Beyond assertion: setup and teardown

UNIT TESTING FOR DATA SCIENCE IN PYTHON

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The preprocessing function

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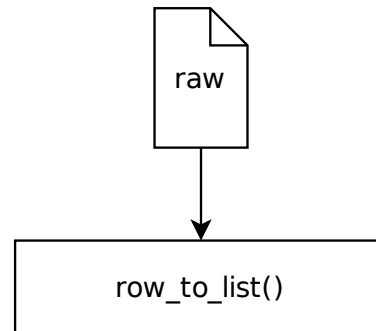
raw

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

The preprocessing function

```python
def preprocess(raw_data_file_path,
               clean_data_file_path
               ):
    ...
```
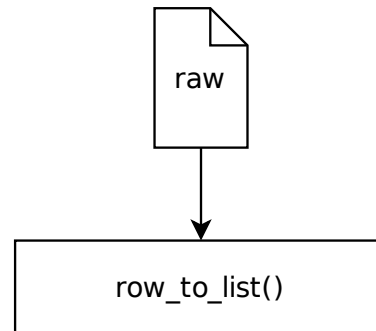
```
1,801    201,411
1,767565,112         # dirty row, no tab
2,002    333,209
1990     782,911
1,285    389129
```


raw

row_to_list()

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
```

raw

↓

row_to_list()

The preprocessing function

```python
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

```python
def preprocess(raw_data_file_path,
               clean_data_file_path
               ):
    ...
```
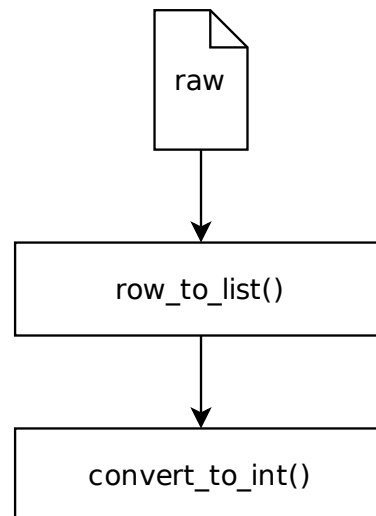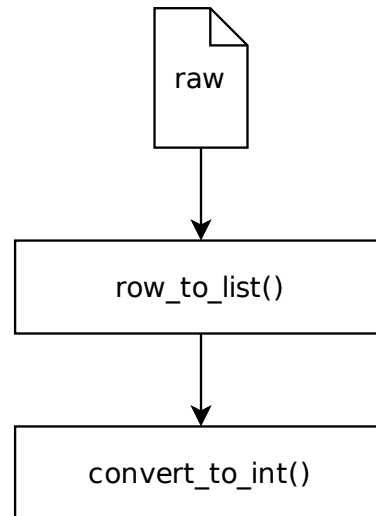
```
1,801    201,411
2,002    333,209
```
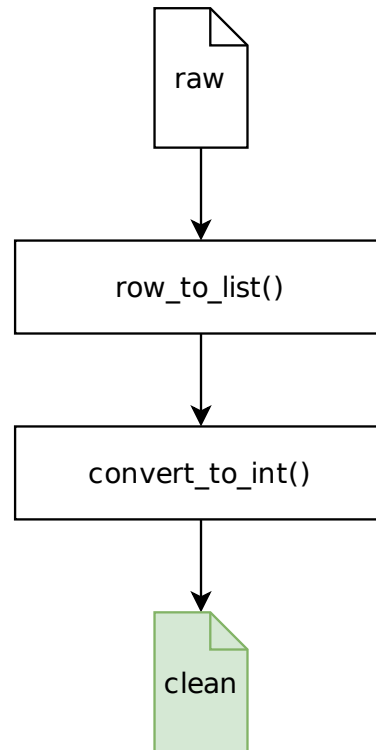
The preprocessing function

```python
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.

raw
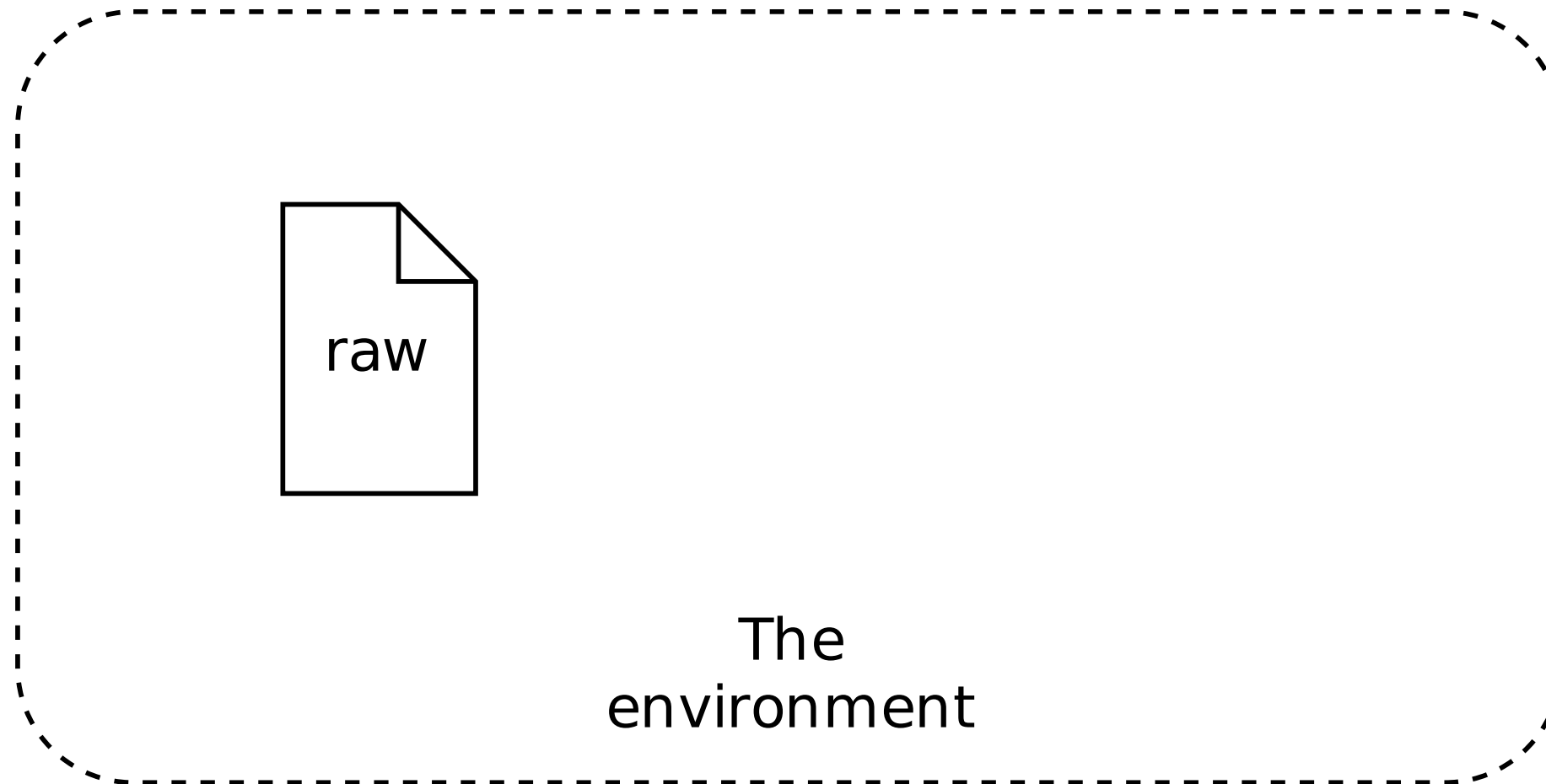
The environment

Environment modification

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

raw

clean

The
environment
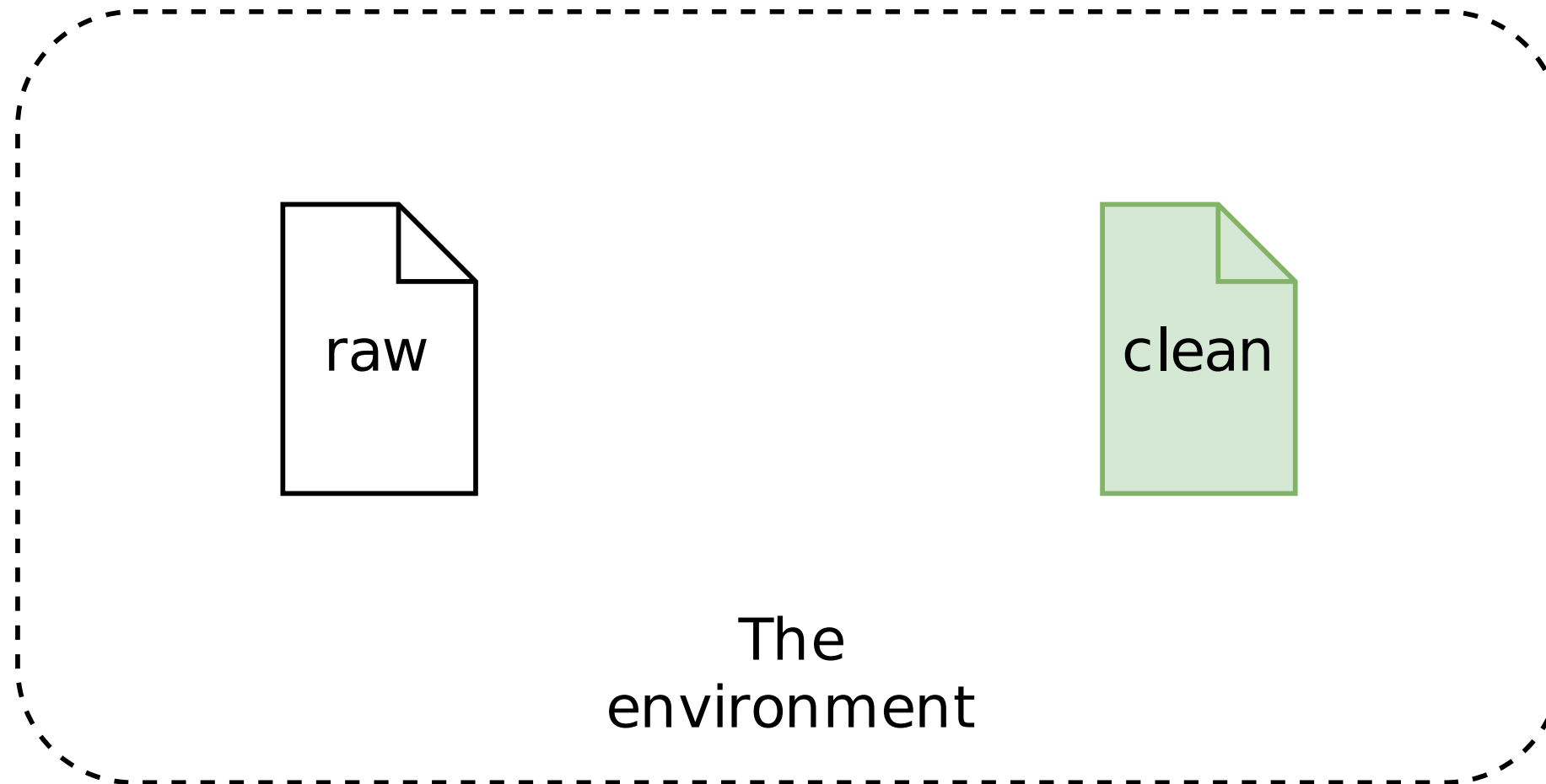
Testing the preprocessing function

```python
def test_on_raw_data():
```

The
environment

Step 1: Setup

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

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

raw

The environment

Step 2: Assert

```python
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"
```

raw

clean

The
environment
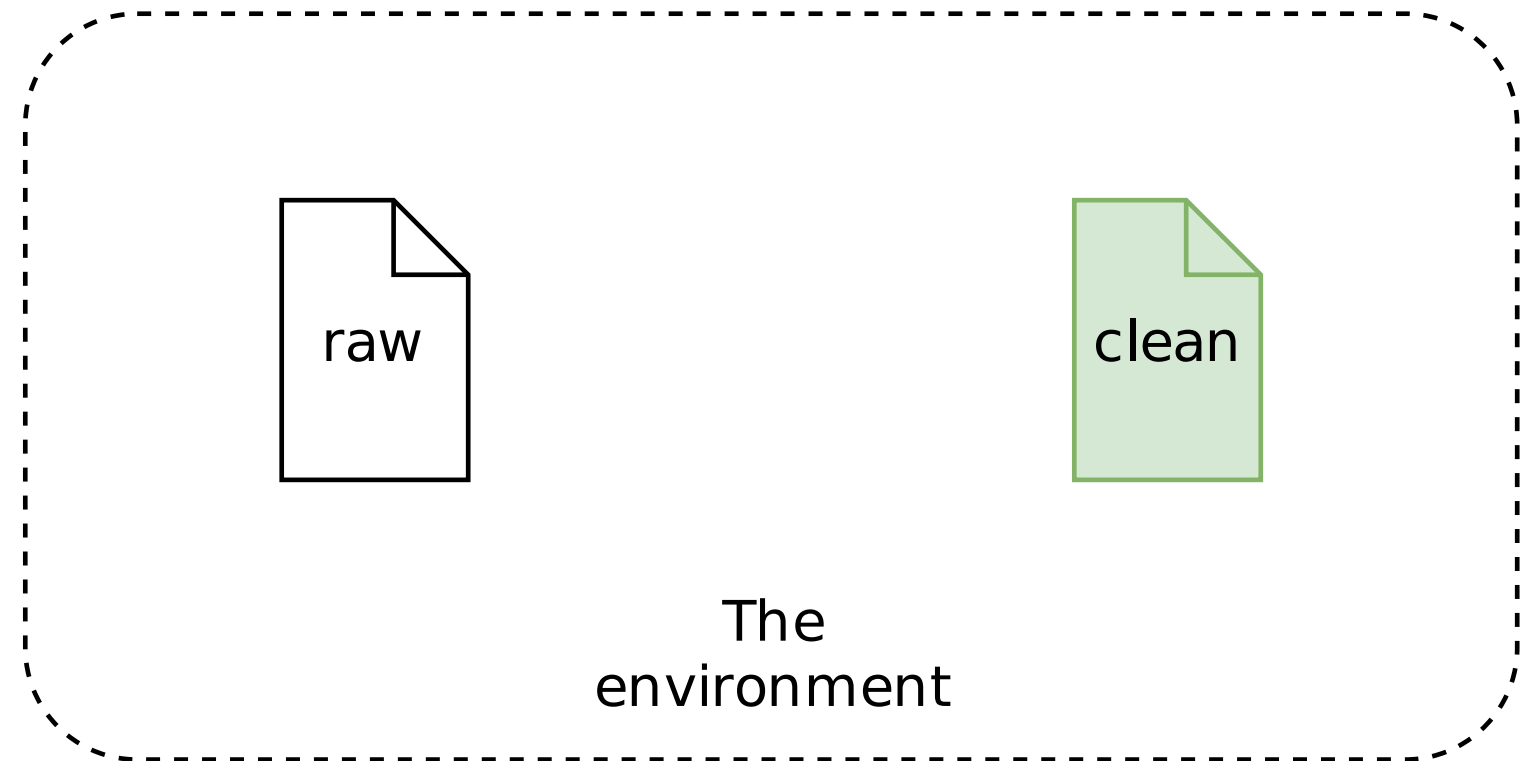
Step 3: Teardown

```python
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
```

The
environment

- Teardown brings environment to initial
  state.

The new workflow

Old workflow

- assert

New workflow

- setup $\rightarrow$ assert $\rightarrow$ teardown

Fixture

```python
import pytest


@pytest.fixture

def my_fixture():

    # Do setup here

    return data

```

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

Fixture

```python
import pytest


@pytest.fixture

def my_fixture():

    # Do setup here

    yield data    # Use yield instead of return

    # Do teardown here
```

```python
def test_something(my_fixture):

    ...
    data = my_fixture

    ...
```

Test

```python
import os
import pytest


def test_on_raw_data():
```

Fixture

```python
@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_pat
    os.remove(raw_data_file_path)
    os.remove(clean_data_file_path)
```

Test

```python
import os
import pytest

def test_on_raw_data(raw_and_clean_data_file):
    raw_path, clean_path = raw_and_clean_data_fil
    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()` .

```python
@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

Dibya Chakravorty
Test Automation Engineer

DataCamp

The preprocessing function

raw

The preprocessing function

The preprocessing function

```
raw
```

↓

```
row_to_list()
```

↓

```
convert_to_int()
```

↓

```
clean
```

```
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 =====
```

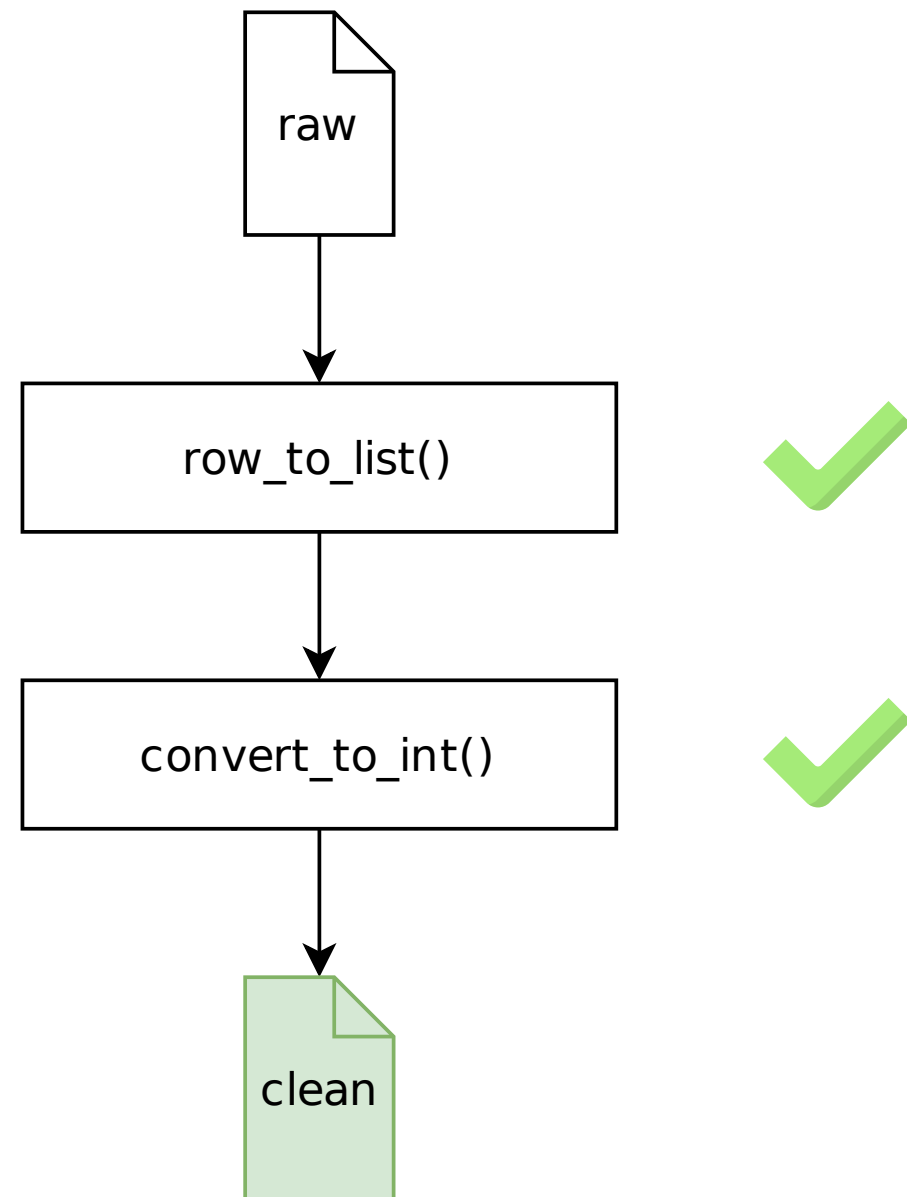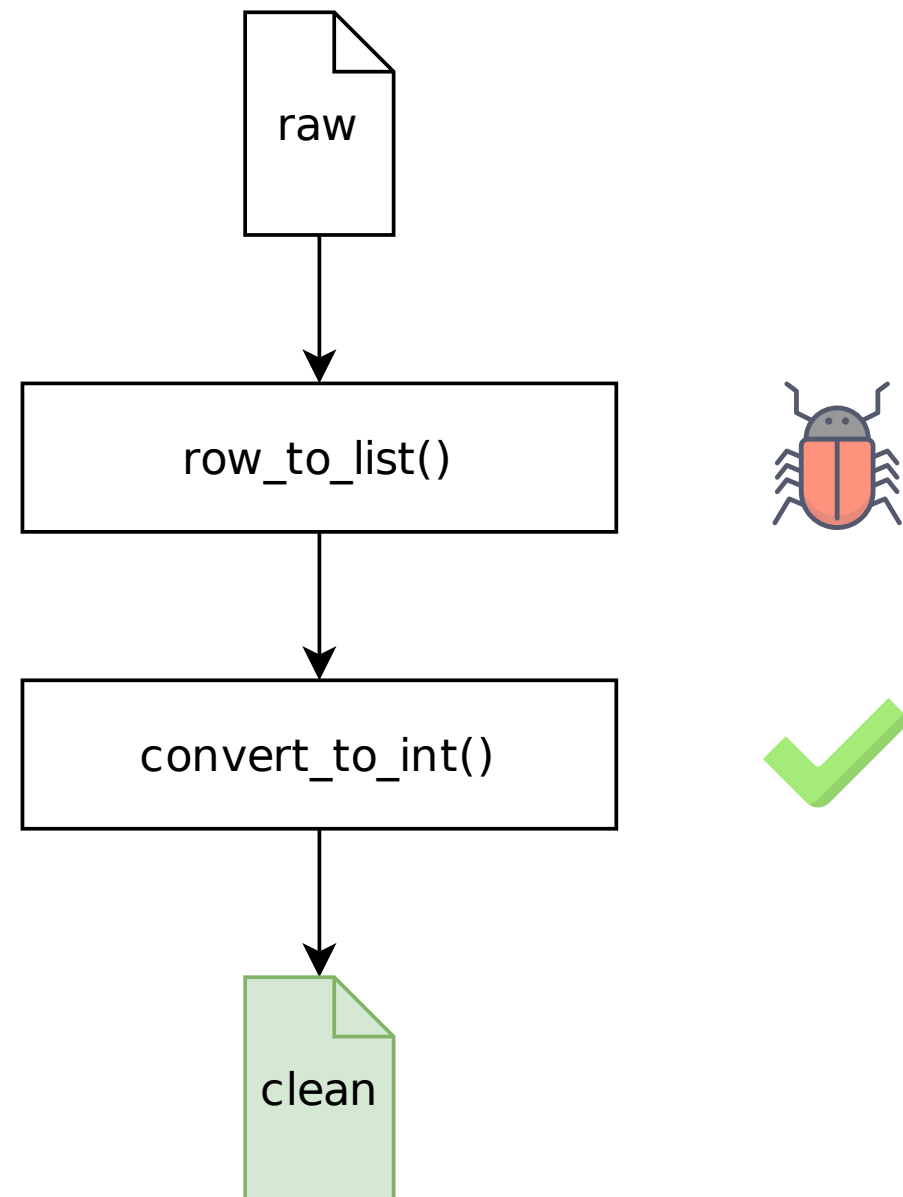# Test result depend on dependencies


```
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()
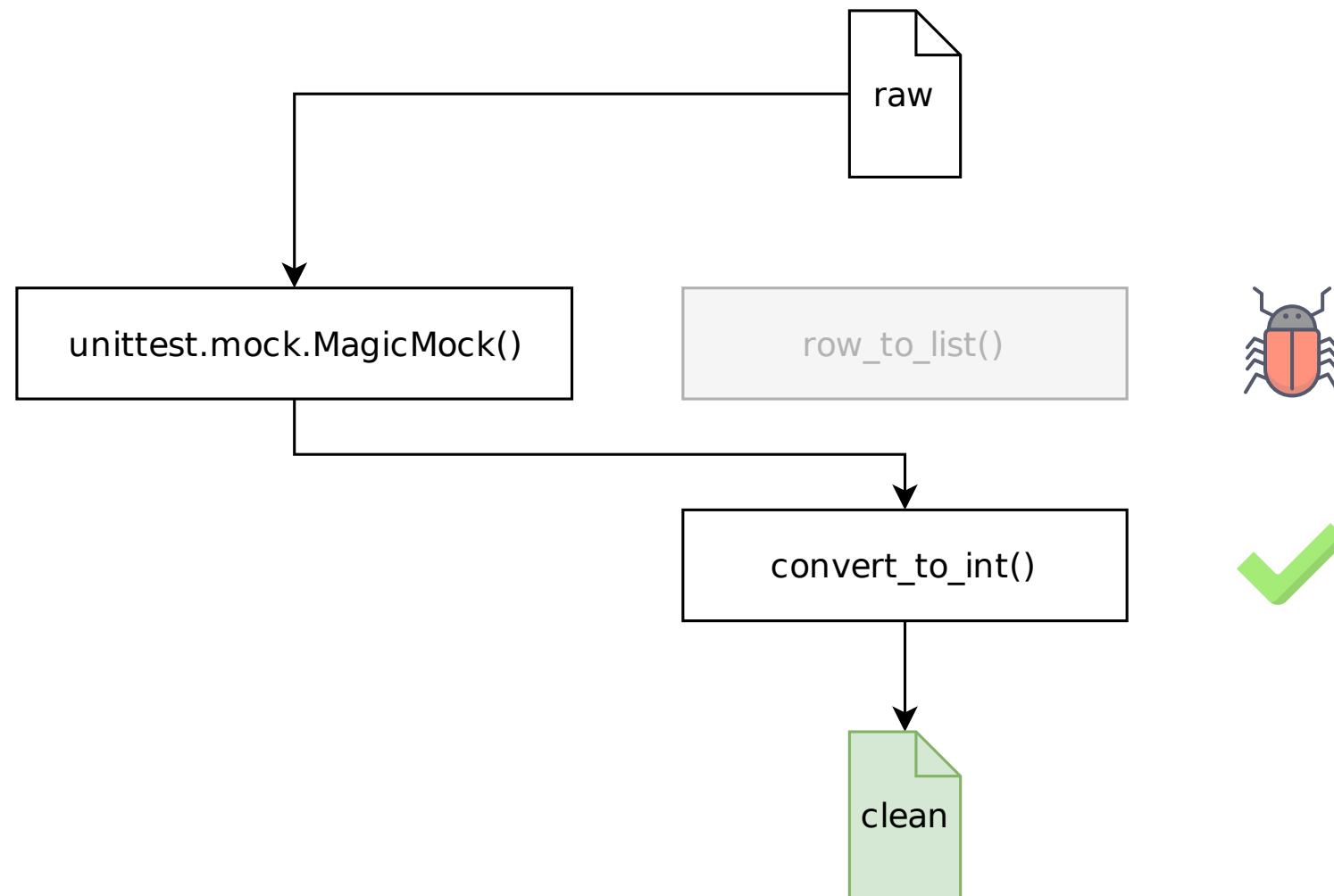

```python
def test_on_raw_data(raw_and_clean_data_file,

                     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>")
```

```python
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()
```

```python
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
```

```python
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]
```

```python
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
```

```python
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]
```

```python
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


```python
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)
```
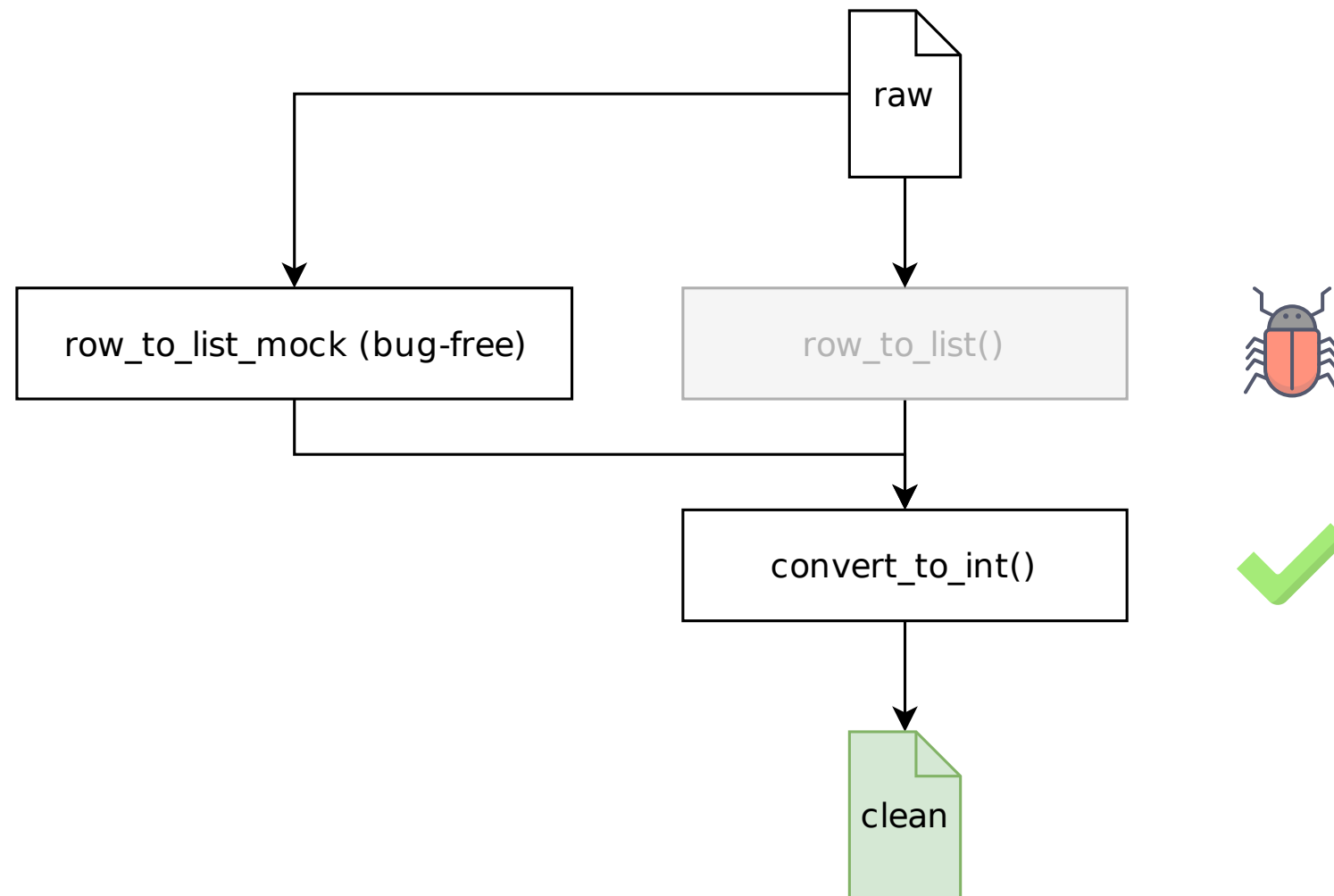
Checking the arguments

- `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")
 ]
```

```python
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")
 ]
```

```python
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

```python
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

```python
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

```python
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
    )
```

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

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

Splitting into training and testing sets

```python
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)
    )
```

```python
split_into_training_and_testing_sets(data)
```

```python
(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

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

The linear regression model

```python
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

Housing area and prices

Return values difficult to compute manually
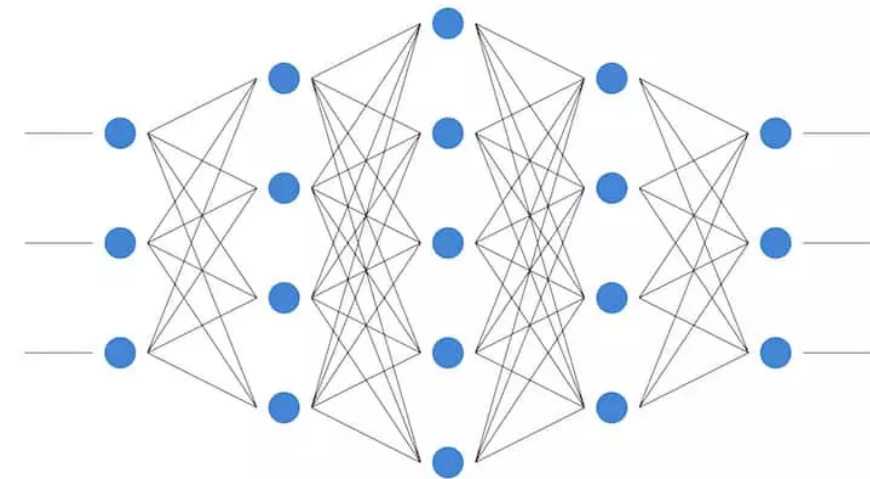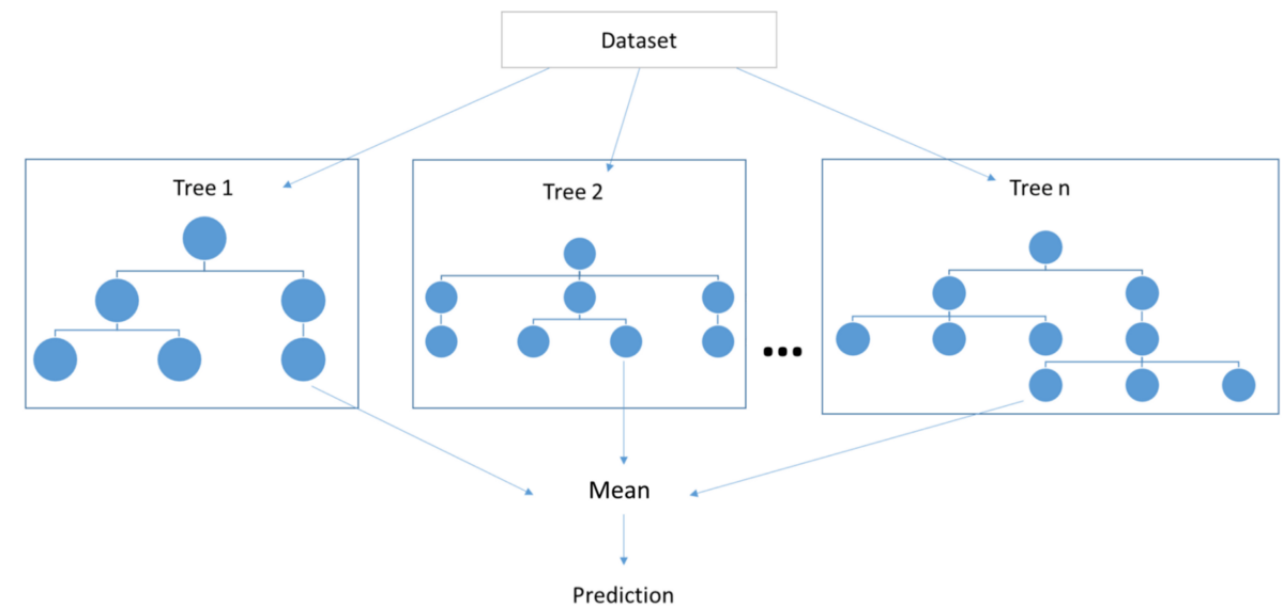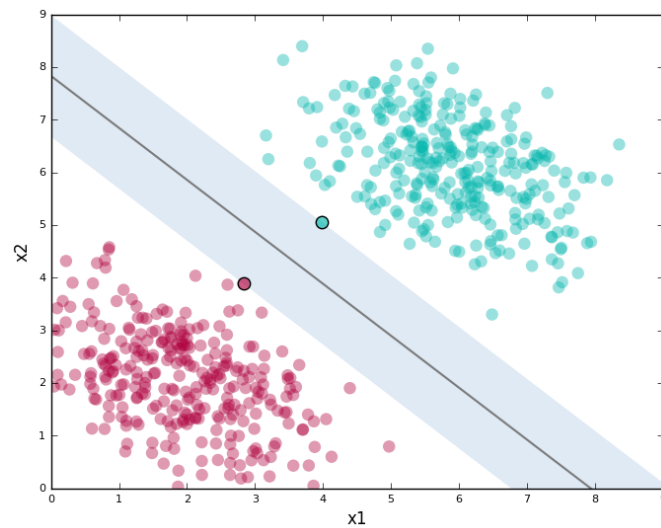

Housing area and prices
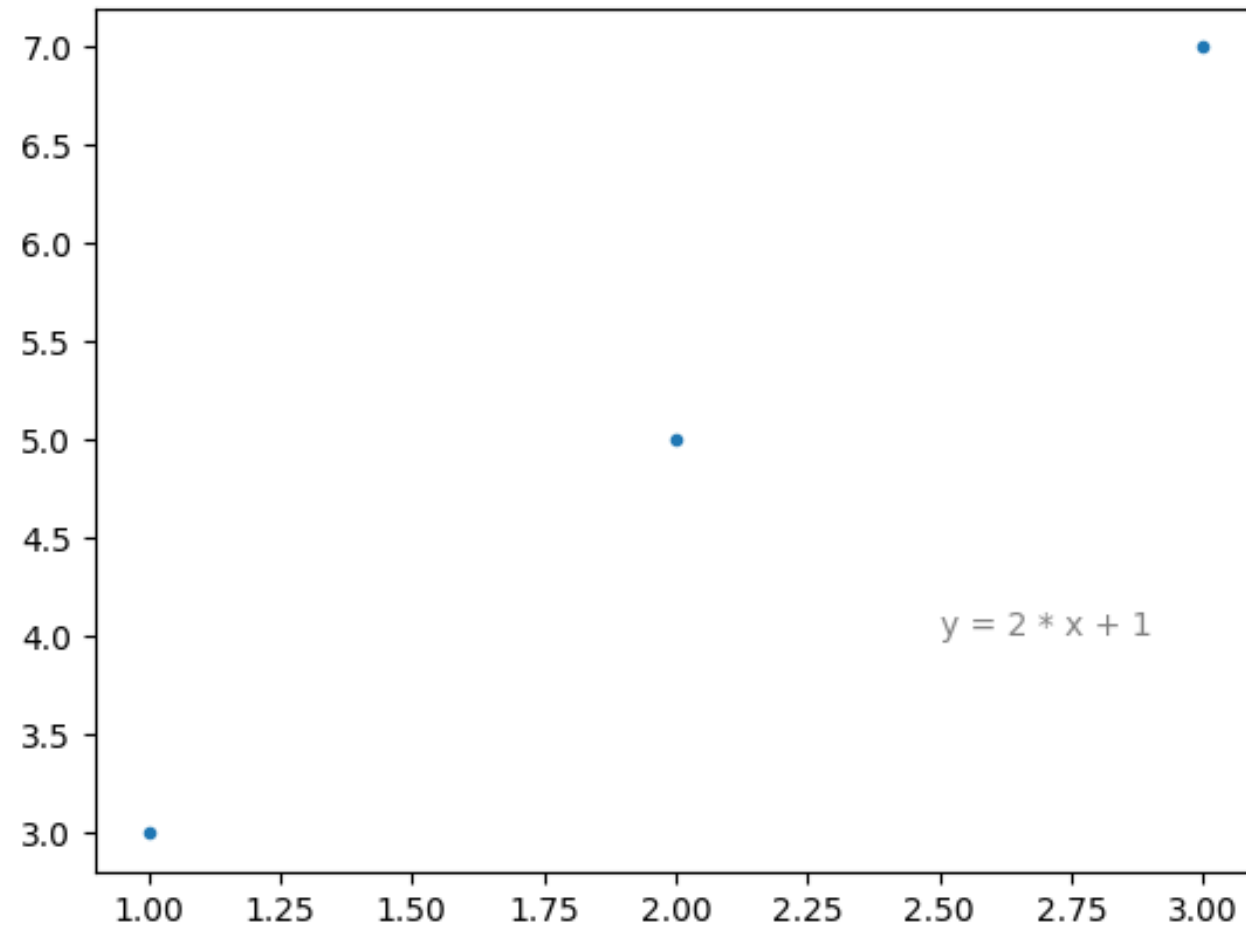
Return values difficult to compute manually

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

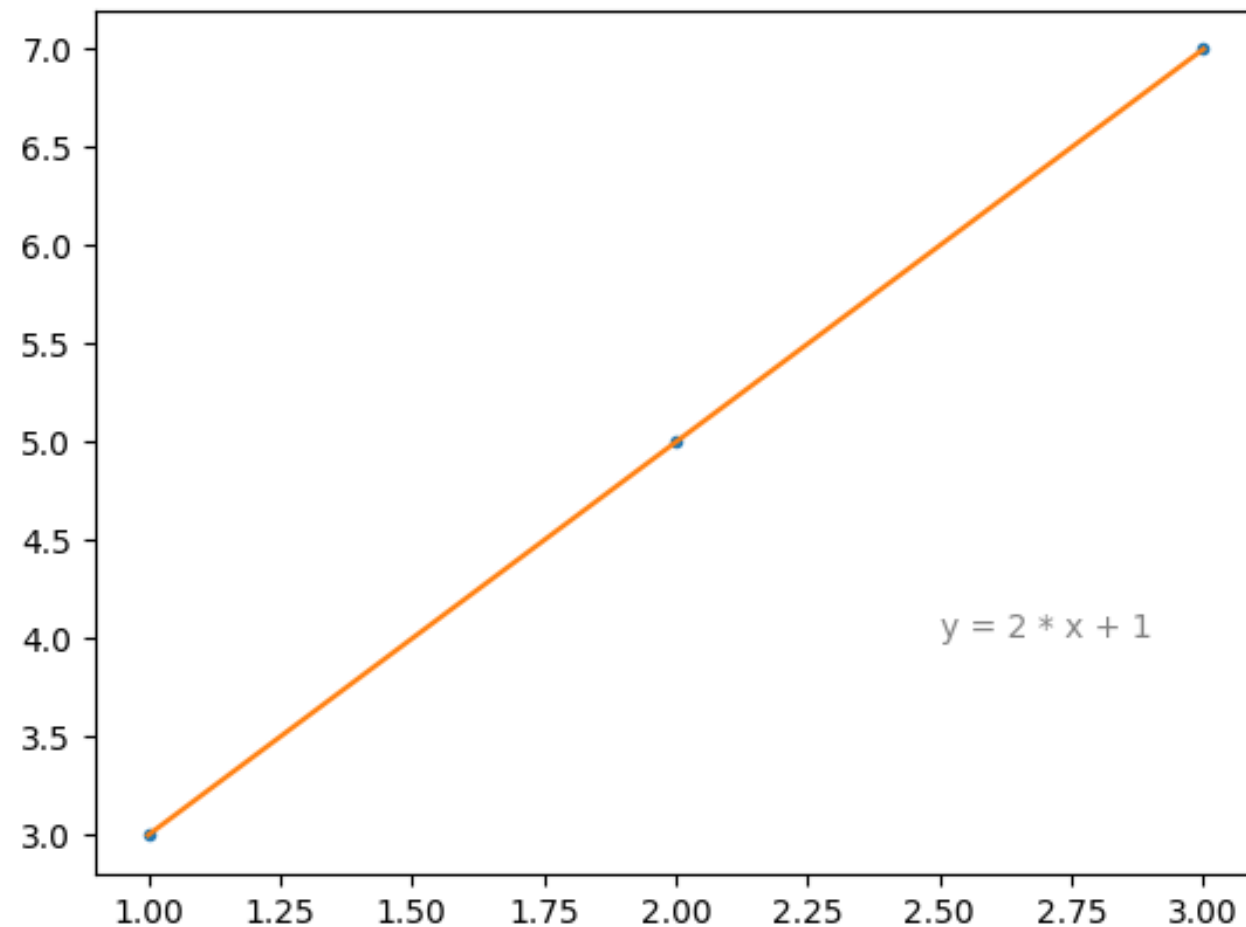# True for all data science models

Trick 1: Use dataset where return value is known


```python
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]
                              ]
                              )
```

y = 2 * x + 1

Trick 1: Use dataset where return value is known

y = 2 * x + 1

```python
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
        )
```
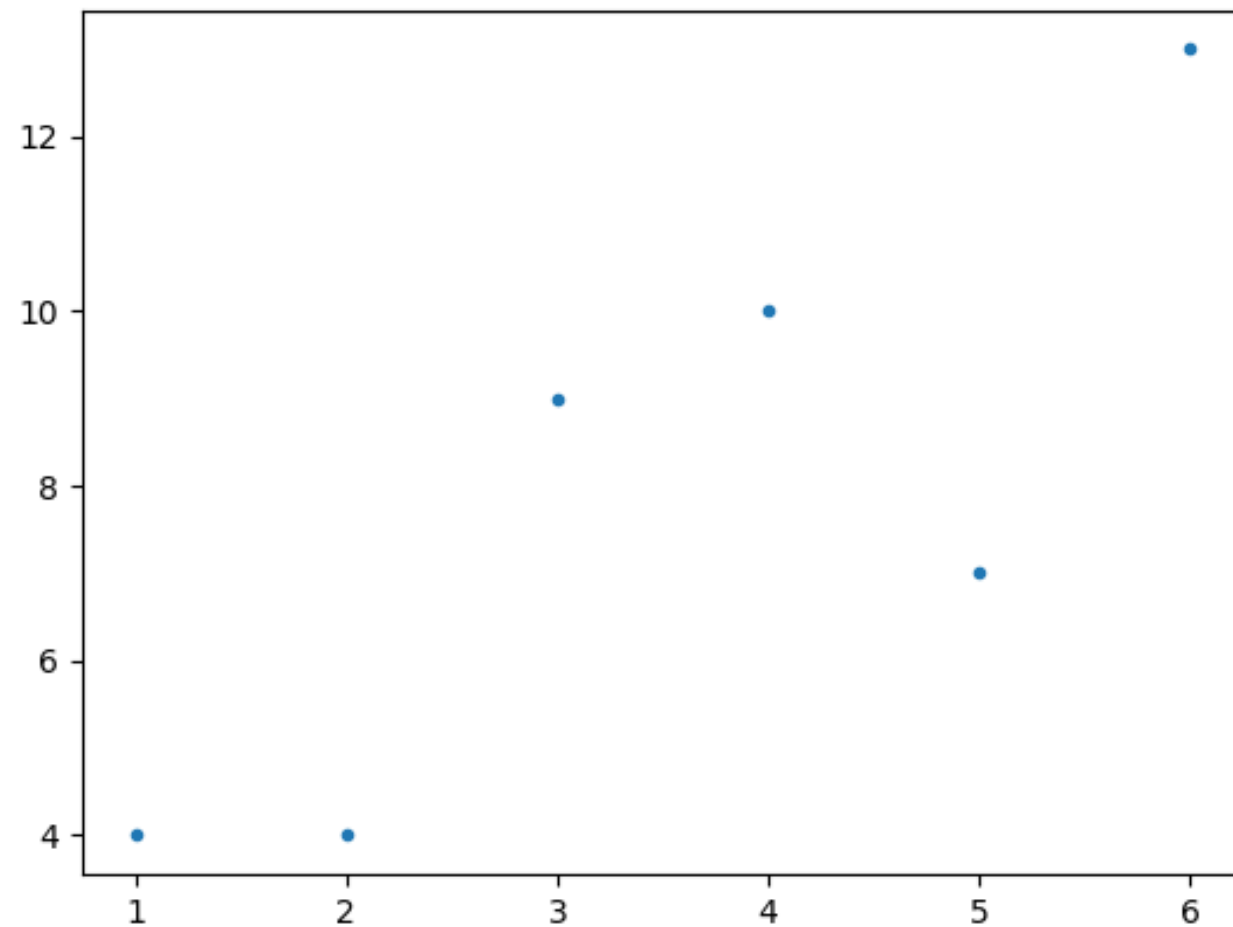
Trick 2: Use inequalities


```python
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],
                              ]
                             )
```
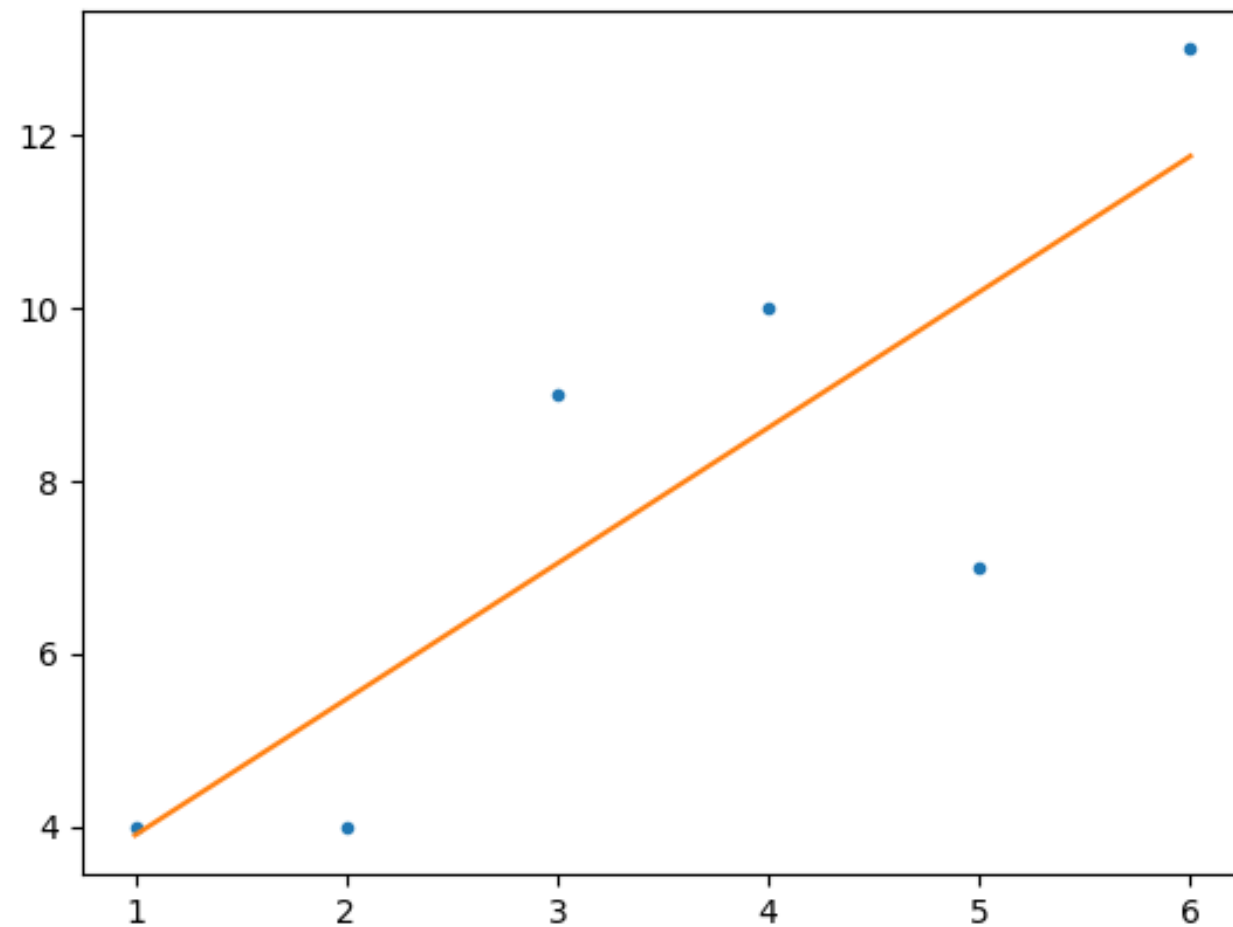
Trick 2: Use inequalities


```python
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

```python
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)
```

```python
train_model(training_set)
```

```
151.78430060614986 17140.77537937442
```

Testing model performance

```python
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`

```python
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`

```python
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

```python
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()
    """
```
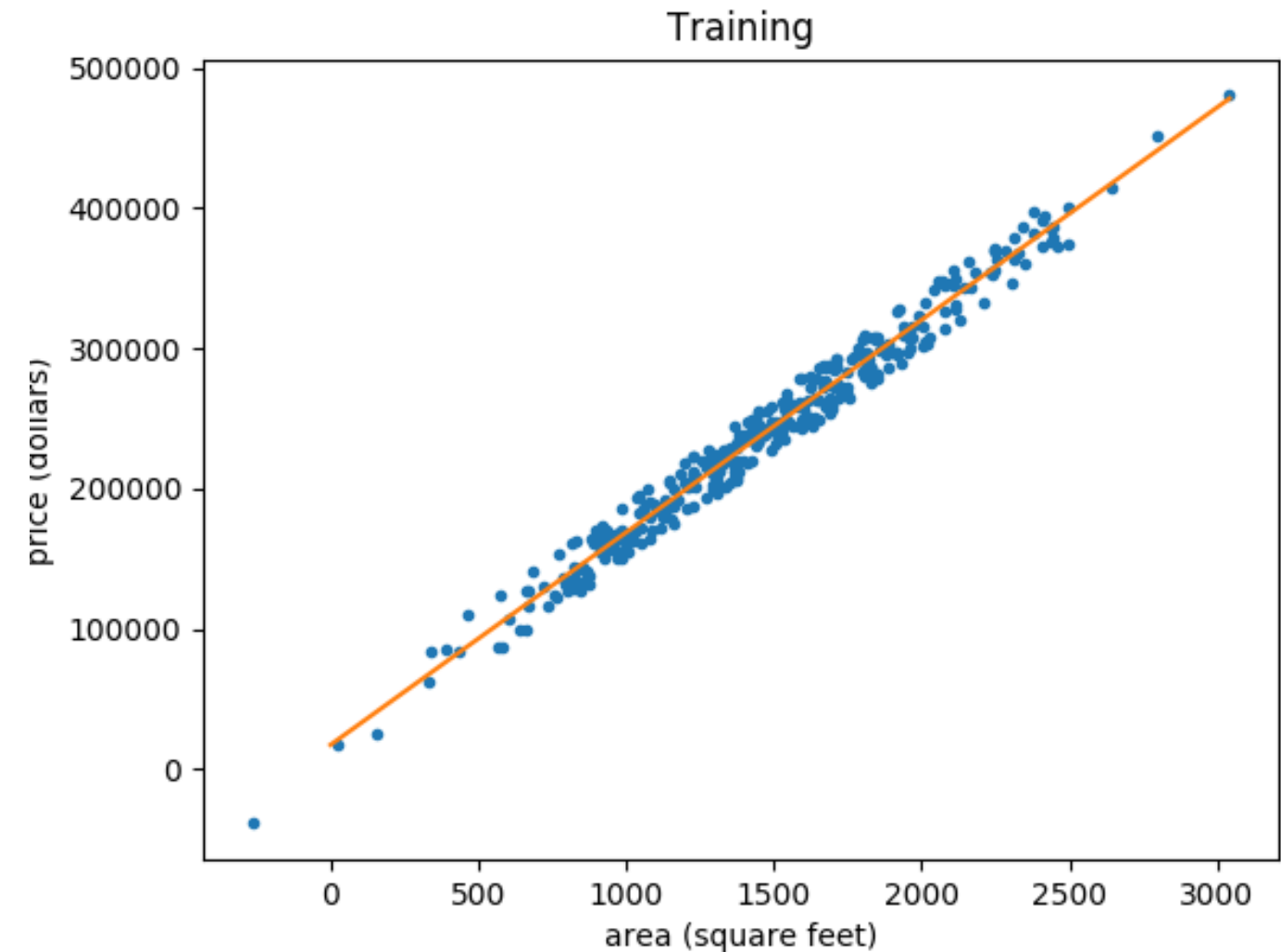
```
data/
src/
|-- data/
|-- features/
|-- models/
|-- visualization
|    |-- __init__.py
|    |-- plots.py
tests/
```

Training plot

```
...
from visualization import get_plot_for_best_fit_l

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"
    )
```
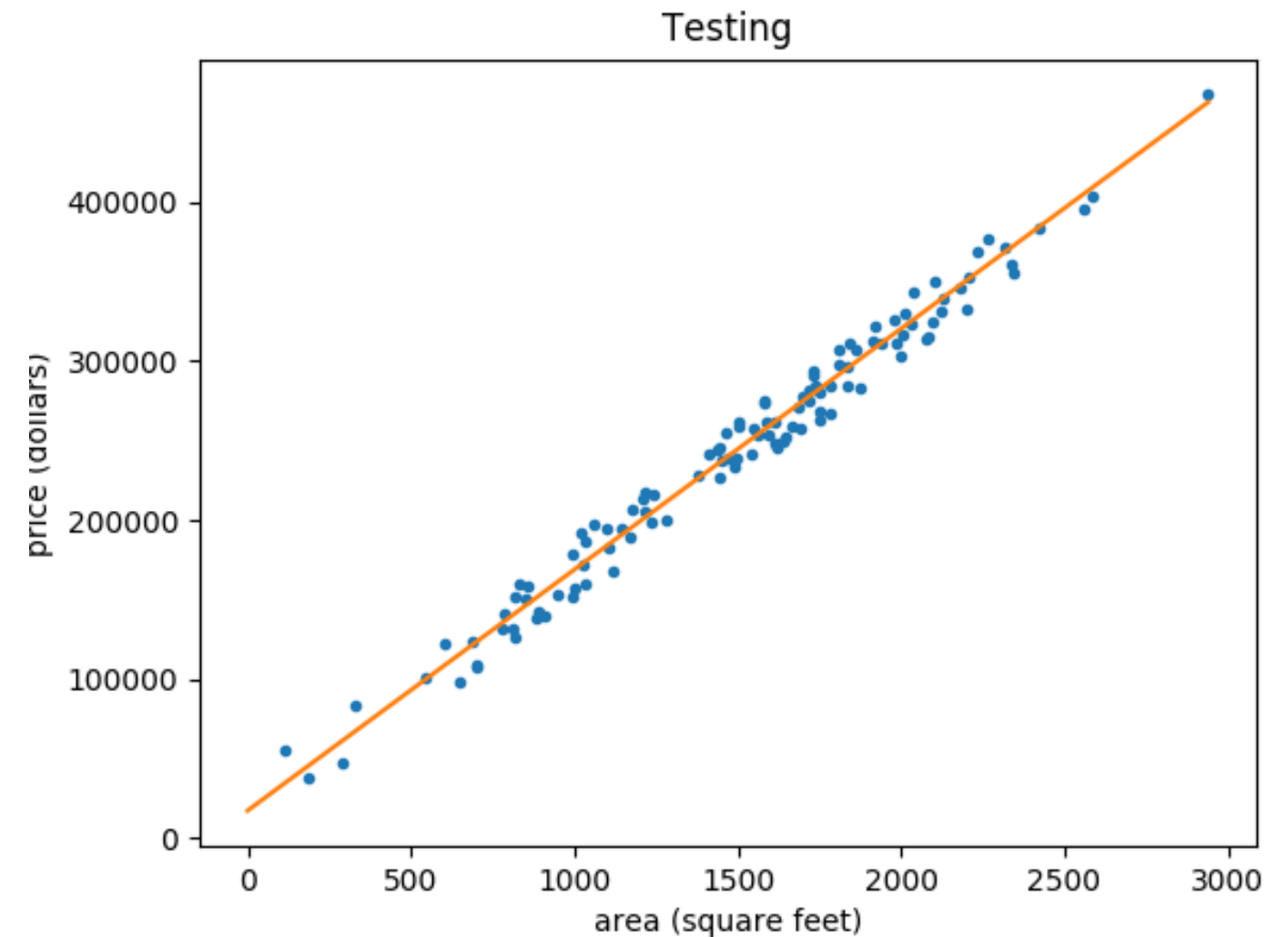
Testing plot

```
...
from visualization import get_plot_for_best_fit_l

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], "Testi
    )
```
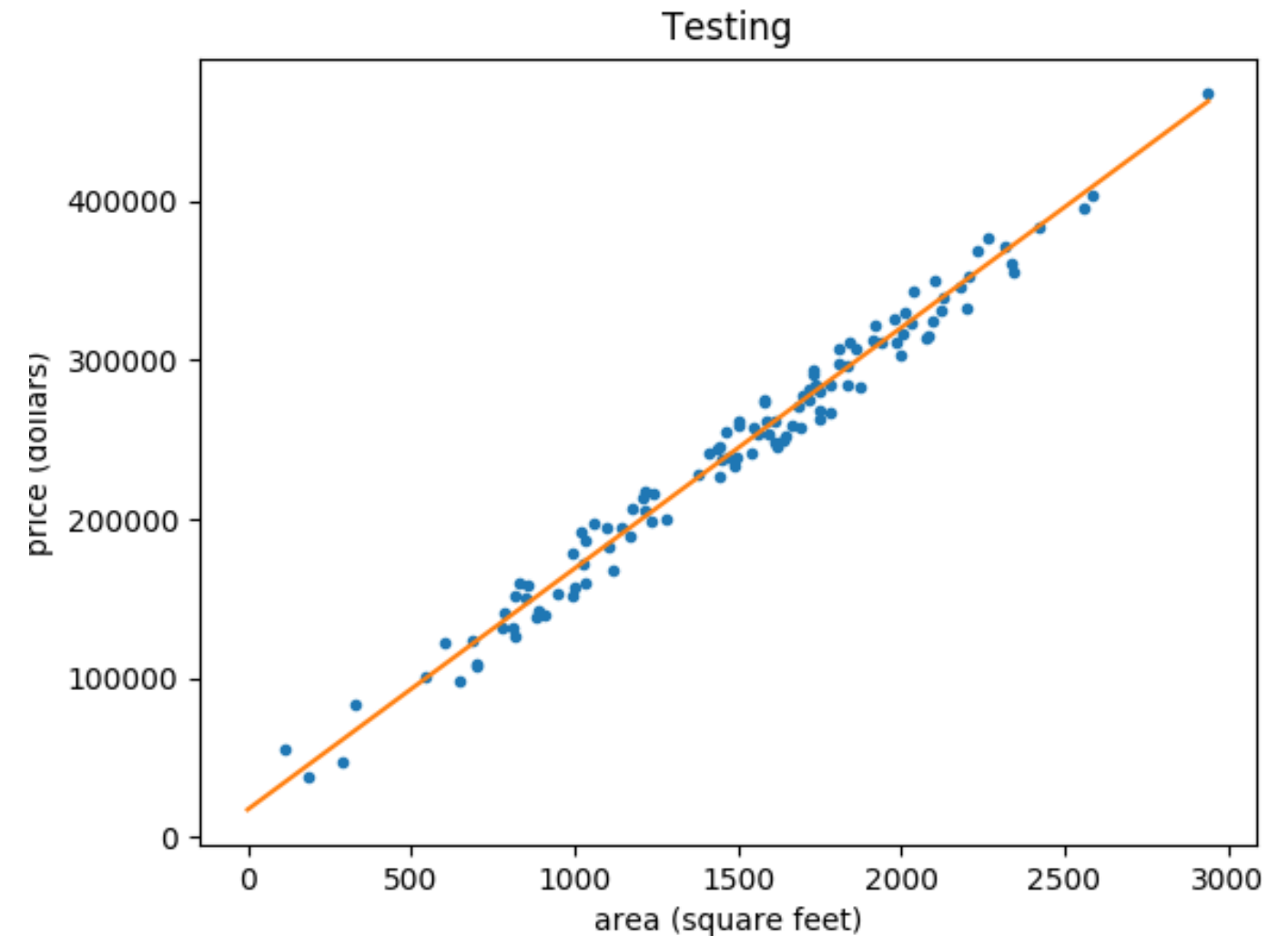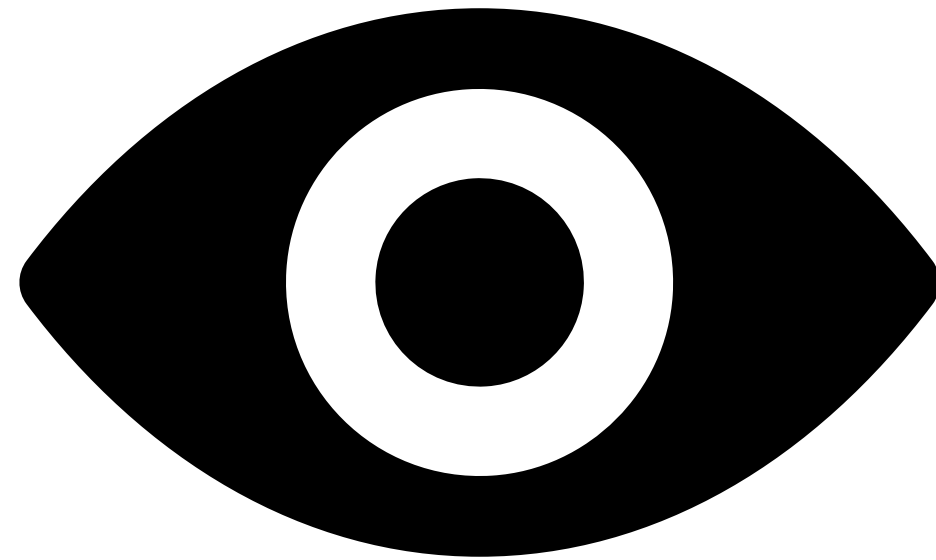
Don't test properties individually

`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

Testing

```
Decide on test
arguments
```

↓

```
Call plotting
function on test
arguments
```

One-time baseline generation

One-time baseline
generation

Testing

Decide on test
arguments

Call plotting
function on test
arguments

Convert Figure()
to PNG image

One-time baseline generation

One-time baseline
generation
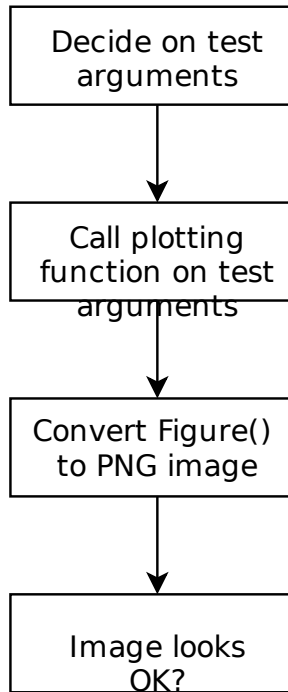
Testing

Decide on test
arguments

↓

Call plotting
function on test
arguments

↓

Convert Figure()
to PNG image

↓

Image looks
OK?

One-time baseline generation

One-time baseline
generation

Testing

Decide on test
arguments

Call plotting
function on test
arguments

Convert Figure()
to PNG image

Image looks
OK?

Yes

Store image as
baseline image

.PNG

One-time baseline generation

Testing

One-time baseline generation

Decide on test arguments

→

Fix plotting function → Call plotting function on test arguments

→

Convert Figure() to PNG image

→

Image looks OK?

No →

Yes →

Store image as baseline image

→ .PNG

Testing

Call plotting function on test arguments

→

Convert Figure() to PNG image

→ .PNG

Testing

One-time baseline generation

Decide on test arguments

↓

Fix plotting function → Call plotting function on test arguments

↓

Convert Figure() to PNG image

↓
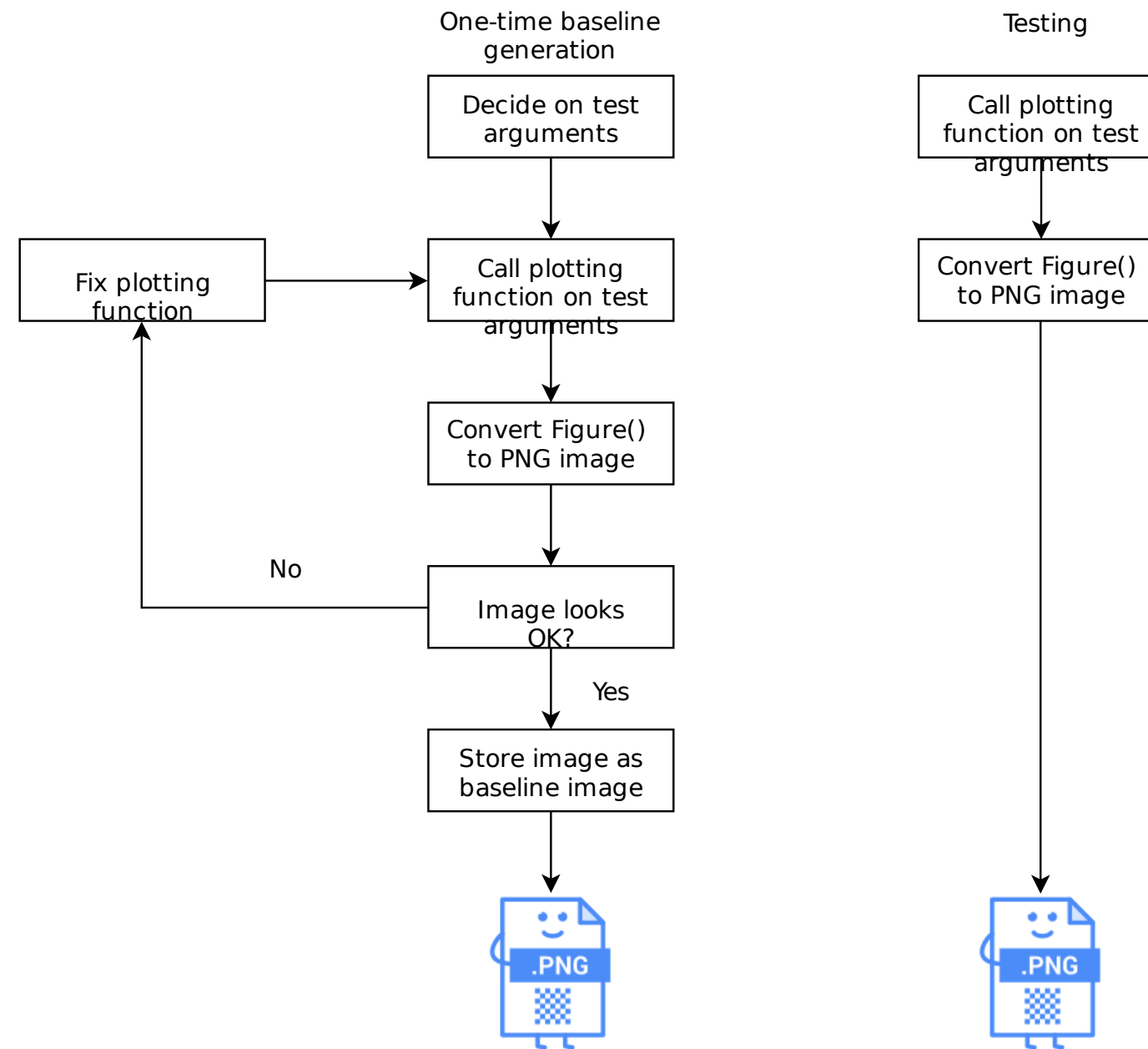
No ← Image looks OK?

Yes ↓

Store image as baseline image

↓

Testing

Call plotting function on test arguments

↓

Convert Figure() to PNG image

↓

Compare
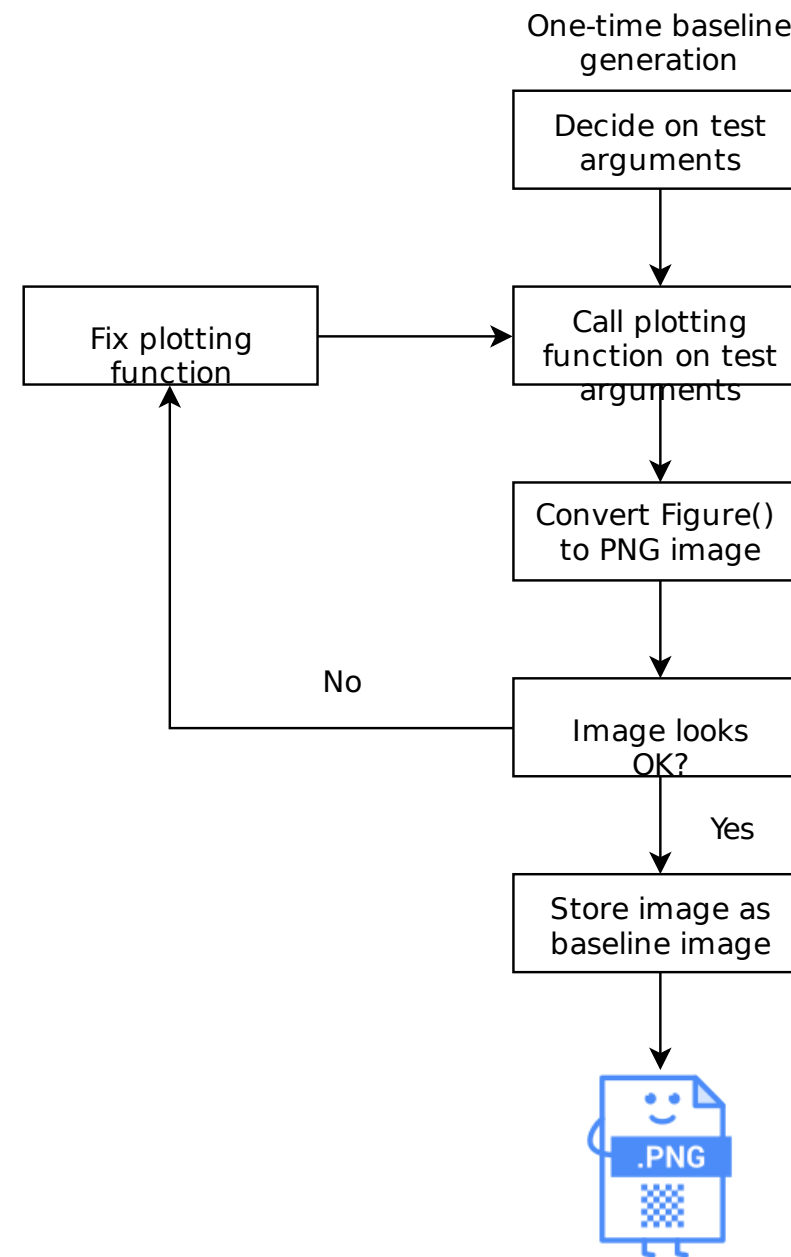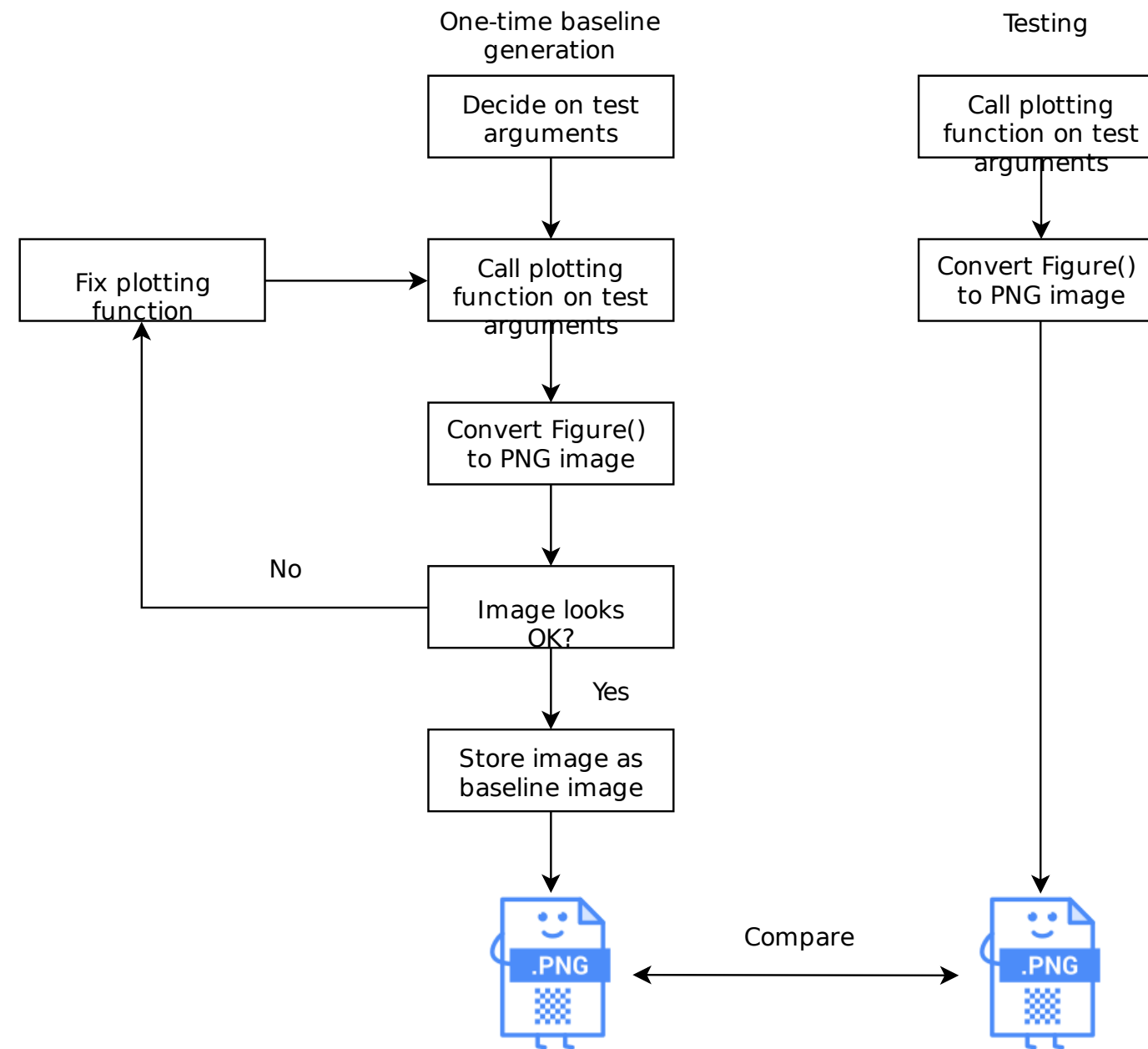
pytest-mpl

- Knows how to ignore OS related differences.

- Makes it easy to generate baseline images.

```
pip install pytest-mpl
```

An example test

```python
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

```python
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)
```
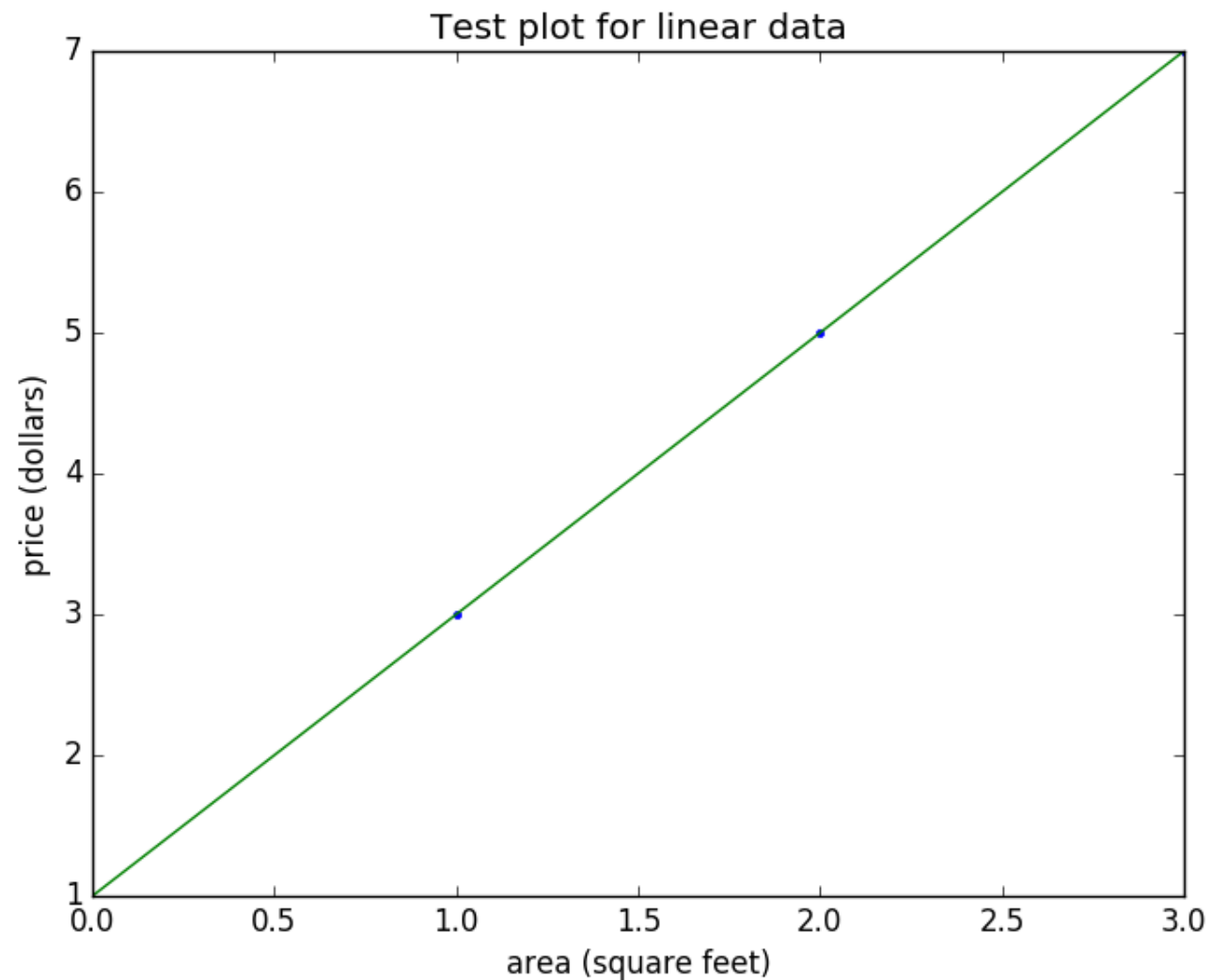
Generating the baseline image

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

Test plot for linear data

```
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/tmplcbtsb10/baseline-test_plot_for_linear_data.png
  Actual:
    /tmp/tmplcbtsb10/test_plot_for_linear_data.png
  Difference:
    /tmp/tmplcbtsb10/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

DataCamp

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
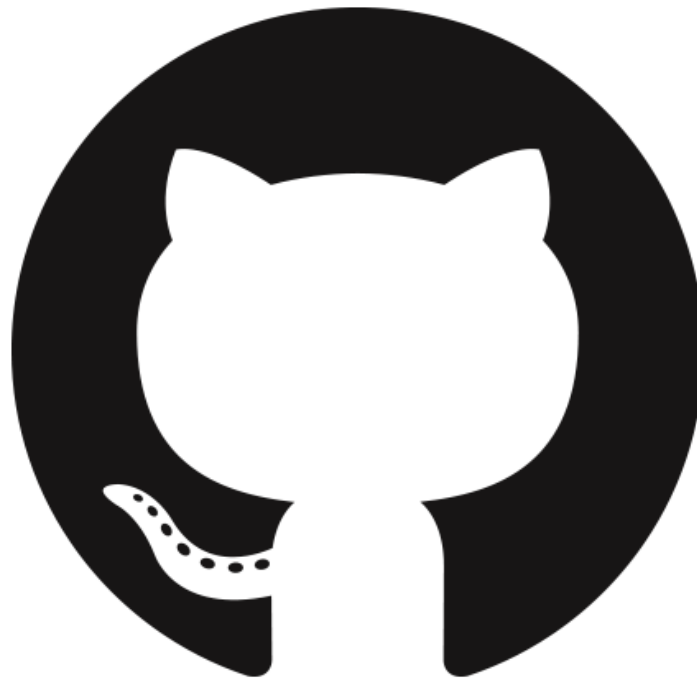
Icon sources

Icons made by the following authors from **flaticon.com**.

- Freepik

- Smashicons

- Vectors Market

- Kiranshastry

- Dimitry Miroliubov

- 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