

Beyond assertion: setup and teardown

UNIT TESTING FOR DATA SCIENCE IN PYTHON



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The preprocessing function

```
def preprocess(raw_data_file_path,  
               clean_data_file_path  
               ):  
  
    ...
```

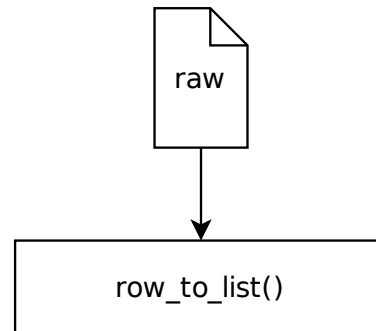


```
1,801      201,411  
1,767565,112  
2,002      333,209  
1990       782,911  
1,285      389129
```

The preprocessing function

```
def preprocess(raw_data_file_path,  
               clean_data_file_path  
               ):  
    ...
```

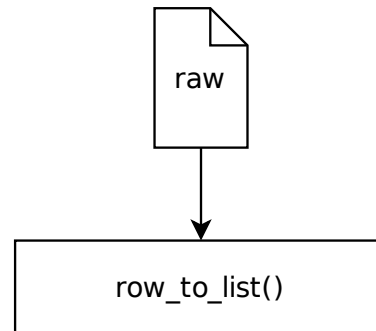
```
1,801      201,411  
1,767565,112      # dirty row, no tab  
2,002      333,209  
1990       782,911  
1,285      389129
```



The preprocessing function

```
def preprocess(raw_data_file_path,  
               clean_data_file_path  
               ):  
  
    ...
```

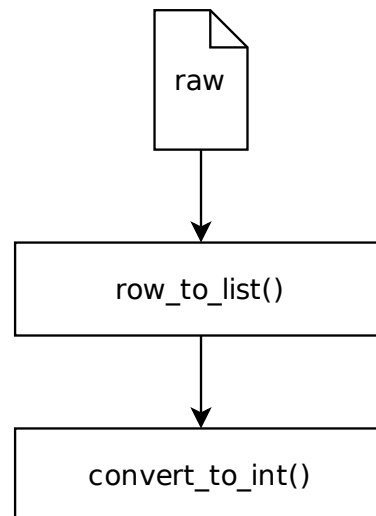
1,801	201,411
2,002	333,209
1990	782,911
1,285	389129



The preprocessing function

```
def preprocess(raw_data_file_path,  
               clean_data_file_path  
               ):  
    ...
```

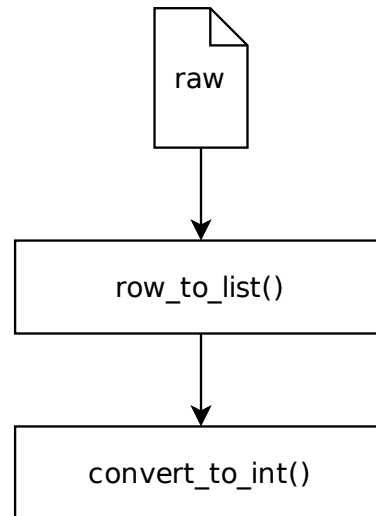
```
1,801      201,411  
2,002      333,209  
1990       782,911      # dirty row, no comma  
1,285      389129       # dirty row, no comma
```



The preprocessing function

```
def preprocess(raw_data_file_path,  
               clean_data_file_path  
               ):  
  
    ...
```

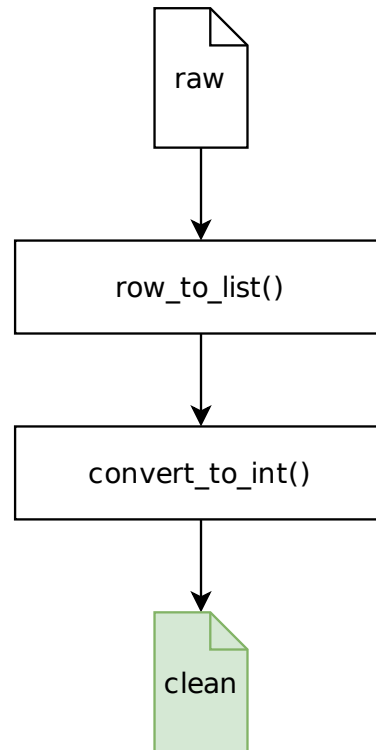
1,801	201,411
2,002	333,209



The preprocessing function

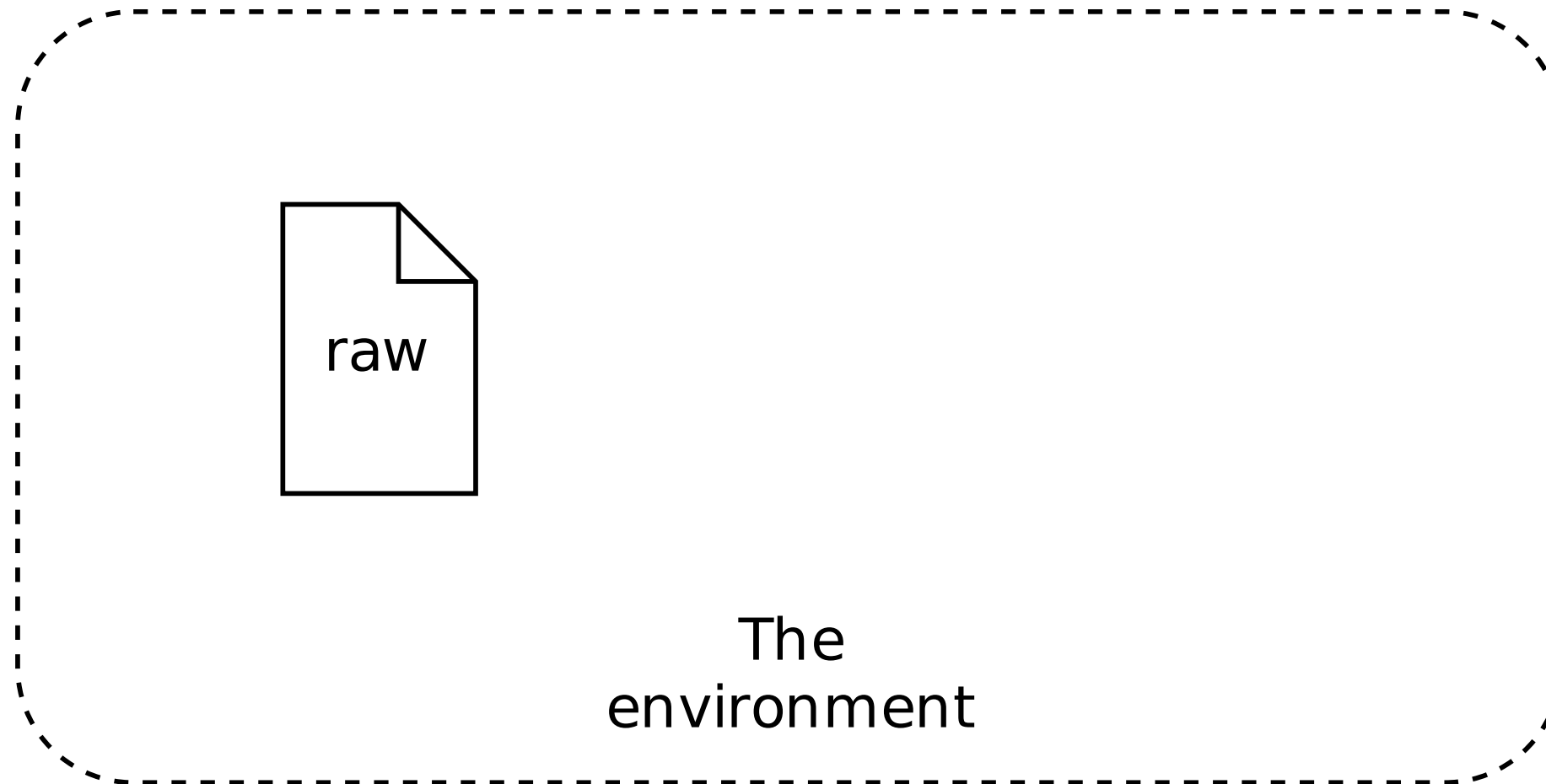
```
def preprocess(raw_data_file_path,  
               clean_data_file_path  
               ):  
  
    ...
```

1801	201411
2002	333209



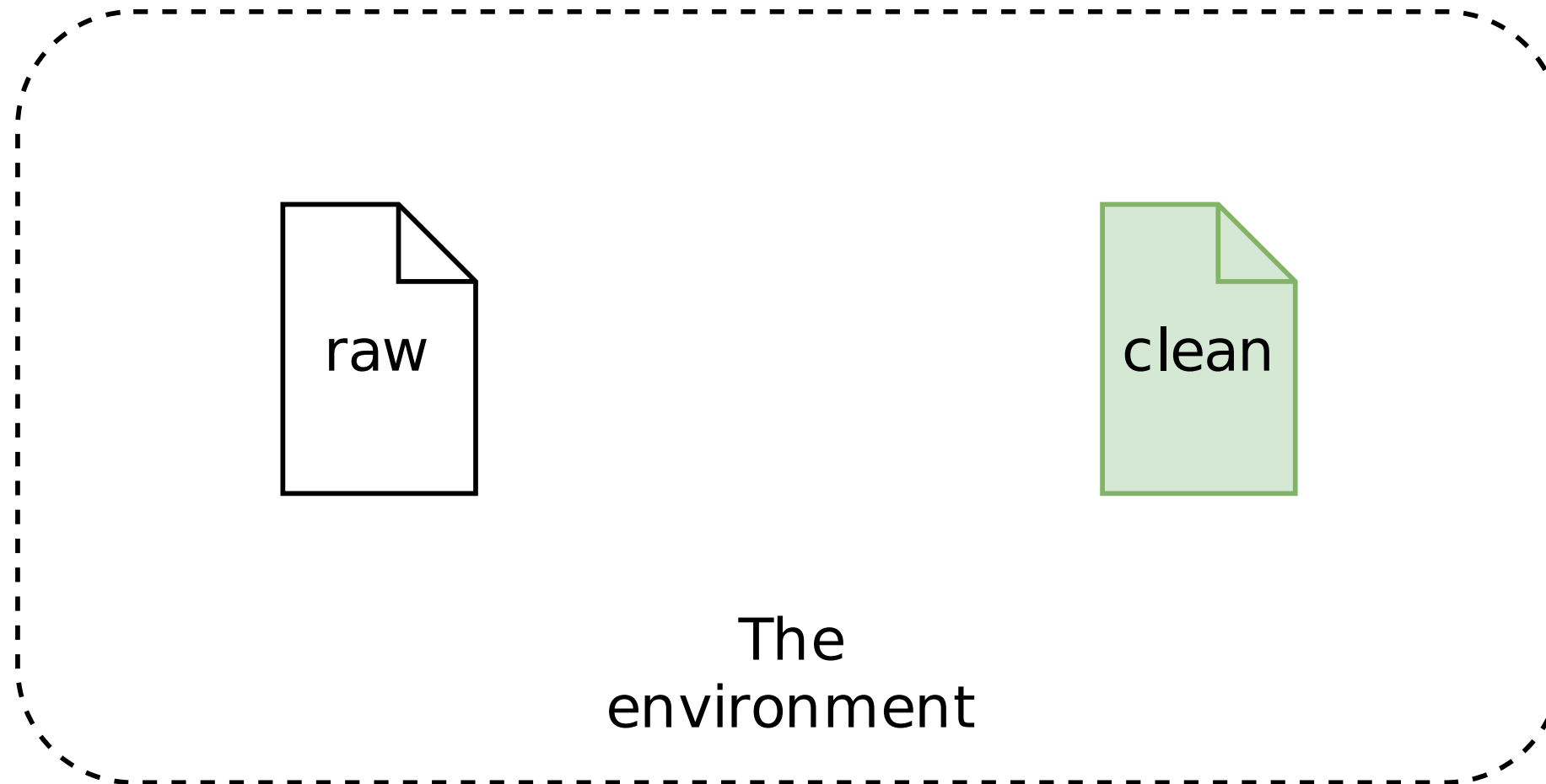
Environment preconditions

- `preprocess()` needs a raw data file in the environment to run.



Environment modification

- `preprocess()` modifies the environment by creating a clean data file.



Testing the preprocessing function

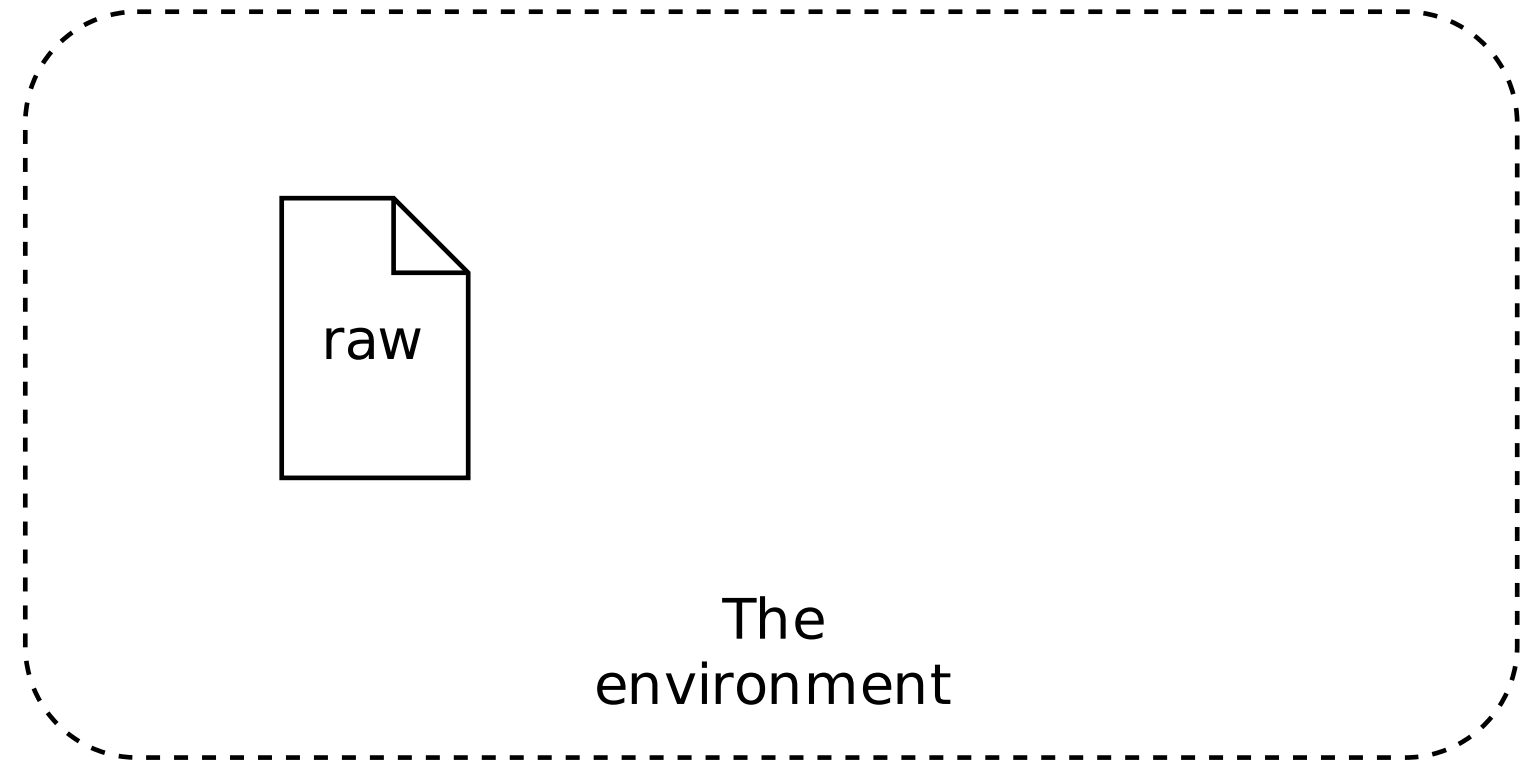
```
def test_on_raw_data():
```

The
environment

Step 1: Setup

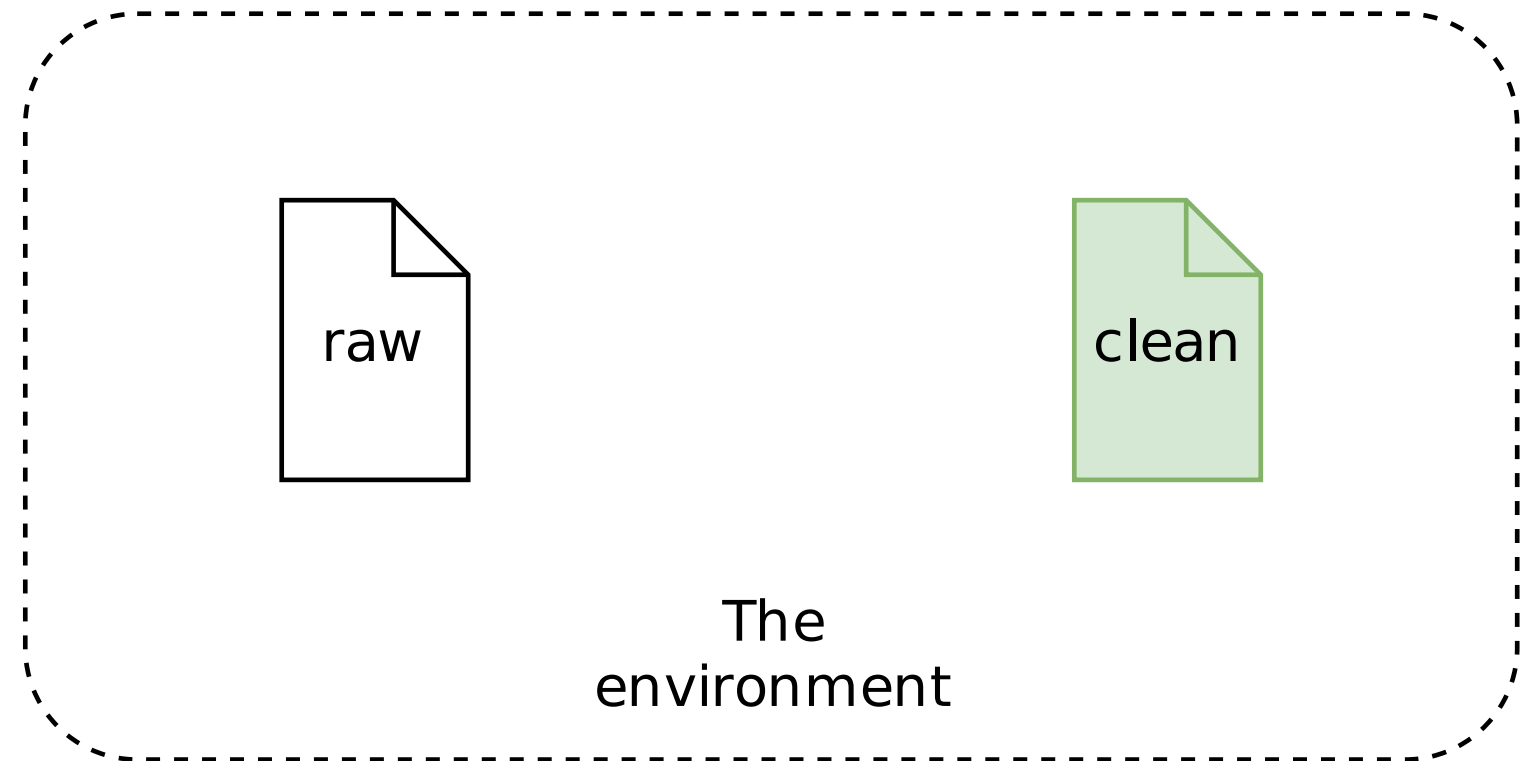
```
def test_on_raw_data():  
    # Setup: create the raw data file
```

- Setup brings the environment to a state where testing can begin.



Step 2: Assert

```
def test_on_raw_data():  
    # Setup: create the raw data file  
    preprocess(raw_data_file_path,  
               clean_data_file_path  
               )  
  
    with open(clean_data_file_path) as f:  
        lines = f.readlines()  
  
    first_line = lines[0]  
    assert first_line == "1801\t201411\n"  
    second_line = lines[1]  
    assert second_line == "2002\t333209\n"
```



Step 3: Teardown

```
def test_on_raw_data():
    # Setup: create the raw data file
    preprocess(raw_data_file_path,
               clean_data_file_path
               )

    with open(clean_data_file_path) as f:
        lines = f.readlines()

    first_line = lines[0]
    assert first_line == "1801\t201411\n"
    second_line = lines[1]
    assert second_line == "2002\t333209\n"
    # Teardown: remove raw and clean data file
```



- Teardown brings environment to initial state.

The new workflow

Old workflow

- assert

New workflow

- setup → assert → teardown

Fixture

```
import pytest

@pytest.fixture
def my_fixture():
    # Do setup here
    return data
```

```
def test_something(my_fixture):
    ...
    data = my_fixture
    ...
```

Fixture

```
import pytest

@pytest.fixture
def my_fixture():
    # Do setup here

    yield data    # Use yield instead of return

    # Do teardown here
```

```
def test_something(my_fixture):
    ...
    data = my_fixture
    ...
```


Test

```
import os
import pytest

def test_on_raw_data():
```

Fixture

```
@pytest.fixture
def raw_and_clean_data_file():
    raw_data_file_path = "raw.txt"
    clean_data_file_path = "clean.txt"
    with open(raw_data_file_path, "w") as f:
        f.write("1,801\t201,411\n"
                "1,767565,112\n"
                "2,002\t333,209\n"
                "1990\t782,911\n"
                "1,285\t389129\n"
                )
    yield raw_data_file_path, clean_data_file_path
    os.remove(raw_data_file_path)
    os.remove(clean_data_file_path)
```

Test

```
import os
import pytest

def test_on_raw_data(raw_and_clean_data_file):
    raw_path, clean_path = raw_and_clean_data_file
    preprocess(raw_path, clean_path)
    with open(clean_data_file_path) as f:
        lines = f.readlines()
    first_line = lines[0]
    assert first_line == "1801\t201411\n"
    second_line = lines[1]
    assert second_line == "2002\t333209\n"
```

The built-in tmpdir fixture

- **Setup:** create a temporary directory.
- **Teardown:** delete the temporary directory along with contents.

tmpdir and fixture chaining

- setup of `tmpdir()` → Setup of `raw_and_clean_data_file()` → test → teardown of `raw_and_clean_data_file()` → teardown of `tmpdir()` .

```
@pytest.fixture
def raw_and_clean_data_file(tmpdir):
    raw_data_file_path = tmpdir.join("raw.txt")
    clean_data_file_path = tmpdir.join("clean.txt")
    with open(raw_data_file_path, "w") as f:
        f.write("1,801\t201,411\n"
                "1,767565,112\n"
                "2,002\t333,209\n"
                "1990\t782,911\n"
                "1,285\t389129\n"
                )
    yield raw_data_file_path, clean_data_file_path
# No teardown code necessary
```

Let's practice setup and teardown using fixtures!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Mocking

UNIT TESTING FOR DATA SCIENCE IN PYTHON

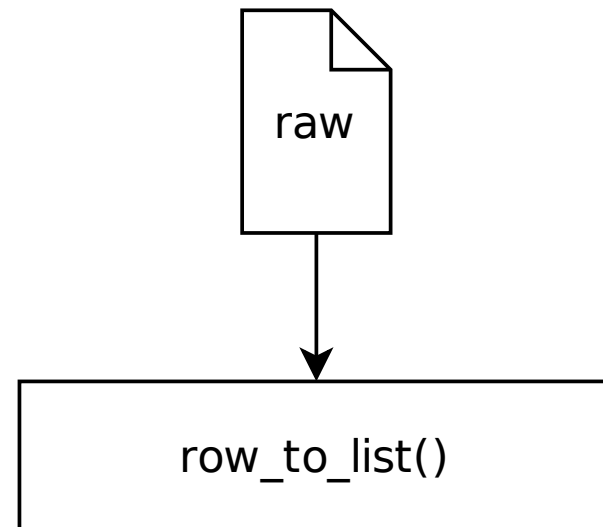


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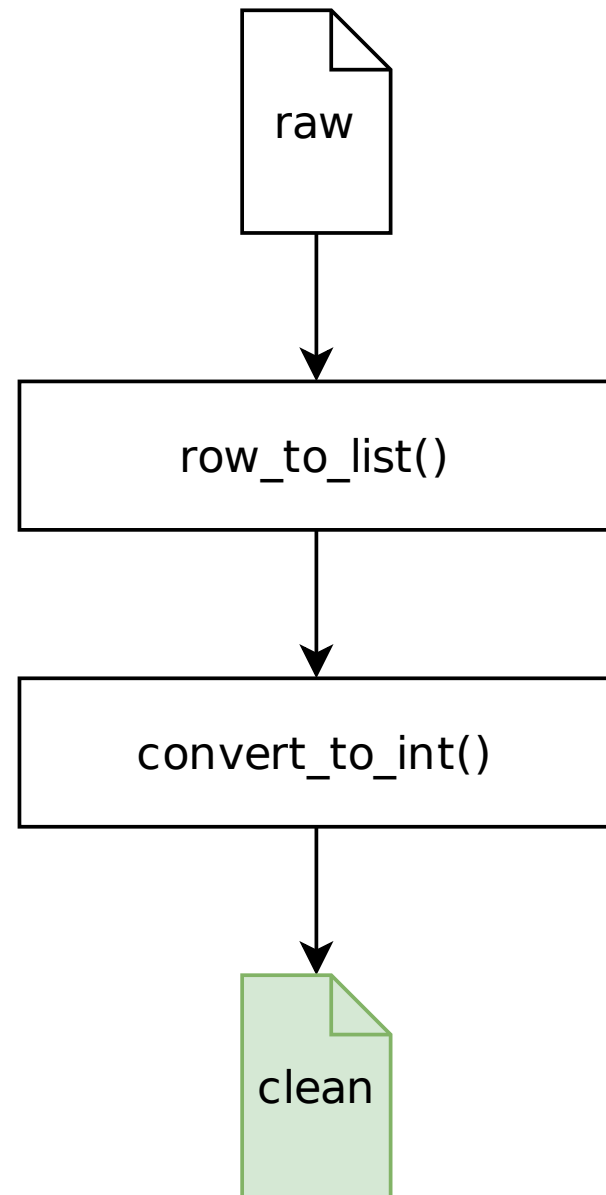
The preprocessing function



The preprocessing function



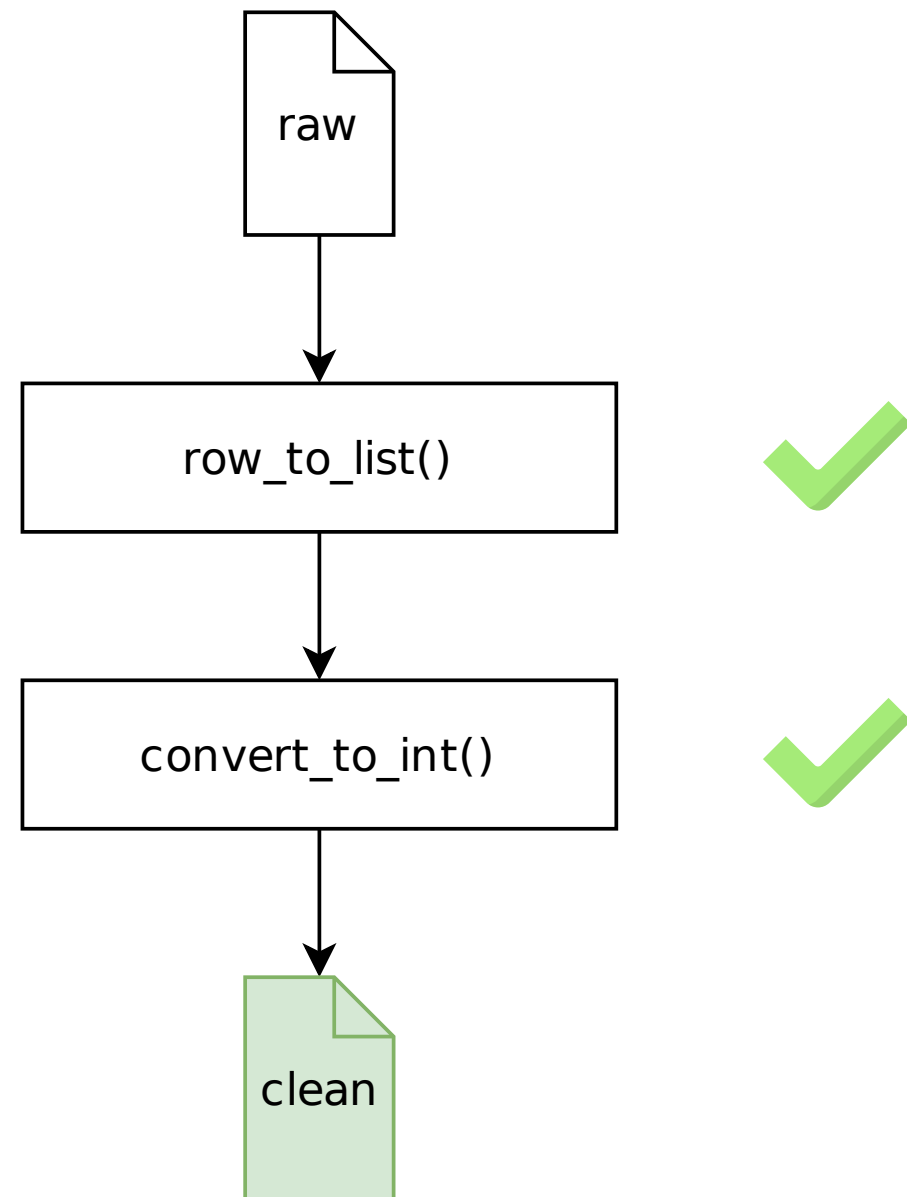
The preprocessing function



```
pytest -k "TestPreprocess"
```

```
===== test session starts =====  
...  
collected 21 items / 20 deselected / 1 selected  
  
data/test_preprocessing_helpers.py .           [100%]  
  
===== 1 passed, 20 deselected in 0.61 seconds =====
```

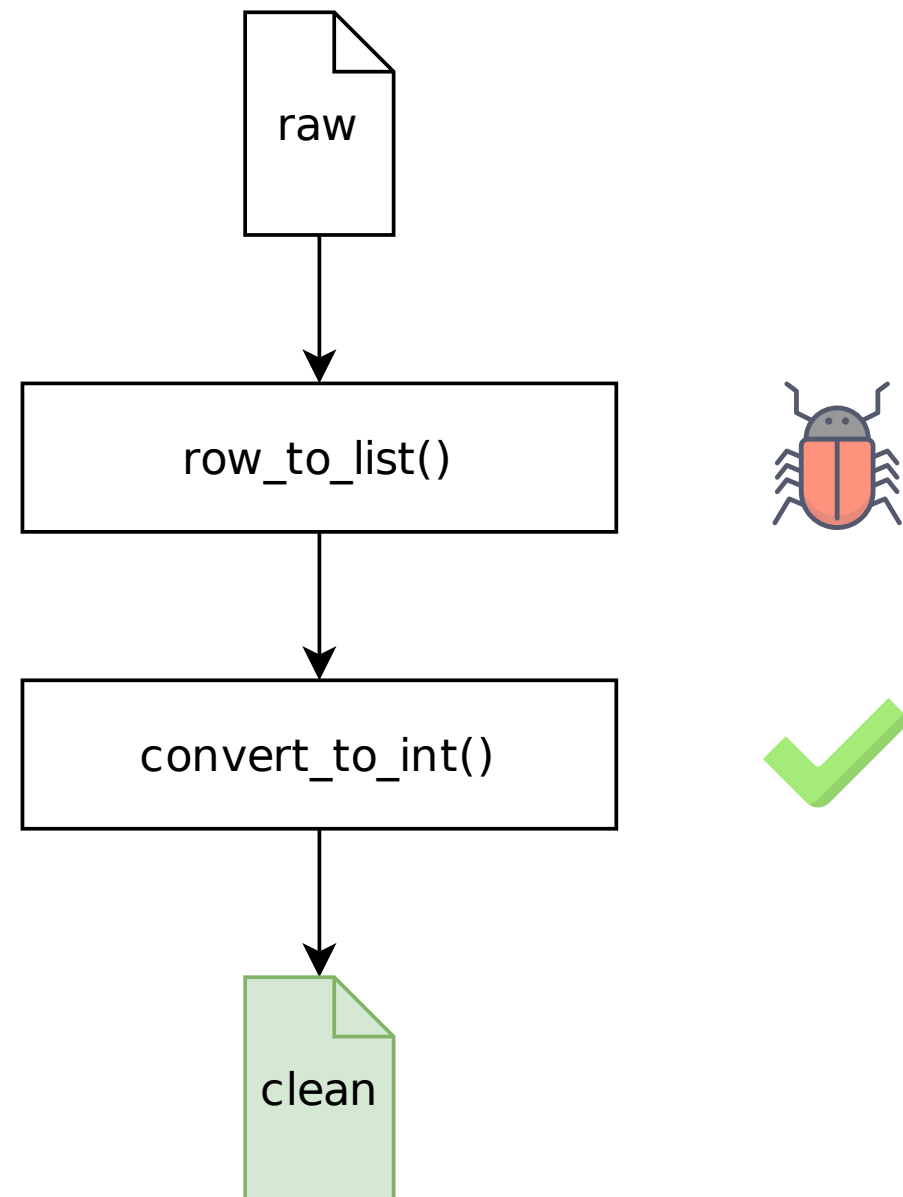
Test result depend on dependencies



```
pytest -k "TestPreprocess"
```

```
===== test session starts =====  
...  
collected 21 items / 20 deselected / 1 selected  
  
data/test_preprocessing_helpers.py .           [100%]  
  
===== 1 passed, 20 deselected in 0.61 seconds =====
```

Test result depend on dependencies



```
pytest -k "TestPreprocess"
```

```
===== test session starts =====
...
collected 21 items / 20 deselected / 1 selected

data/test_preprocessing_helpers.py F          [100%]

===== FAILURES =====
----- TestPreprocess.test_on_raw_data -----

    def test_on_raw_data(self, raw_and_clean_data_file):
        raw_path, clean_path = raw_and_clean_data_file
        preprocess(raw_path, clean_path)
        with open(clean_path, "r") as f:
            lines = f.readlines()
>       first_line = lines[0]
E       IndexError: list index out of range

data/test_preprocessing_helpers.py:121: IndexError
1 failed, 20 deselected in 0.60 seconds
```

Test result depends on dependencies

Test result should indicate bugs in

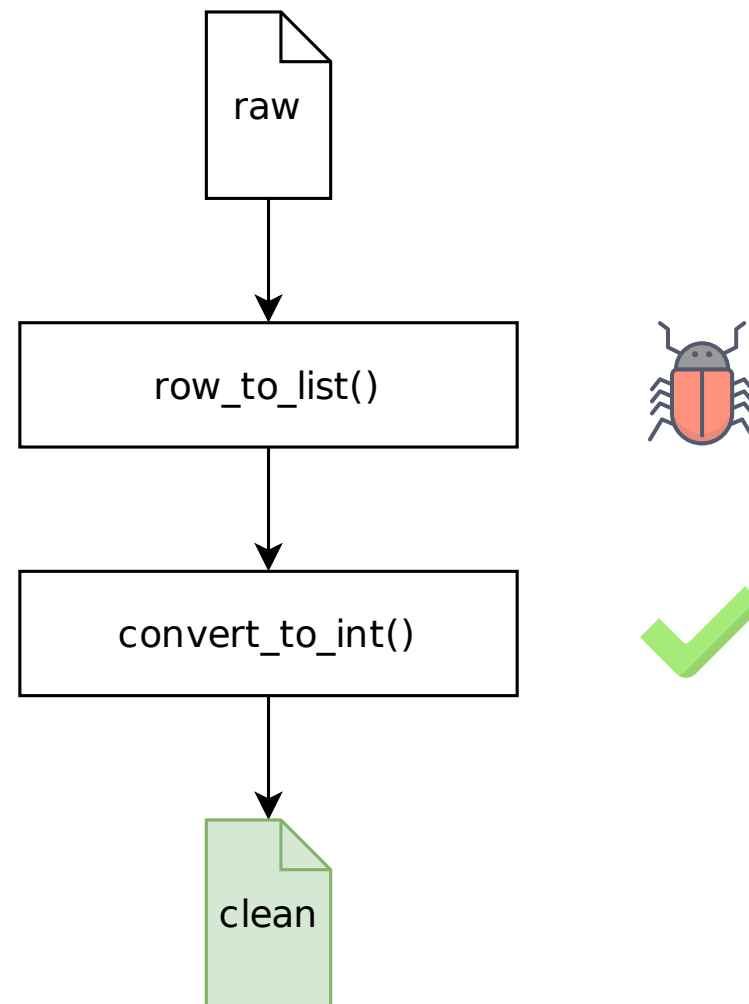
- function under test i.e. `preprocess()` .
- not dependencies e.g. `row_to_list()` or `convert_to_int()` .

Mocking: testing functions independently of dependencies

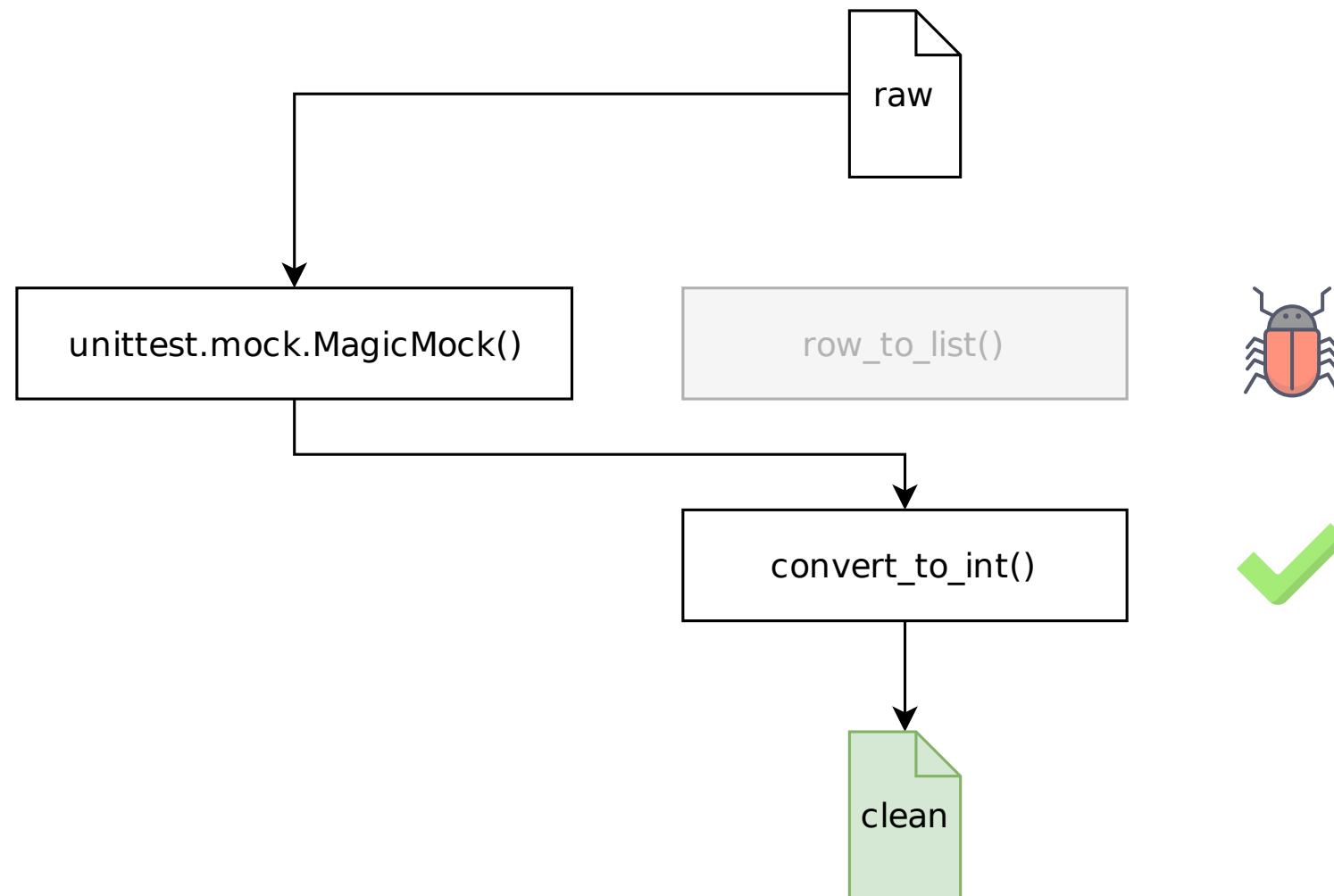
Packages for mocking in `pytest`

- `pytest-mock` : Install using `pip install pytest-mock` .
- `unittest.mock` : Python standard library package.

MagicMock() and mocker.patch()



MagicMock() and mocker.patch()



```
def test_on_raw_data(raw_and_clean_data_file,
                     mocker,
                     ):
    raw_path, clean_path = raw_and_clean_data_file
    row_to_list_mock = mocker.patch(...)
```

MagicMock() and mocker.patch()

- Theoretical structure of `mocker.patch()`

```
mocker.patch("<dependency name with module name>")
```

```
def test_on_raw_data(raw_and_clean_data_file,
                    mocker,
                    ):
    raw_path, clean_path = raw_and_clean_data_file
    row_to_list_mock = mocker.patch(...)
```


MagicMock() and mocker.patch()

- Theoretical structure of `mocker.patch()`

```
mocker.patch("data.preprocessing_helpers.row_to_list")
```

```
unittest.mock.MagicMock()
```

```
def test_on_raw_data(raw_and_clean_data_file,
                     mocker,
                     ):
    raw_path, clean_path = raw_and_clean_data_file
    row_to_list_mock = mocker.patch(
        "data.preprocessing_helpers.row_to_list"
    )
```

Making the MagicMock() bug-free

- Raw data

```
1,801      201,411
1,767565,112
2,002      333,209
1990       782,911
1,285      389129
```

```
def row_to_list_bug_free(row):
    return_values = {
        "1,801\t201,411\n": ["1,801", "201,411"],
        "1,767565,112\n": None,
        "2,002\t333,209\n": ["2,002", "333,209"],
        "1990\t782,911\n": ["1990", "782,911"],
        "1,285\t389129\n": ["1,285", "389129"],
    }
    return return_values[row]
```

```
def test_on_raw_data(raw_and_clean_data_file,
                     mocker,
                     ):
    raw_path, clean_path = raw_and_clean_data_file
    row_to_list_mock = mocker.patch(
        "data.preprocessing_helpers.row_to_list"
    )
    row_to_list_mock.side_effect = row_to_list_bug_free
```

Side effect

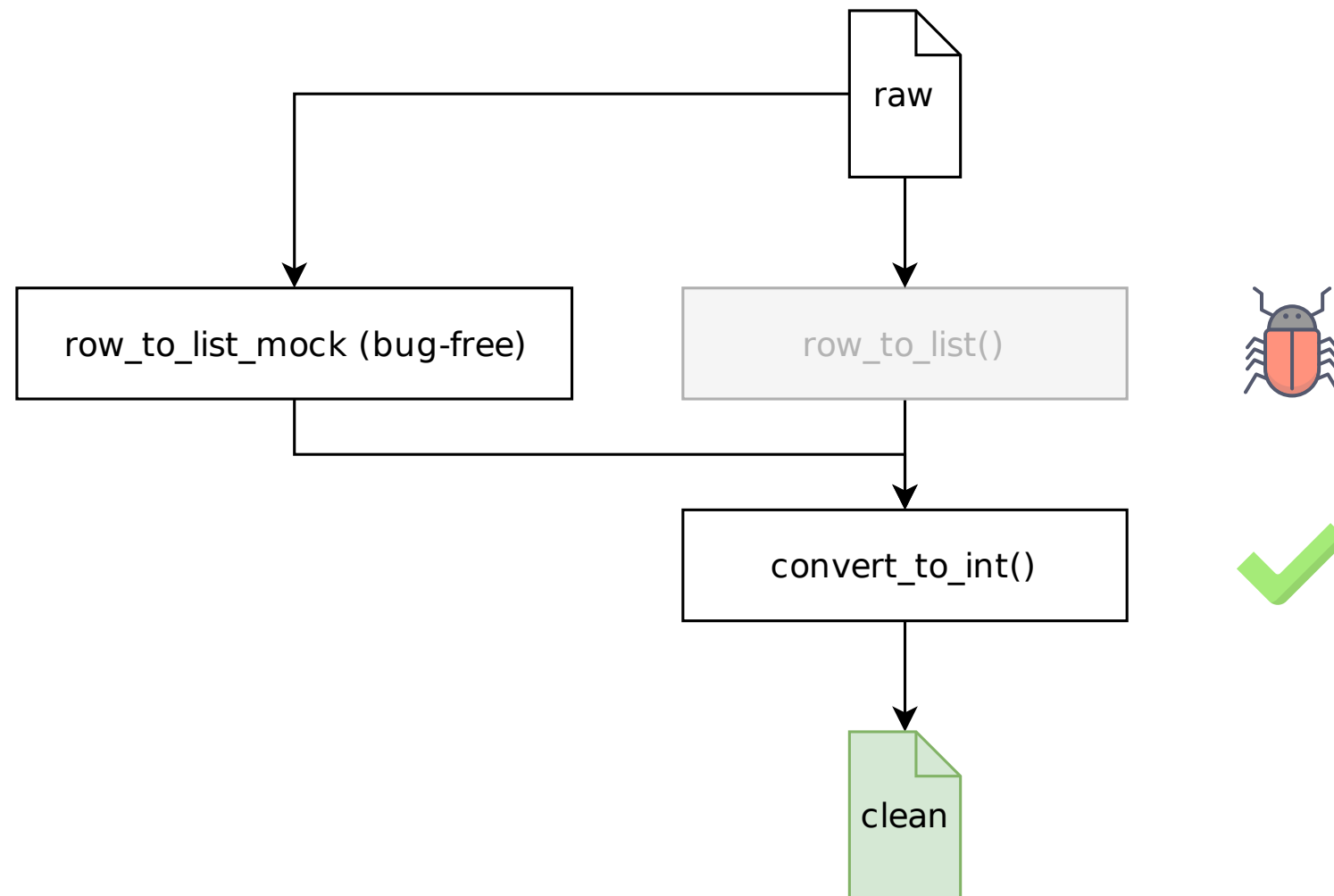
- Raw data

```
1,801      201,411
1,767565,112
2,002      333,209
1990       782,911
1,285      389129
```

```
def row_to_list_bug_free():
    return_values = {
        "1,801\t201,411\n": ["1,801", "201,411"],
        "1,767565,112\n": None,
        "2,002\t333,209\n": ["2,002", "333,209"],
        "1990\t782,911\n": ["1990", "782,911"],
        "1,285\t389129\n": ["1,285", "389129"],
    }
    return return_values[row]
```

```
def test_on_raw_data(raw_and_clean_data_file,
                     mocker,
                     ):
    raw_path, clean_path = raw_and_clean_data_file
    row_to_list_mock = mocker.patch(
        "data.preprocessing_helpers.row_to_list",
        side_effect = row_to_list_bug_free
    )
```

Bug free replacement of dependency



```
def test_on_raw_data(raw_and_clean_data_file,
                     mocker,
                     ):
    raw_path, clean_path = raw_and_clean_data_file
    row_to_list_mock = mocker.patch(
        "data.preprocessing_helpers.row_to_list",
        side_effect = row_to_list_bug_free
    )
    preprocess(raw_path, clean_path)
```

Checking the arguments

- `call_args_list` attribute returns a list of arguments that the mock was called with

```
row_to_list_mock.call_args_list
```

```
[call("1,801\t201,411\n"),  
 call("1,767565,112\n"),  
 call("2,002\t333,209\n"),  
 call("1990\t782,911\n"),  
 call("1,285\t389129\n")  
]
```

```
def test_on_raw_data(raw_and_clean_data_file,  
                    mocker,  
                    ):  
    raw_path, clean_path = raw_and_clean_data_file  
    row_to_list_mock = mocker.patch(  
        "data.preprocessing_helpers.row_to_list",  
        side_effect = row_to_list_bug_free  
    )  
    preprocess(raw_path, clean_path)
```

Checking the arguments

- `call_args_list` attribute returns a list of arguments that the mock was called with

```
row_to_list_mock.call_args_list
```

```
[call("1,801\t201,411\n"),  
 call("1,767565,112\n"),  
 call("2,002\t333,209\n"),  
 call("1990\t782,911\n"),  
 call("1,285\t389129\n")  
]
```

```
from unittest.mock import call  
  
def test_on_raw_data(raw_and_clean_data_file,  
                    mocker,  
                    ):  
    raw_path, clean_path = raw_and_clean_data_file  
    row_to_list_mock = mocker.patch(  
        "data.preprocessing_helpers.row_to_list",  
        side_effect = row_to_list_bug_free  
    )  
    preprocess(raw_path, clean_path)  
    assert row_to_list_mock.call_args_list == [  
        call("1,801\t201,411\n"),  
        call("1,767565,112\n"),  
        call("2,002\t333,209\n"), call("1990\t782,911\n"),  
        call("1,285\t389129\n")  
    ]
```

Dependency buggy, function bug-free, test still passes!

```
pytest -k "TestRowToList"
```

```
===== test session starts =====
collected 21 items / 14 deselected / 7 selected

data/test_preprocessing_helpers.py .....FF [100%]

===== FAILURES =====
----- TestRowToList.test_on_normal_argument_1 -----

...
----- TestRowToList.test_on_normal_argument_2 -----

...
===== 2 failed, 5 passed, 14 deselected in 0.70 seconds =====
```

Dependency buggy, function bug-free, test still passes!

```
pytest -k "TestPreprocess"
```

```
===== test session starts =====  
collected 21 items / 20 deselected / 1 selected  
  
data/test_preprocessing_helpers.py . [100%]  
  
===== 1 passed, 20 deselected in 0.63 seconds =====
```


Let's practice mocking!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Testing models

UNIT TESTING FOR DATA SCIENCE IN PYTHON



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Functions we have tested so far

- `preprocess()`
- `get_data_as_numpy_array()`
- `split_into_training_and_testing_sets()`

Raw data to clean data

```
from data.preprocessing_helpers import preprocess
from features.as_numpy import get_data_as_numpy_array
from models.train import (
    split_into_training_and_testing_sets
)

preprocess("data/raw/housing_data.txt",
           "data/clean/clean_housing_data.txt")
```

```
data
|-- raw
|    |-- housing_data.txt
|-- clean
|
src
tests
```

data/raw/housing_data.txt

```
2,081    314,942
1,059    186,606
      293,410    <-- row with missing area
1,148    206,186
...
```

Raw data to clean data

```
from data.preprocessing_helpers import preprocess
from features.as_numpy import get_data_as_numpy_array
from models.train import (
    split_into_training_and_testing_sets
)

preprocess("data/raw/housing_data.txt",
           "data/clean/clean_housing_data.txt")
```

```
data
|-- raw
|    |-- housing_data.txt
|-- clean
|    |-- clean_housing_data.txt
src
tests
```

data/clean/clean_housing_data.txt

```
2081    314942
1059    186606
1148    206186
...
```

Clean data to NumPy array

```
from data.preprocessing_helpers import preprocess
from features.as_numpy import get_data_as_numpy_array
from models.train import (
    split_into_training_and_testing_sets
)

preprocess("data/raw/housing_data.txt",
           "data/clean/clean_housing_data.txt"
)

data = get_data_as_numpy_array(
    "data/clean/clean_housing_data.txt", 2
)
```

```
get_data_as_numpy_array(
    "data/clean/clean_housing_data.txt", 2
)
```

```
array([[ 2081., 314942.],
       [ 1059., 186606.],
       [ 1148., 206186.]
       ...
       ]
)
```

Splitting into training and testing sets

```
from data.preprocessing_helpers import preprocess
from features.as_numpy import get_data_as_numpy_array
from models.train import (
    split_into_training_and_testing_sets
)

preprocess("data/raw/housing_data.txt",
           "data/clean/clean_housing_data.txt"
)

data = get_data_as_numpy_array(
    "data/clean/clean_housing_data.txt", 2
)

training_set, testing_set = (
    split_into_training_and_testing_sets(data)
)
```

```
split_into_training_and_testing_sets(data)
```

```
(array([[1148, 206186],      # Training set (3/4)
        [2081, 314942],
        ...
        ]
      ),
array([[1059, 186606]      # Testing set (1/4)
        ...
        ]
      )
)
```

Functions are well tested - thanks to you!



The linear regression model

```
def train_model(training_set):
```

The linear regression model

```
from scipy.stats import linregress

def train_model(training_set):
    slope, intercept, _, _, _ = linregress(training_set[:, 0], training_set[:, 1])
    return slope, intercept
```

Return values difficult to compute manually



Return values difficult to compute manually

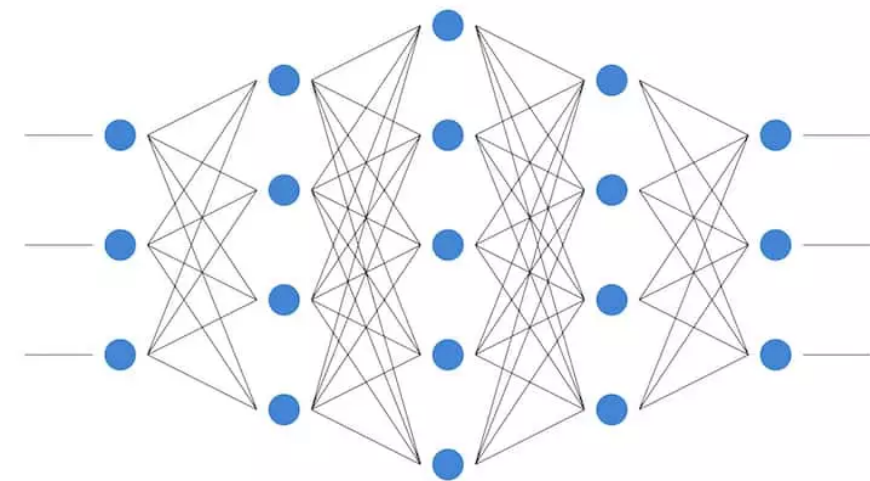
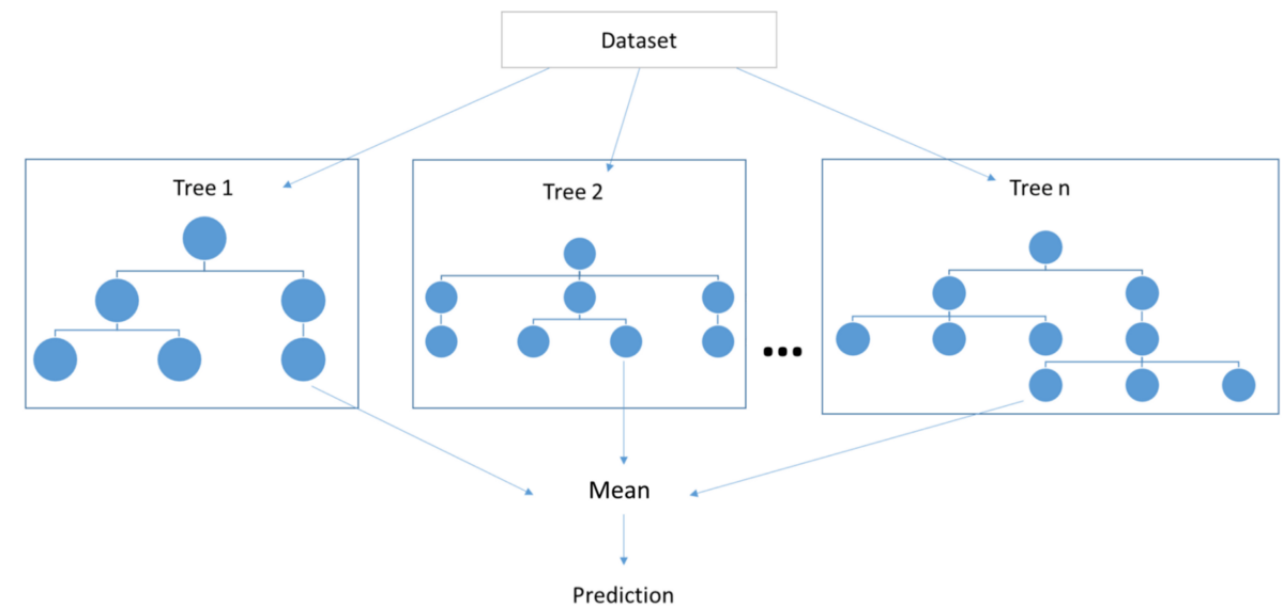
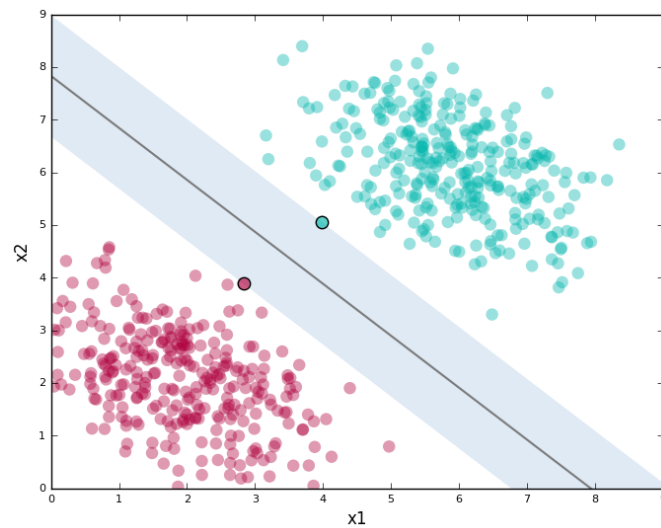


Return values difficult to compute manually

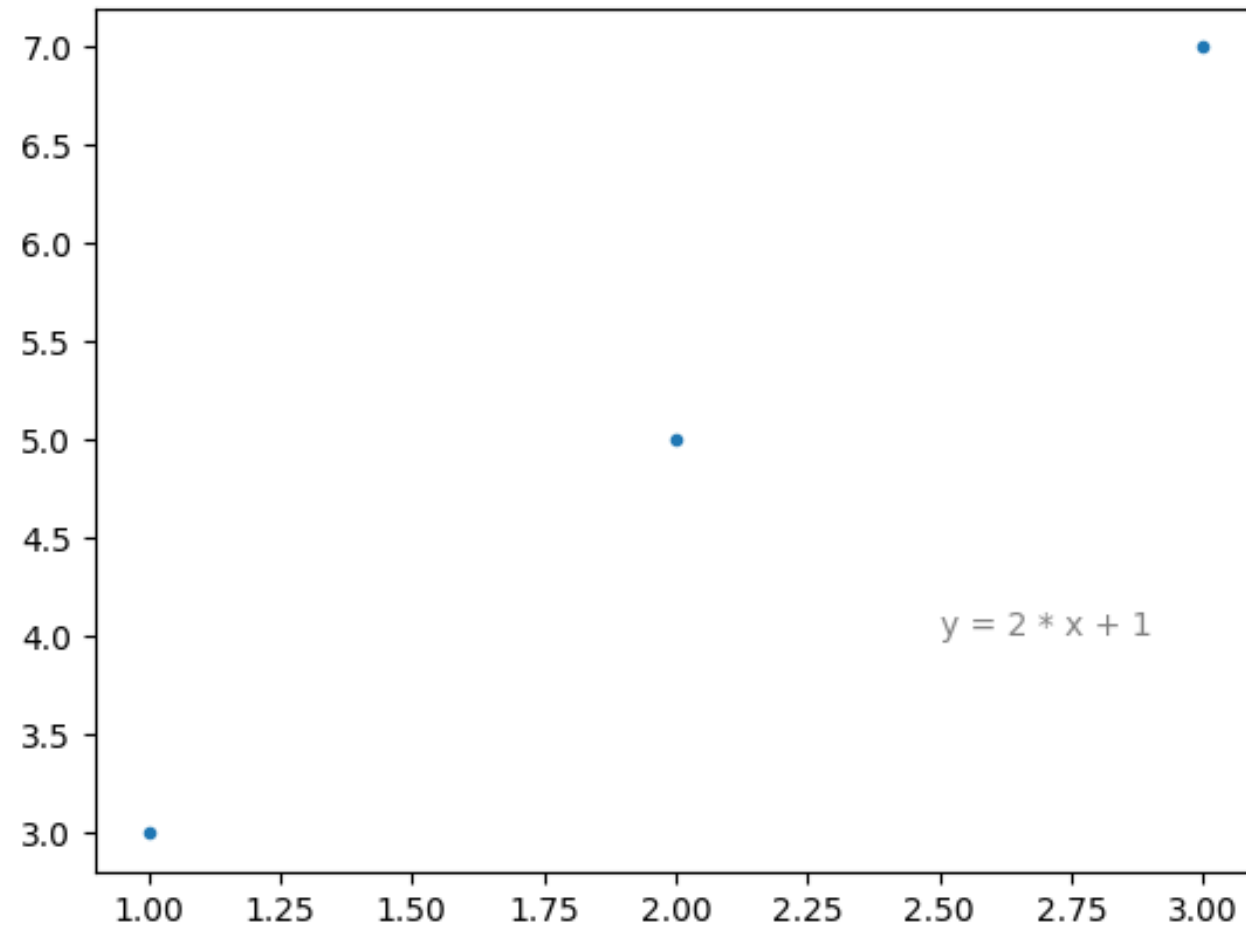


- Cannot test `train_model()` without knowing expected return values.

True for all data science models



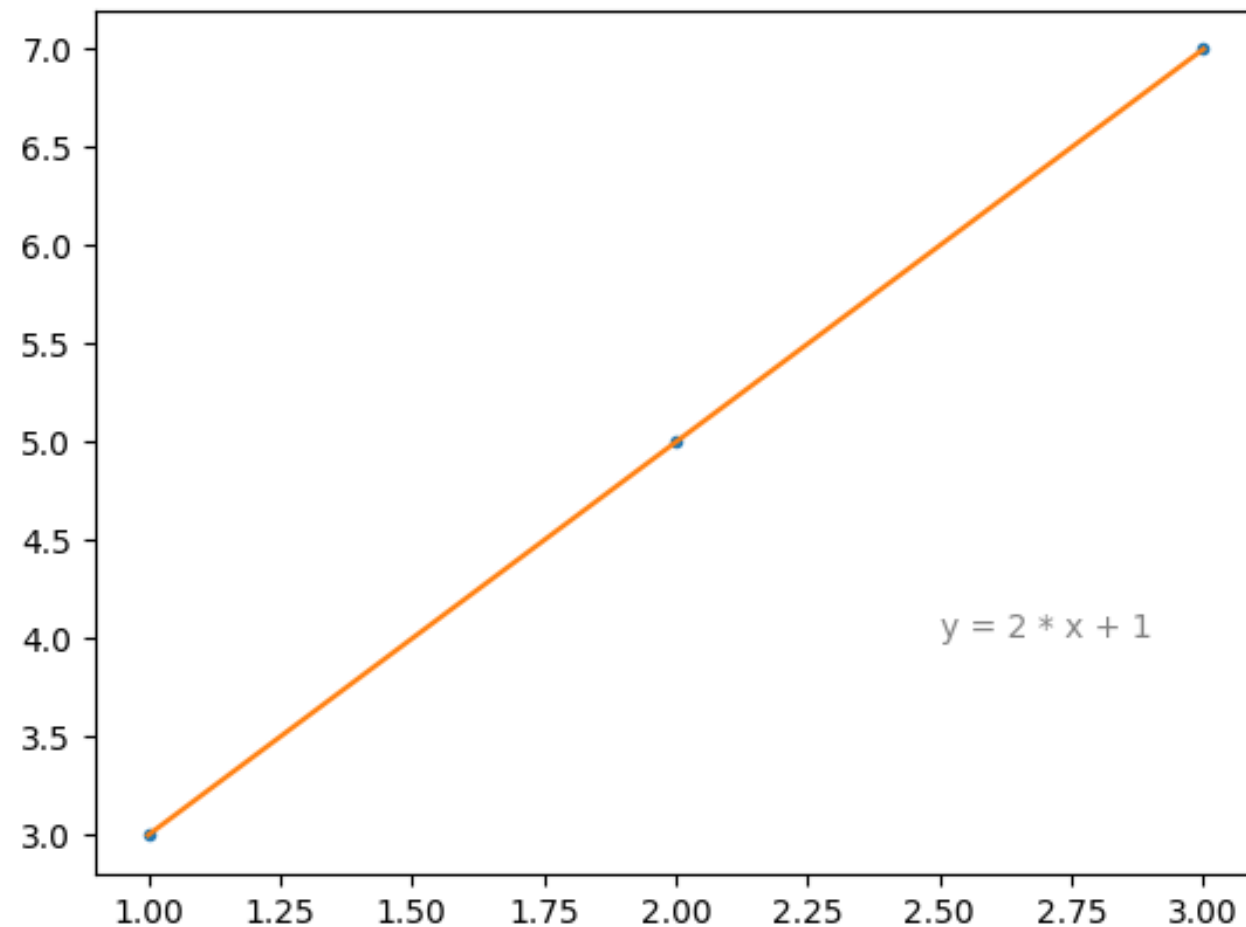
Trick 1: Use dataset where return value is known



```
import pytest
import numpy as np
from models.train import train_model

def test_on_linear_data():
    test_argument = np.array([[1.0, 3.0],
                              [2.0, 5.0],
                              [3.0, 7.0]
                              ]
                              )
```

Trick 1: Use dataset where return value is known



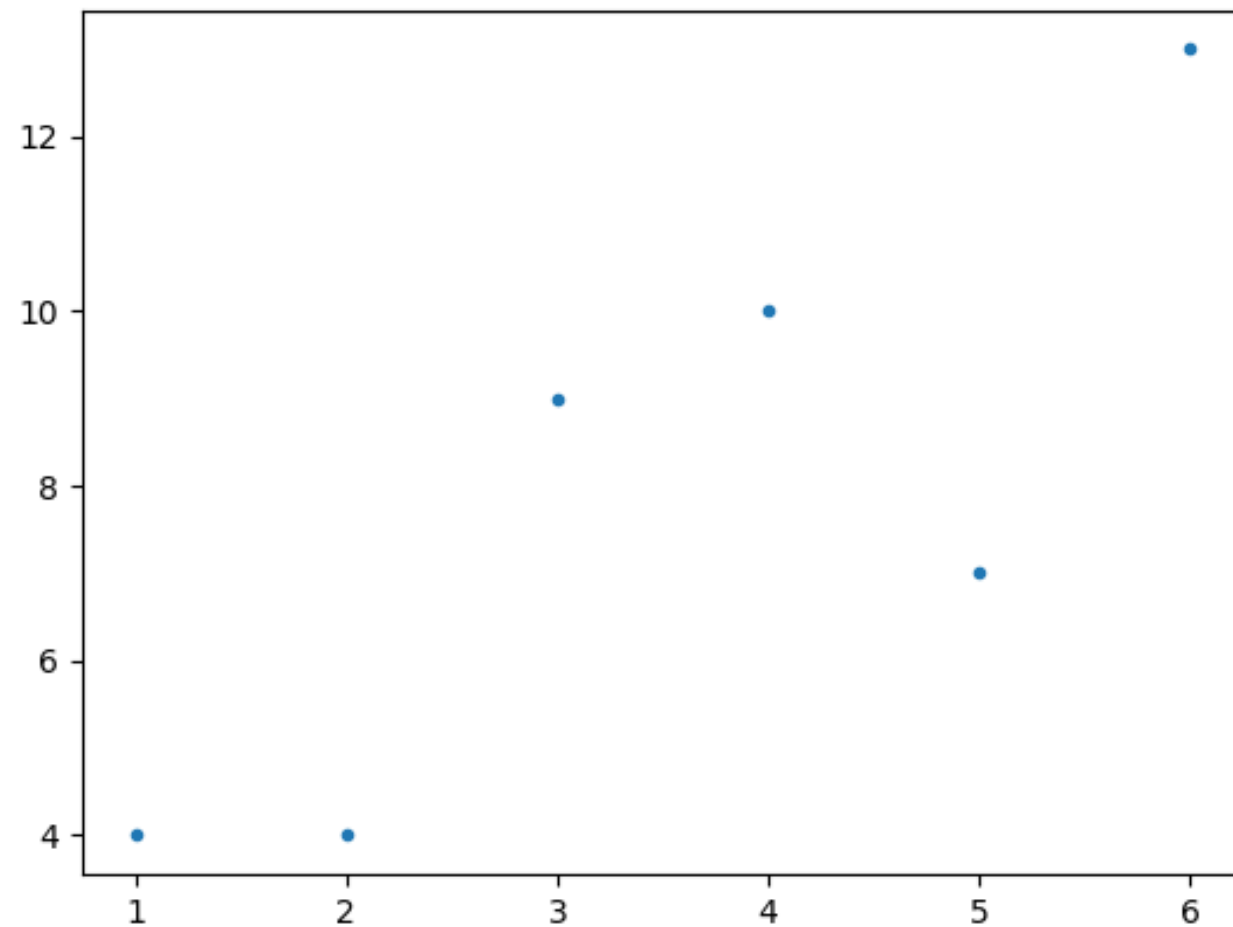
```
import pytest
import numpy as np
from models.train import train_model

def test_on_linear_data():
    test_argument = np.array([[1.0, 3.0],
                              [2.0, 5.0],
                              [3.0, 7.0]
                              ])

    expected_slope = 2.0
    expected_intercept = 1.0

    slope, intercept = train_model(test_argument)
    assert slope == pytest.approx(expected_slope)
    assert intercept == pytest.approx(
        expected_intercept
    )
```

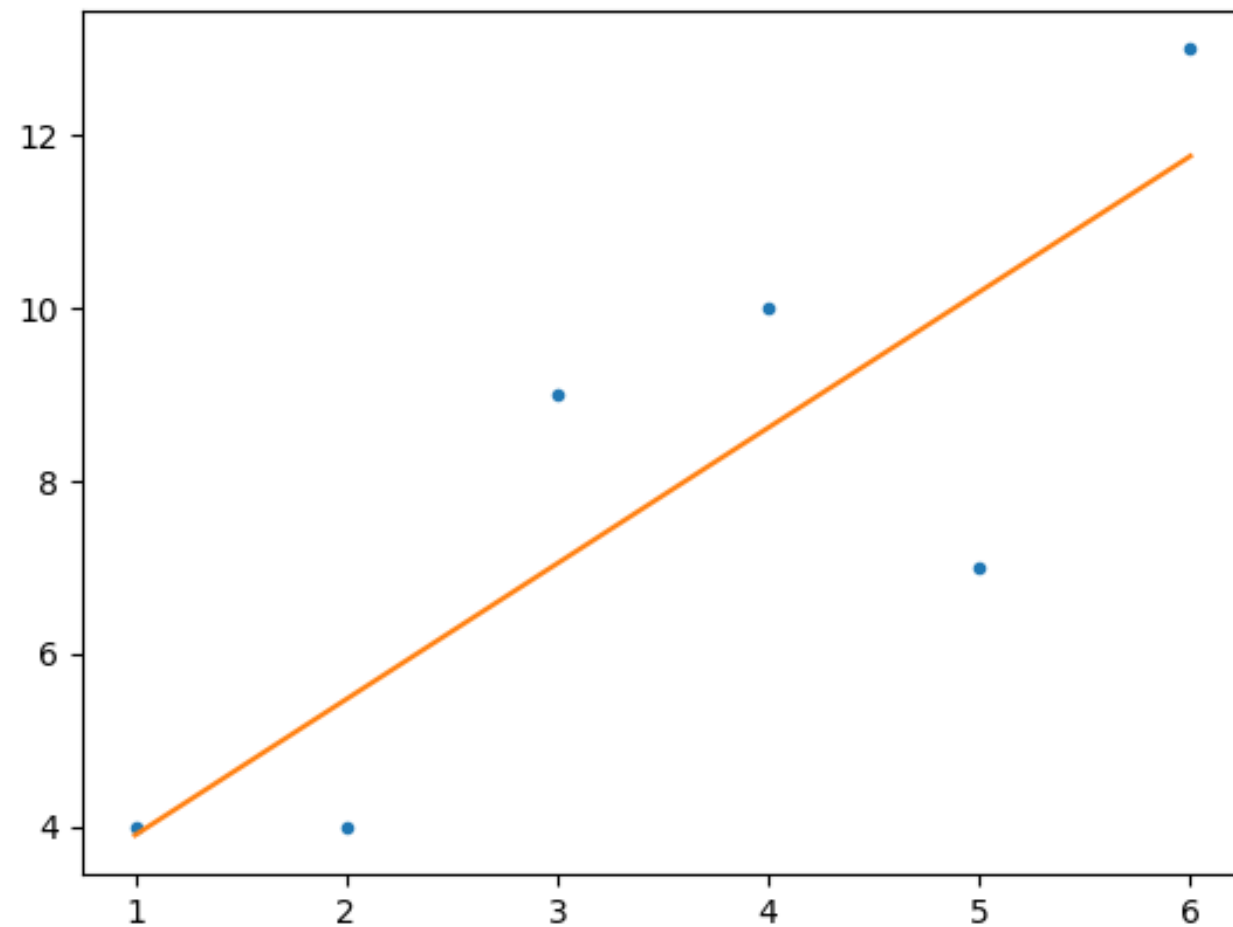

Trick 2: Use inequalities



```
import numpy as np
from models.train import train_model

def test_on_positively_correlated_data():
    test_argument = np.array([[1.0, 4.0], [2.0, 4.0],
                              [3.0, 9.0], [4.0, 10.0],
                              [5.0, 7.0], [6.0, 13.0],
                              ])
    )
```

Trick 2: Use inequalities



```
import numpy as np
from models.train import train_model

def test_on_positively_correlated_data():
    test_argument = np.array([[1.0, 4.0], [2.0, 4.0],
                              [3.0, 9.0], [4.0, 10.0],
                              [5.0, 7.0], [6.0, 13.0],
                              ])

    slope, intercept = train_model(test_argument)
    assert slope > 0
```

Recommendations

- Do not leave models untested just because they are complex.
- Perform as many sanity checks as possible.

Using the model

```
from data.preprocessing_helpers import preprocess
from features.as_numpy import get_data_as_numpy_array
from models.train import (
    split_into_training_and_testing_sets, train_model
)

preprocess("data/raw/housing_data.txt",
           "data/clean/clean_housing_data.txt"
           )

data = get_data_as_numpy_array(
    "data/clean/clean_housing_data.txt", 2
)

training_set, testing_set = (
    split_into_training_and_testing_sets(data)
)

slope, intercept = train_model(training_set)
```

```
train_model(training_set)
```

```
151.78430060614986 17140.77537937442
```

Testing model performance

```
def model_test(testing_set, slope, intercept):  
    """Return  $r^2$  of fit"""
```

- Returns a quantity r^2 .
- Indicates how well the model performs on unseen data.
- Usually, $0 \leq r^2 \leq 1$.
- $r^2 = 1$ indicates perfect fit.
- $r^2 = 0$ indicates no fit.
- Complicated to compute r^2 manually.

Let's practice writing sanity tests!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Testing plots

UNIT TESTING FOR DATA SCIENCE IN PYTHON



Dibya Chakravorty
Test Automation Engineer

Pizza without cheese!



This lesson: testing matplotlib visualizations



The plotting function

```
data/  
src/  
|-- data/  
|-- features/  
|-- models/  
|-- visualization  
|   |-- __init__.py  
tests/
```

The plotting function

- `plots.py`

```
def get_plot_for_best_fit_line(slope,
                              intercept,
                              x_array,
                              y_array,
                              title
                              ):

    """
    slope: slope of best fit line
    intercept: intercept of best fit line
    """
```

```
data/
src/
|-- data/
|-- features/
|-- models/
|-- visualization
|   |-- __init__.py
|   |-- plots.py
tests/
```

The plotting function

- `plots.py`

```
def get_plot_for_best_fit_line(slope,
                              intercept,
                              x_array,
                              y_array,
                              title
                              ):

    """
    slope: slope of best fit line
    intercept: intercept of best fit line
    x_array: array containing housing areas
    y_array: array containing housing prices
    """
```

```
data/
src/
|-- data/
|-- features/
|-- models/
|-- visualization
|   |-- __init__.py
|   |-- plots.py
tests/
```

The plotting function

- `plots.py`

```
def get_plot_for_best_fit_line(slope,
                              intercept,
                              x_array,
                              y_array,
                              title
                              ):

    """
    slope: slope of best fit line
    intercept: intercept of best fit line
    x_array: array containing housing areas
    y_array: array containing housing prices
    title: title of the plot
    """
```

```
data/
src/
|-- data/
|-- features/
|-- models/
|-- visualization
|   |-- __init__.py
|   |-- plots.py
tests/
```

The plotting function

- `plots.py`

```
def get_plot_for_best_fit_line(slope,
                               intercept,
                               x_array,
                               y_array,
                               title
                               ):

    """

    slope: slope of best fit line
    intercept: intercept of best fit line
    x_array: array containing housing areas
    y_array: array containing housing prices
    title: title of the plot

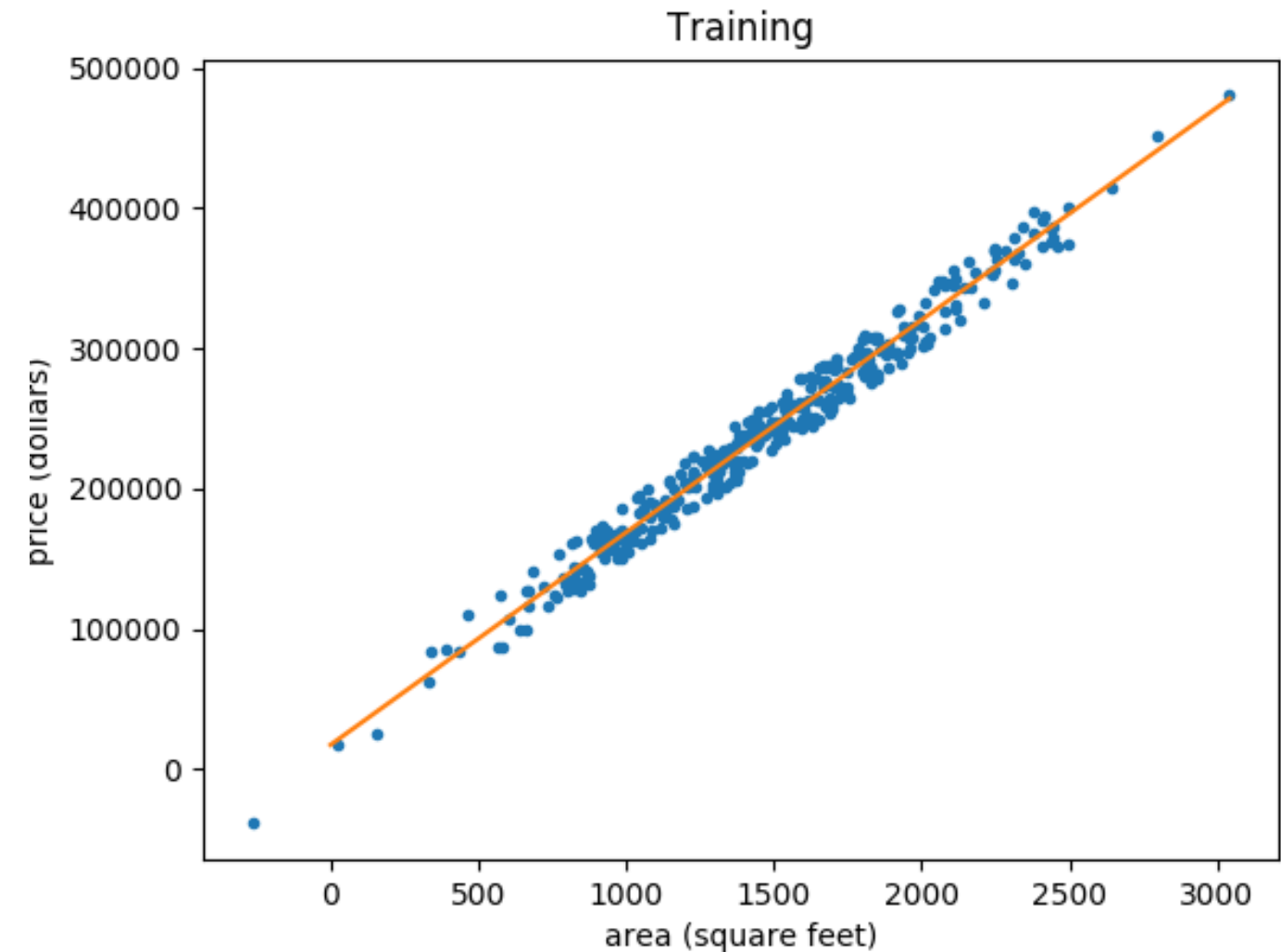
    Returns: matplotlib.figure.Figure()
    """
```

```
data/
src/
|-- data/
|-- features/
|-- models/
|-- visualization
|   |-- __init__.py
|   |-- plots.py
tests/
```

Training plot

```
...
from visualization import get_plot_for_best_fit_line

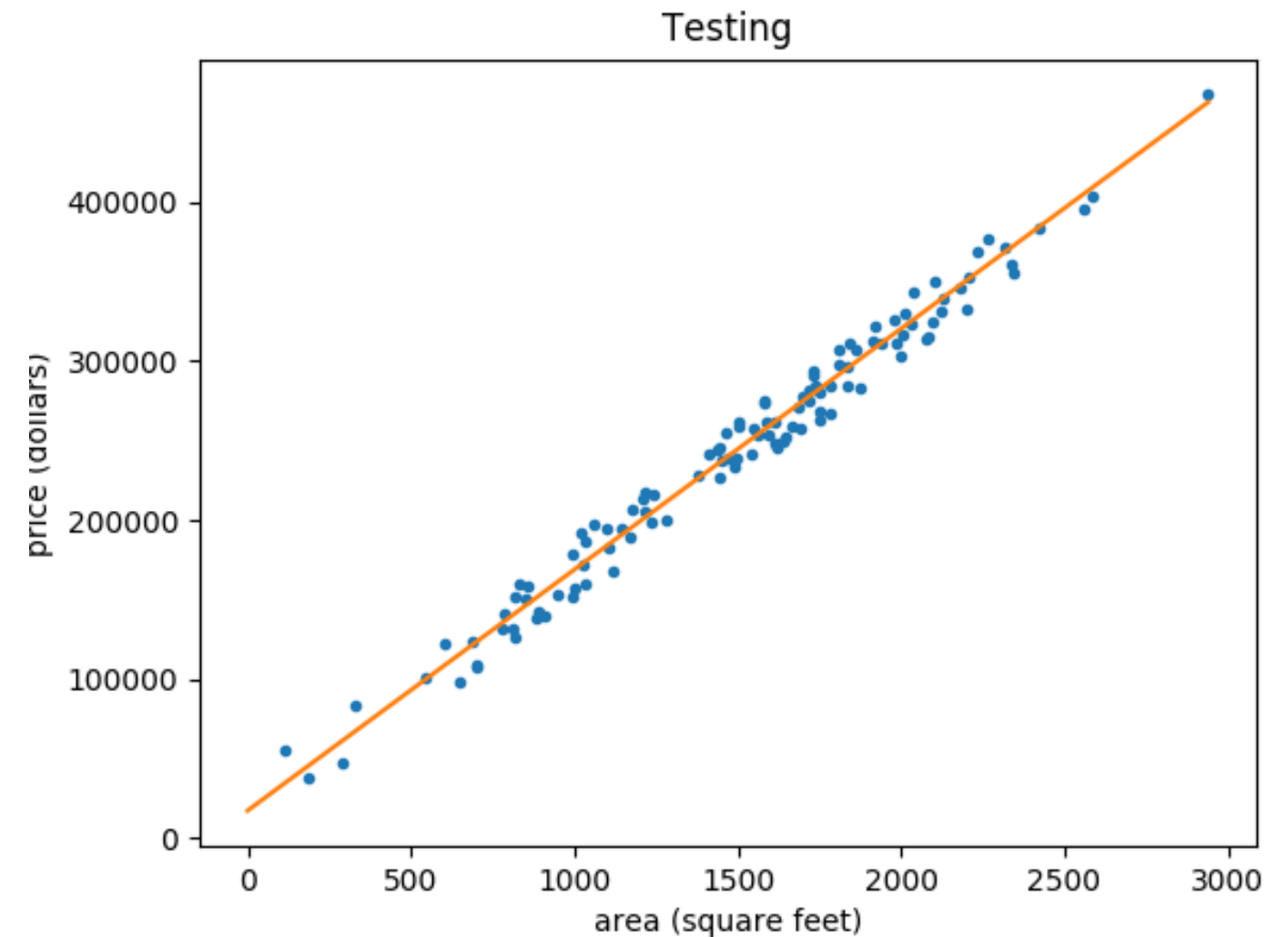
preprocess(...)
data = get_data_as_numpy_array(...)
training_set, testing_set = (
    split_into_training_and_testing_sets(data)
)
slope, intercept = train_model(training_set)
get_plot_for_best_fit_line(slope, intercept,
    training_set[:, 0], training_set[:, 1],
    "Training"
)
```



Testing plot

```
...
from visualization import get_plot_for_best_fit_line

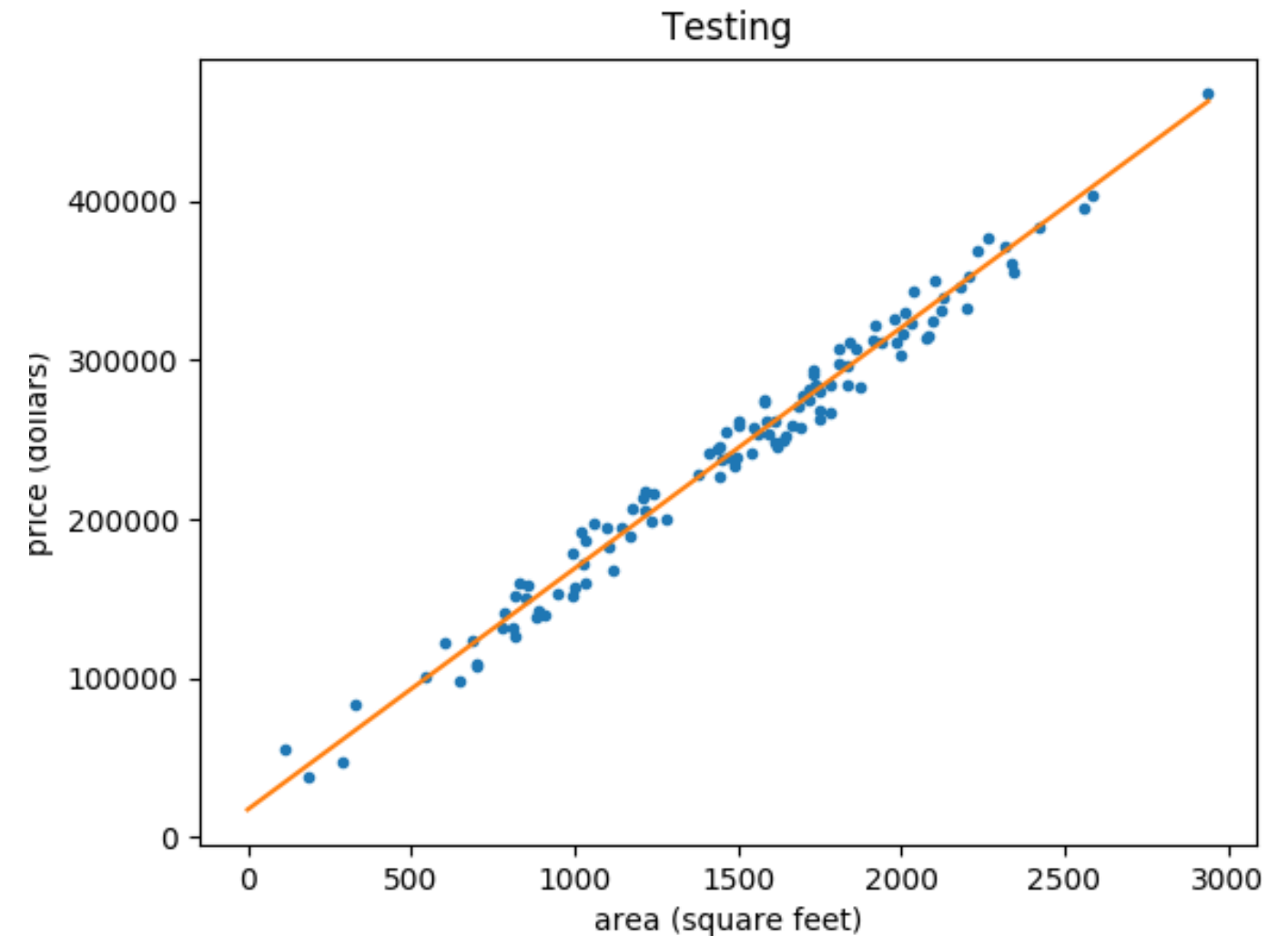
preprocess(...)
data = get_data_as_numpy_array(...)
training_set, testing_set = (
    split_into_training_and_testing_sets(data)
)
slope, intercept = train_model(training_set)
get_plot_for_best_fit_line(slope, intercept,
    training_set[:, 0], training_set[:, 1],
    "Training"
)
get_plot_for_best_fit_line(slope, intercept,
    testing_set[:, 0], testing_set[:, 1], "Testing"
)
```



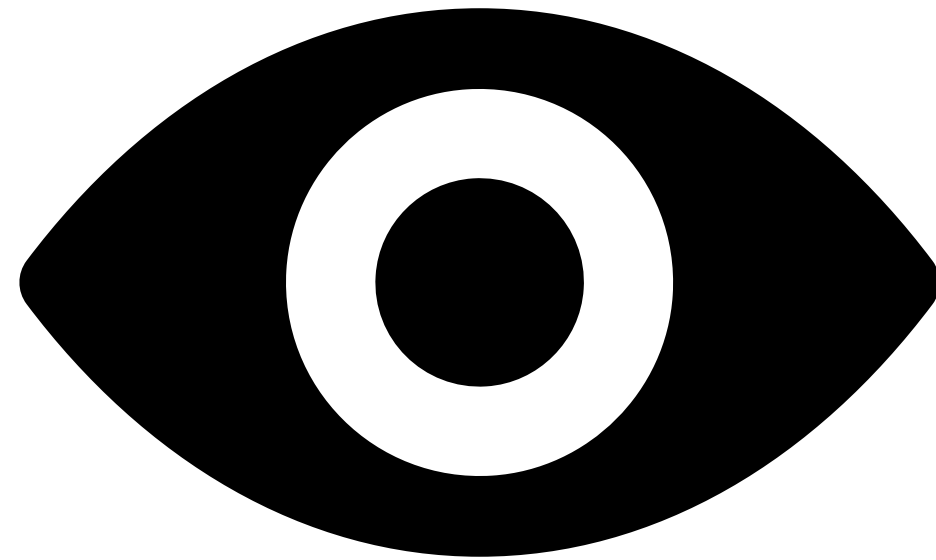
Don't test properties individually

```
matplotlib.figure.Figure()
```

- Axes
 - configuration
 - style
- Data
 - style
- Annotations
 - style
- ...



Testing strategy for plots



Testing strategy for plots

One-time baseline
generation

Testing

One-time baseline generation

One-time baseline
generation

Decide on test
arguments

Testing

One-time baseline generation

One-time baseline
generation

Decide on test
arguments



Call plotting
function on test
arguments

Testing

One-time baseline generation

One-time baseline
generation

Decide on test
arguments

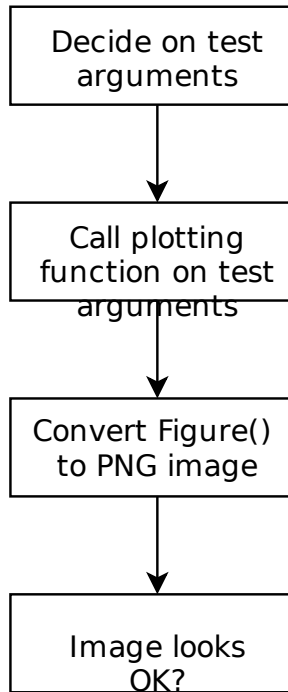
Call plotting
function on test
arguments

Convert Figure()
to PNG image

Testing

One-time baseline generation

One-time baseline
generation



Testing

One-time baseline generation

One-time baseline
generation

Decide on test
arguments

Call plotting
function on test
arguments

Convert Figure()
to PNG image

Image looks
OK?

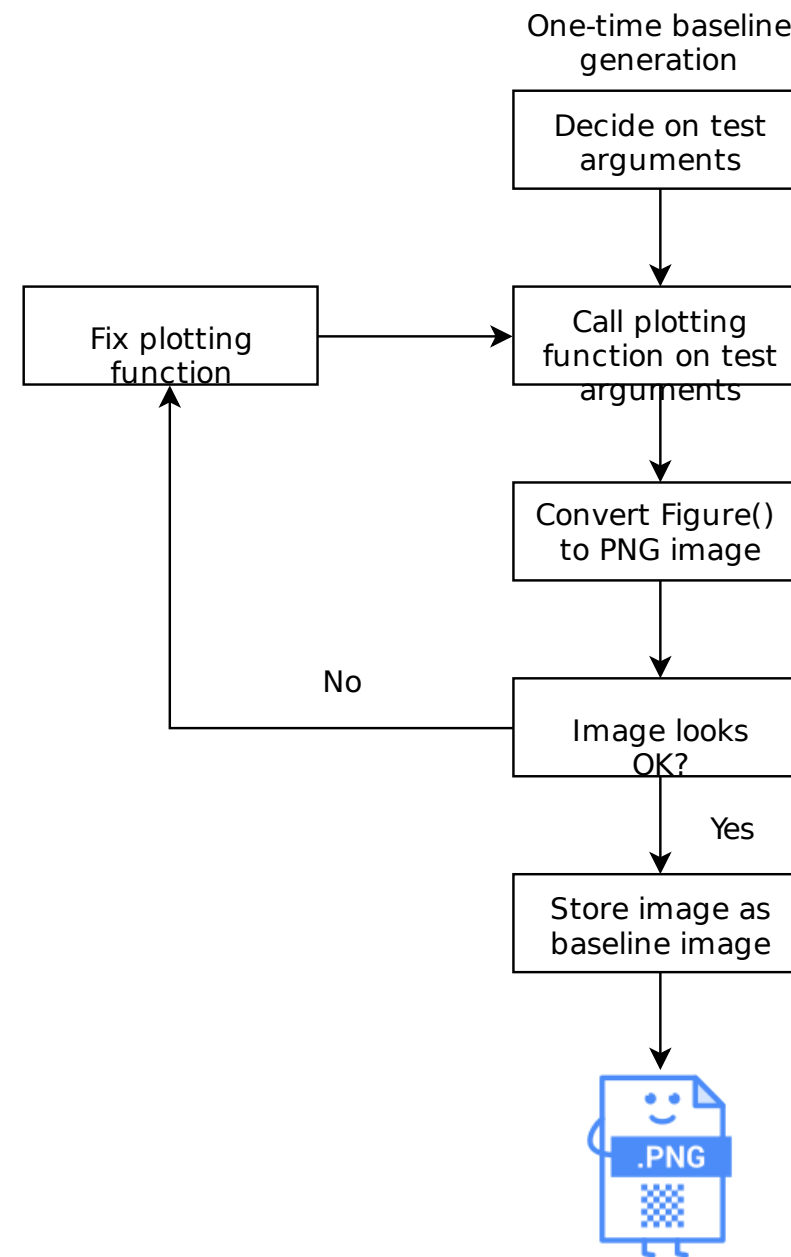
Yes

Store image as
baseline image



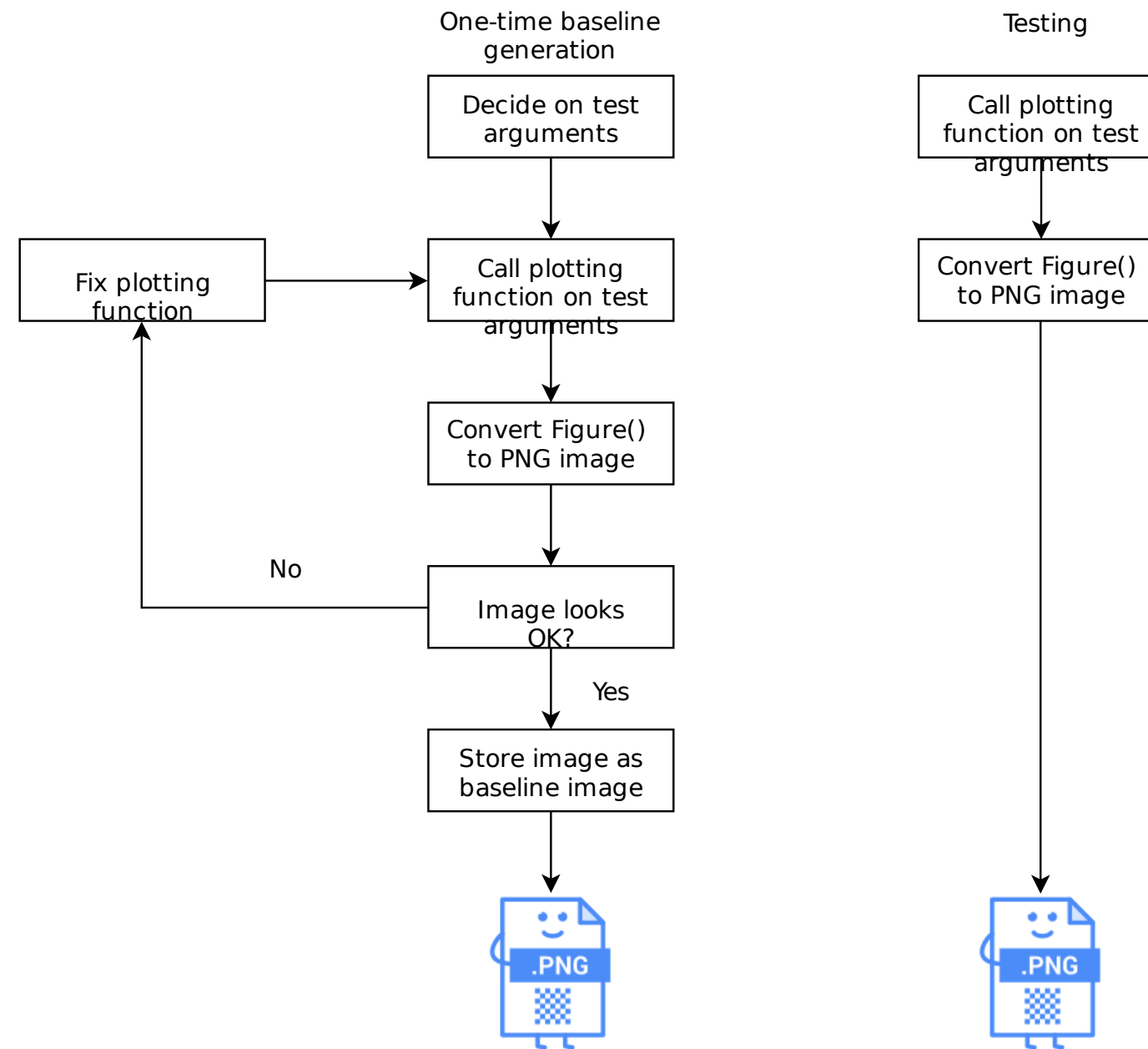
Testing

One-time baseline generation

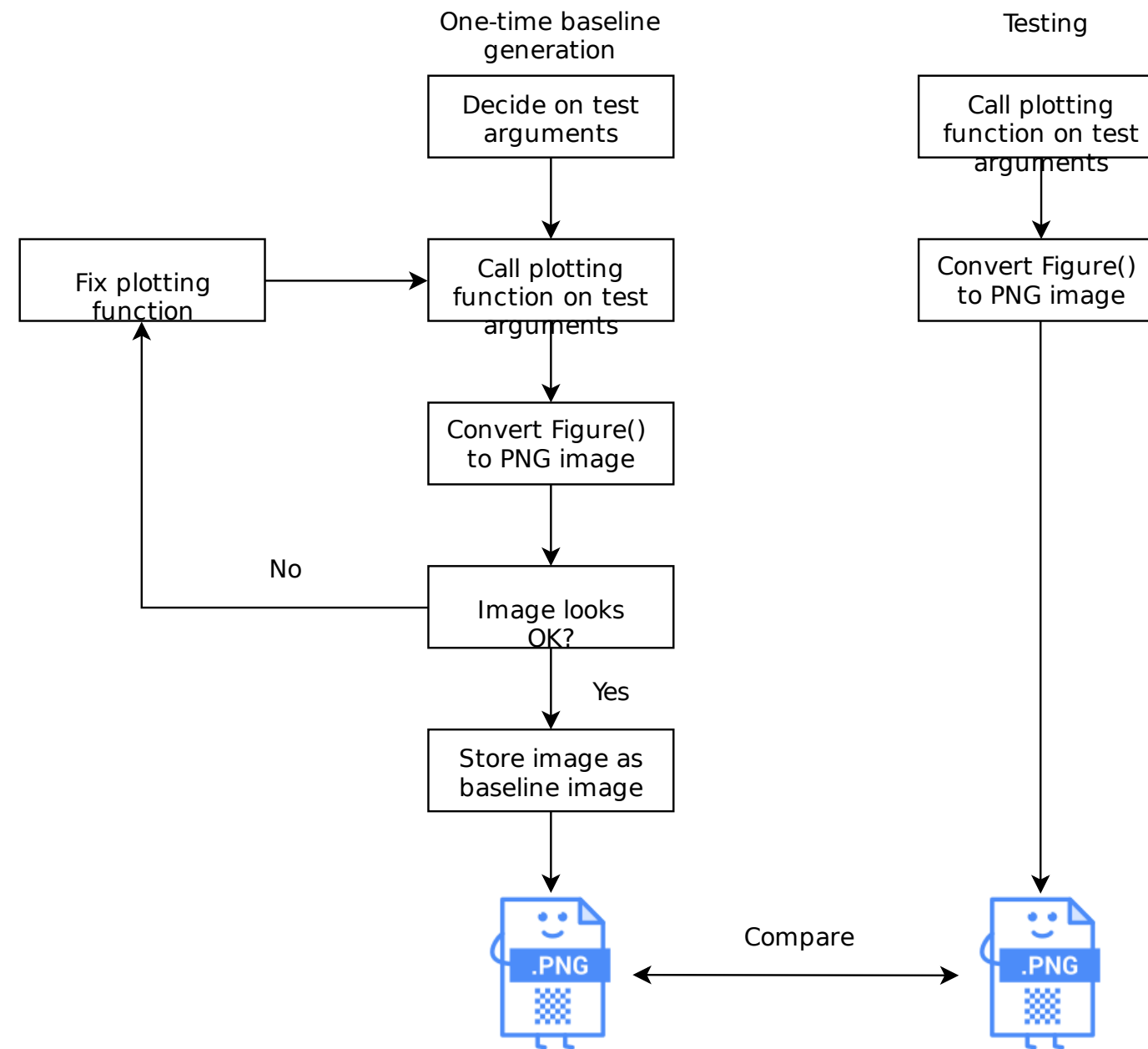


Testing

Testing



Testing



pytest-mpl

- Knows how to ignore OS related differences.
- Makes it easy to generate baseline images.

```
pip install pytest-mpl
```

An example test

```
import pytest
import numpy as np
from visualization import get_plot_for_best_fit_line

def test_plot_for_linear_data():
    slope = 2.0
    intercept = 1.0
    x_array = np.array([1.0, 2.0, 3.0])    # Linear data set
    y_array = np.array([3.0, 5.0, 7.0])
    title = "Test plot for linear data"
    return get_plot_for_best_fit_line(slope, intercept, x_array, y_array, title)
```

An example test

```
import pytest
import numpy as np
from visualization import get_plot_for_best_fit_line

@pytest.mark.mpl_image_compare      # Under the hood baseline generation and comparison
def test_plot_for_linear_data():
    slope = 2.0
    intercept = 1.0
    x_array = np.array([1.0, 2.0, 3.0])    # Linear data set
    y_array = np.array([3.0, 5.0, 7.0])
    title = "Test plot for linear data"
    return get_plot_for_best_fit_line(slope, intercept, x_array, y_array, title)
```

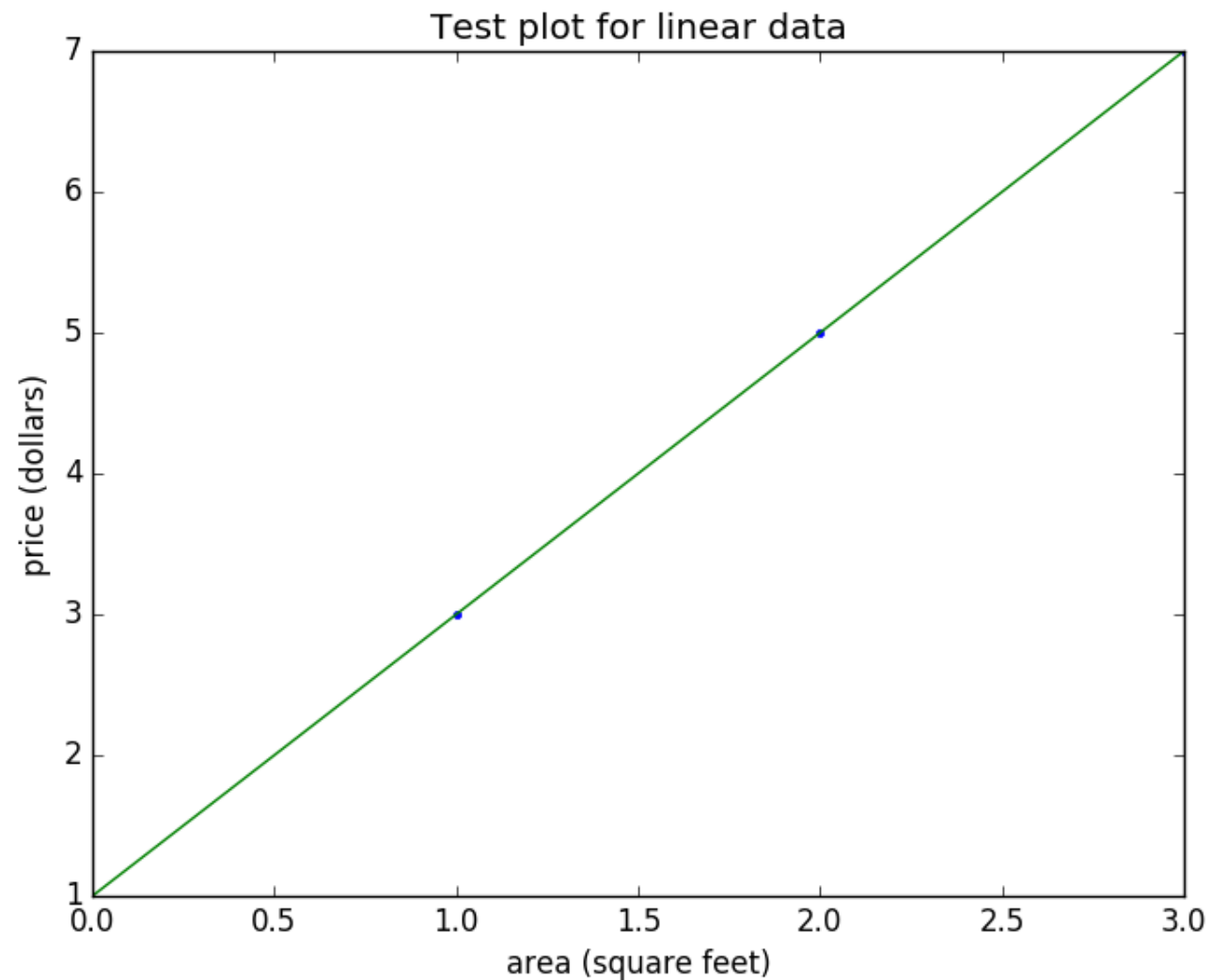
Generating the baseline image

Generate baseline image

```
!pytest -k "test_plot_for_linear_data"  
        --mpl-generate-path  
        visualization/baseline
```

```
data/  
src/  
tests/  
|-- data/  
|-- features/  
|-- models/  
|-- visualization  
    |-- __init__.py  
    |-- test_plots.py    # Test module  
    |-- baseline        # Contains baselines
```

Verify the baseline image



```
data/  
src/  
tests/  
|-- data/  
|-- features/  
|-- models/  
|-- visualization  
    |-- __init__.py  
    |-- test_plots.py      # Test module  
    |-- baseline          # Contains baselines  
        |-- test_plot_for_linear_data.png
```


Run the test

```
!pytest -k "test_plot_for_linear_data" --mpl
```

```
===== test session starts =====
...
collected 24 items / 23 deselected / 1 selected

visualization/test_plots.py .           [100%]

===== 1 passed, 23 deselected in 0.68 seconds =====
```

Reading failure reports

```
!pytest -k "test_plot_for_linear_data" --mpl
```

```
===== FAILURES =====
_____ TestGetPlotForBestFitLine.test_plot_for_linear_data _____
Error: Image files did not match.
  RMS Value: 11.191347848524174
  Expected:
    /tmp/tmp1cbtsb10/baseline-test_plot_for_linear_data.png
  Actual:
    /tmp/tmp1cbtsb10/test_plot_for_linear_data.png
  Difference:
    /tmp/tmp1cbtsb10/test_plot_for_linear_data-failed-diff.png
  Tolerance:
    2
===== 1 failed, 36 deselected in 1.13 seconds =====
```

Yummy!



Let's test plots!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Congratulations

UNIT TESTING FOR DATA SCIENCE IN PYTHON



Dibya Chakravorty
Test Automation Engineer



You've written so many tests

1

You've written so many tests

5

You've written so many tests

10

You've written so many tests

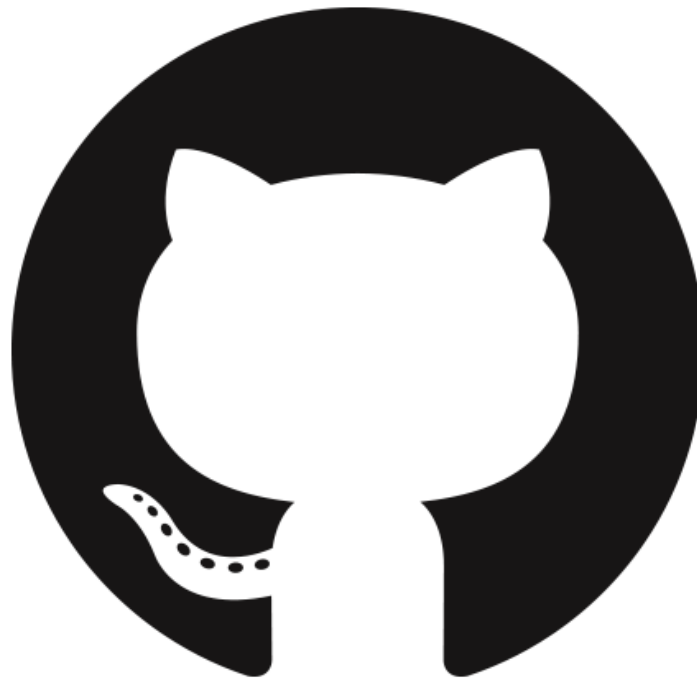
25

You learned a lot

- Testing saves time and effort.
- `pytest`
 - Testing return values and exceptions.
 - Running tests and reading the test result report.
- Best practices
 - Well tested function using normal, special and bad arguments.
 - TDD, where tests get written before implementation.
 - Test organization and management.
- Advanced skills
 - Setup and teardown with fixtures, mocking.
 - Sanity tests for data science models.
 - Plot testing.

Code for this course

<https://github.com/gutfeeling/univariate-linear-regression>



Icon sources

Icons made by the following authors from flaticon.com.

- Freepik
- Smashicons
- Vectors Market
- Kiranshastry
- Dimitry Miroljubov
- Creaticca Creative Agency
- Gregor Cresnar

Image sources

1. <https://chibird.com/post/20998191414/i-make-a-lot-of-procrastination-drawings-theyre>
2. <http://www.dekoleidenschaft.de/ratgeber/10-tipps-fuer-mehr-ordnung-im-kleiderschrank/>
3. <http://me-monaco.me/paper-storage-box-with-lid/>
4. <https://towardsdatascience.com/random-forests-and-decision-trees-from-scratch-in-python-3e4fa5ae4249>
5. <https://towardsdatascience.com/demystifying-support-vector-machines-8453b39f7368>
6. <https://www.bbc.co.uk/bbcthree/article/b290ff0e-1d75-43b1-8ff1-a9ac80d4d842>

**I wish you all the
best!**

UNIT TESTING FOR DATA SCIENCE IN PYTHON