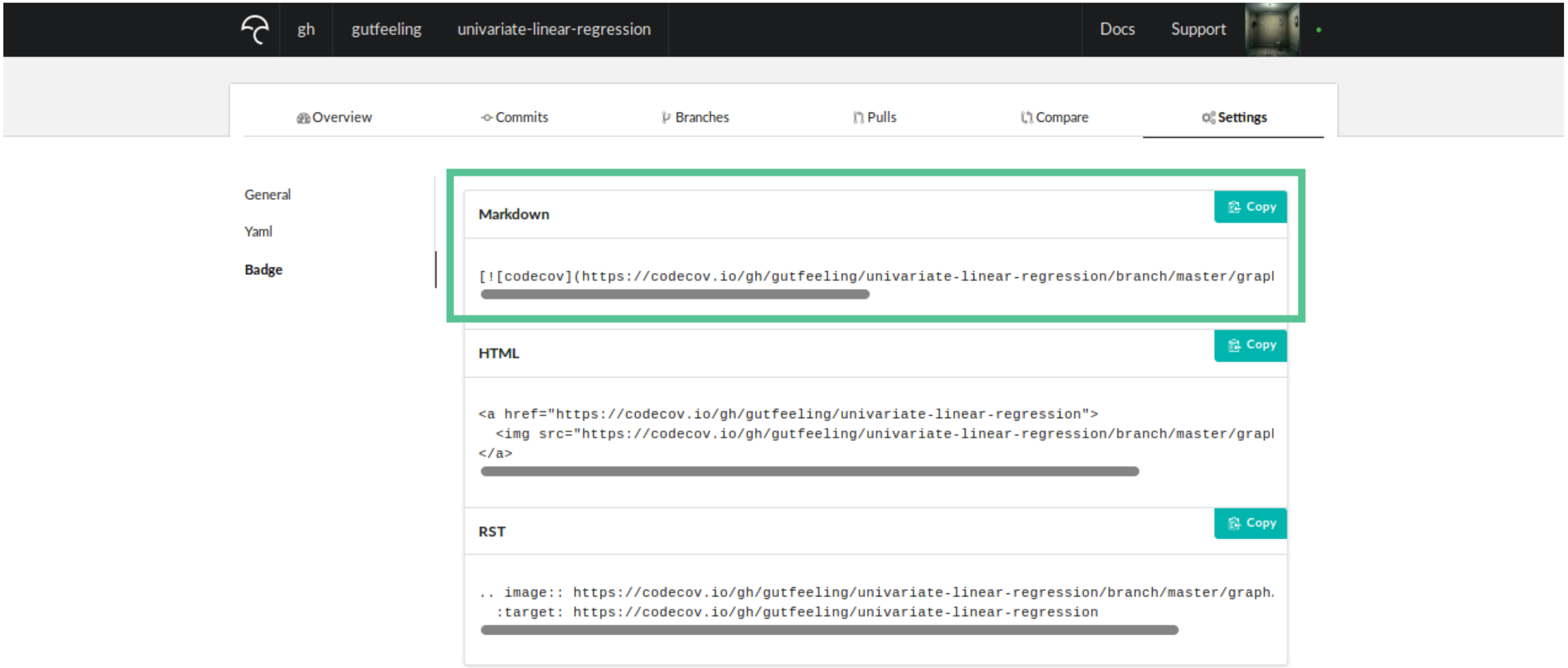
gutfeeling 7 days ago master 7ef5ef2 CI Passed

Add codecov badge — Browse Report

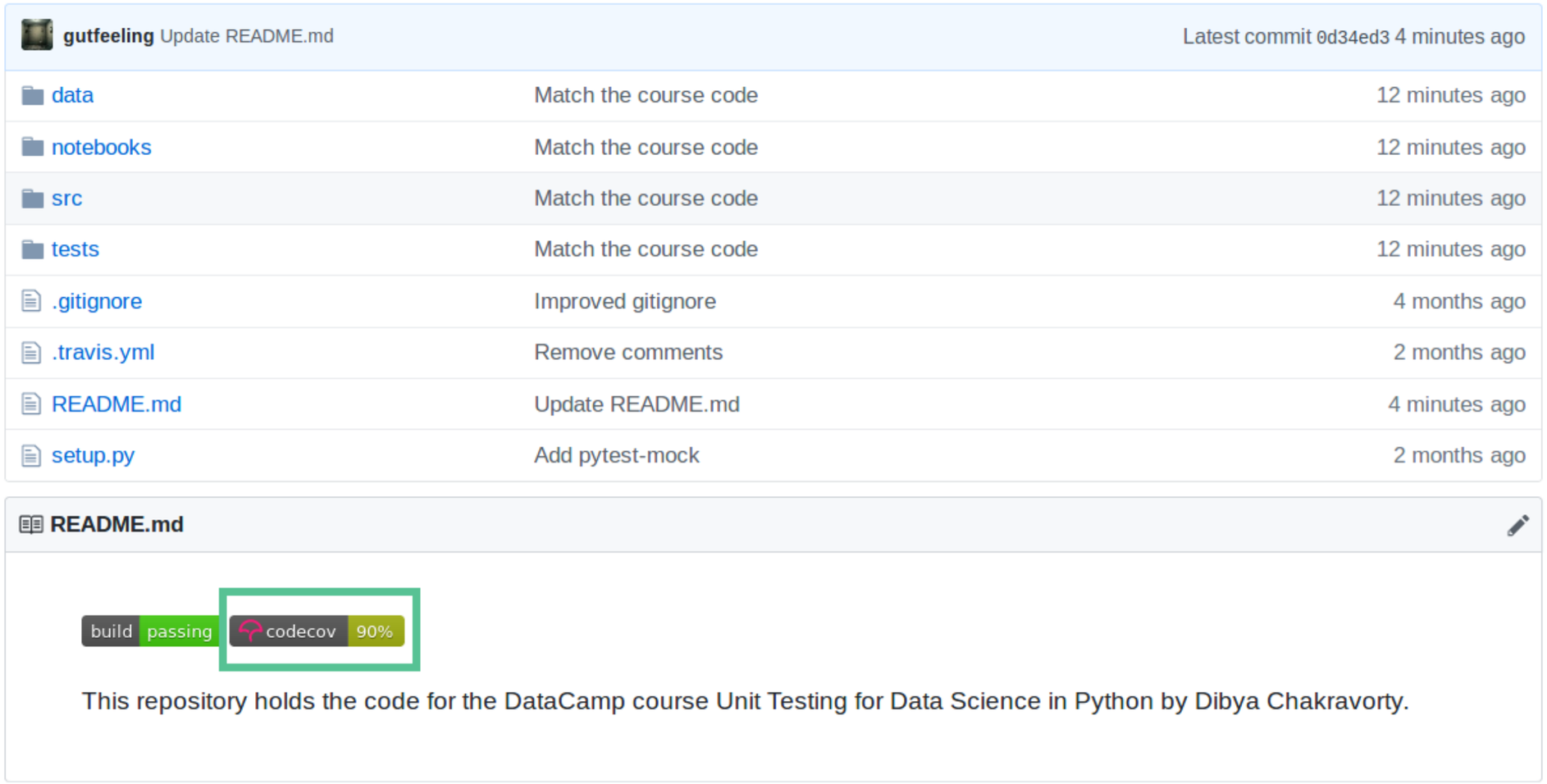
gutfeeling 10 days ago master 960fa3f CI Passed

View all recent commits

Step 3: Showing the badge in GitHub



Step 3: Showing the badge in GitHub



Let's practice CI and code coverage!

UNIT TESTING FOR DATA SCIENCE IN PYTHON