

Why unit test?

UNIT TESTING FOR DATA SCIENCE IN PYTHON



Dibya Chakravorty
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How can we test an implementation?

```
def my_function(argument):  
    ...
```



```
my_function(argument_1)
```

```
return_value_1
```

```
my_function(argument_2)
```

```
return_value_2
```

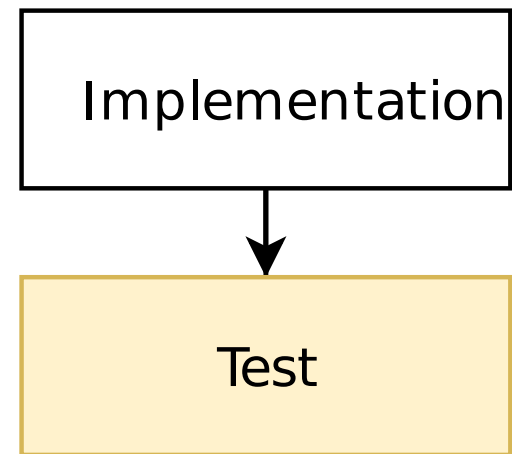
```
my_function(argument_3)
```

```
return_value_3
```

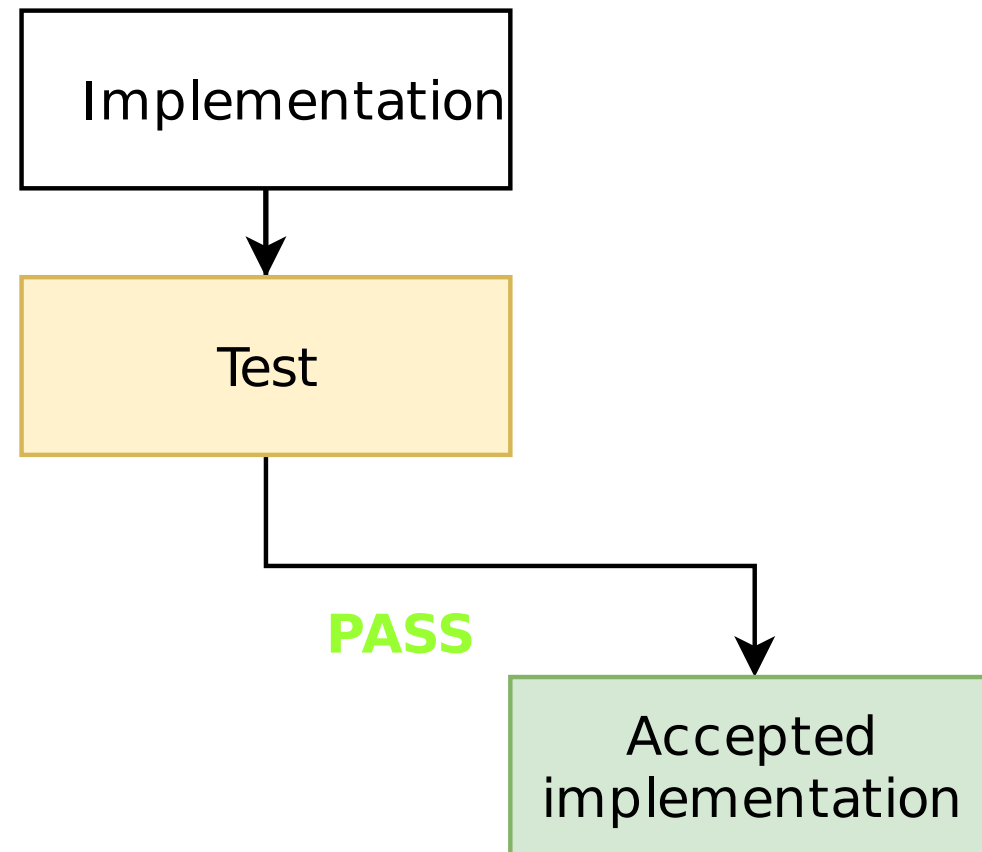
Life cycle of a function

Implementation

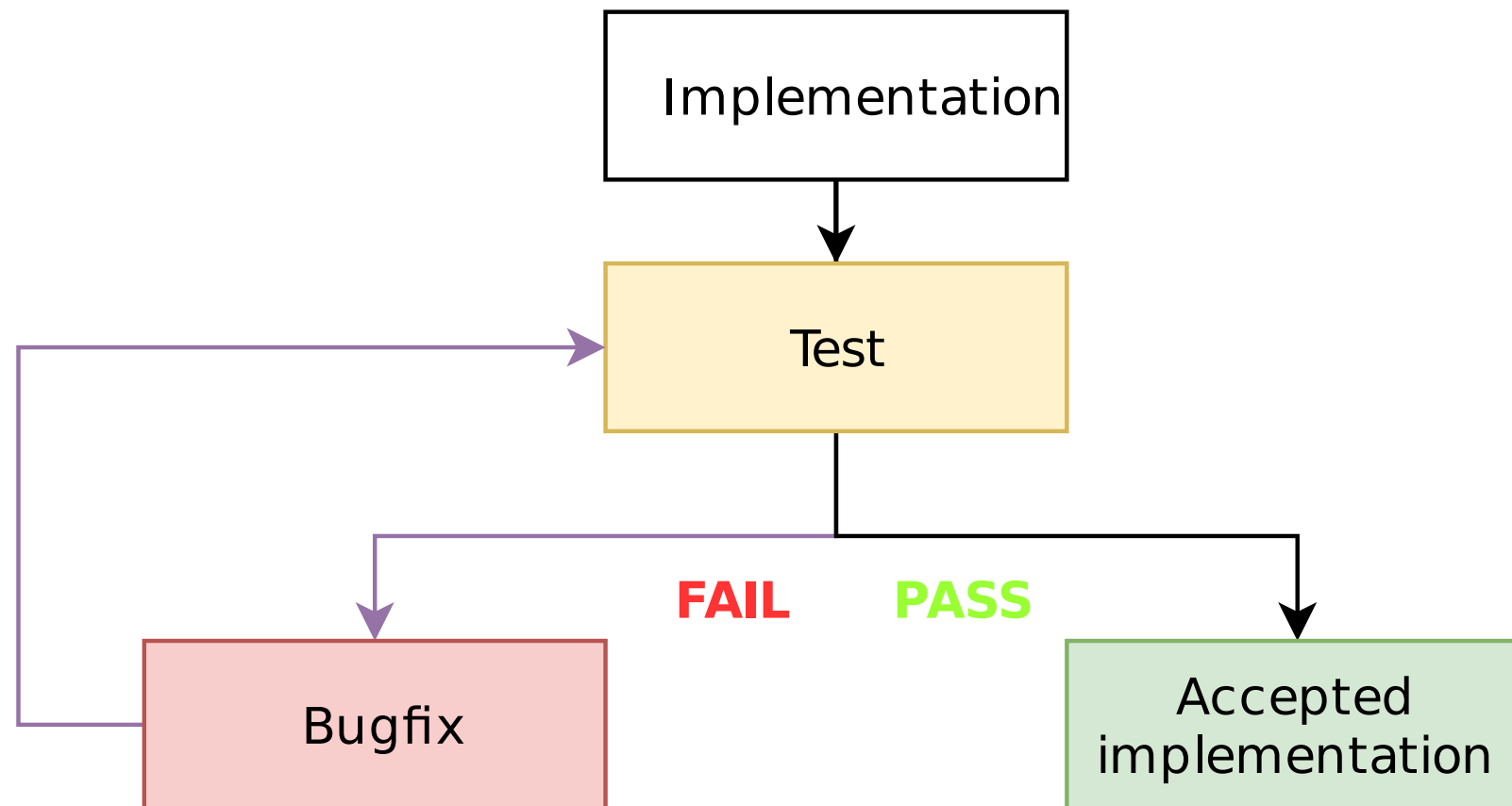
Life cycle of a function



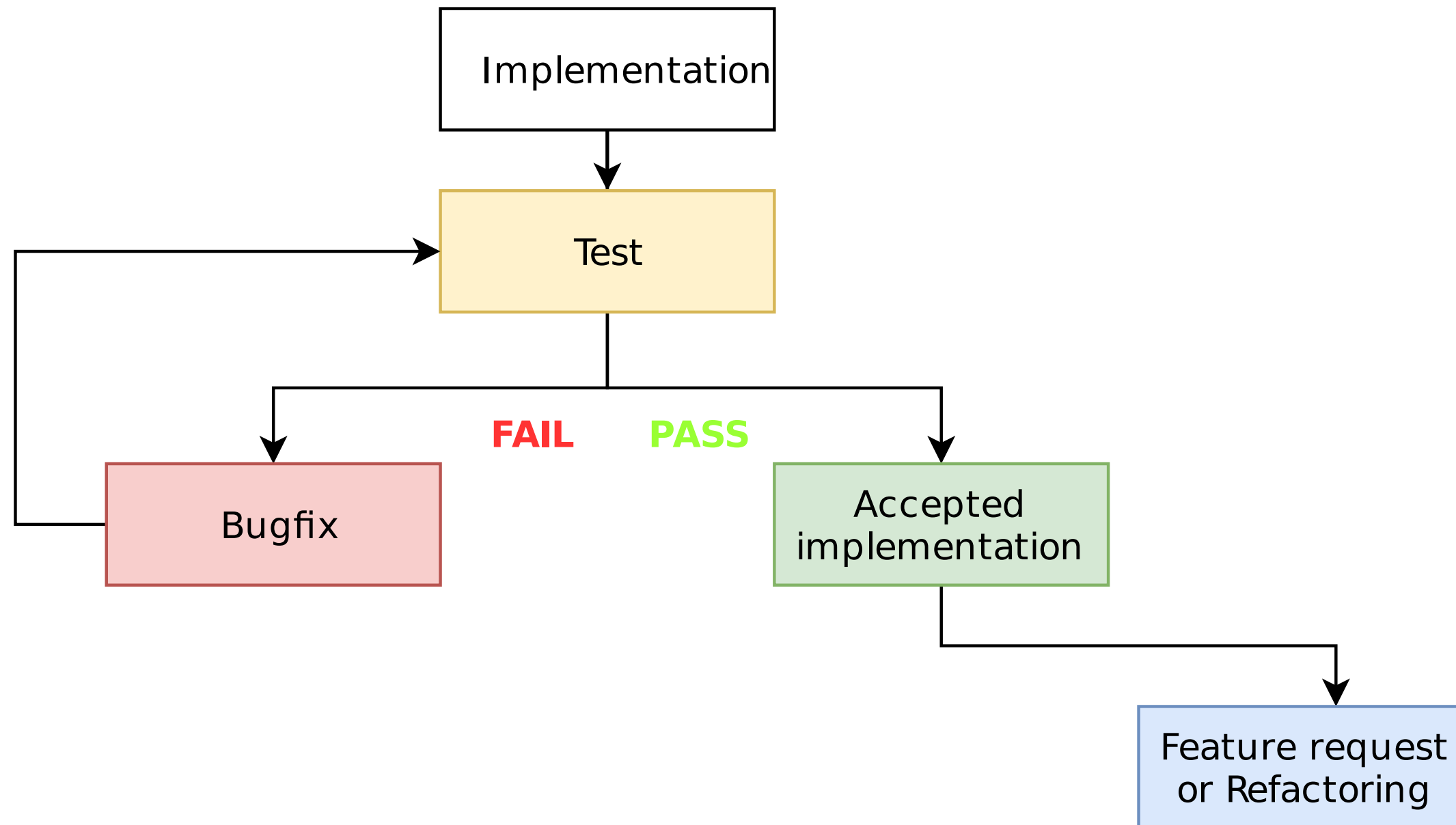
Life cycle of a function



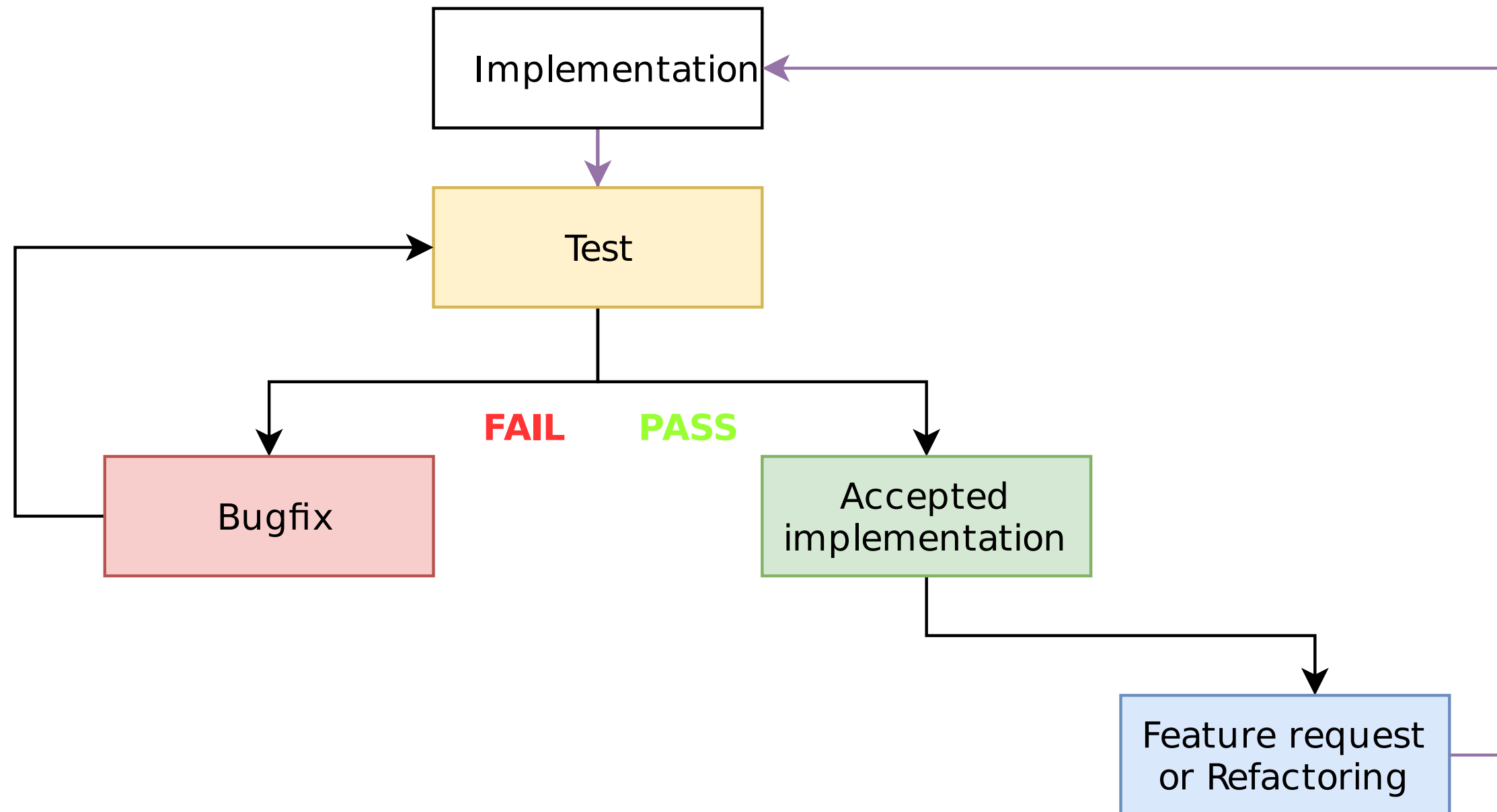
Life cycle of a function



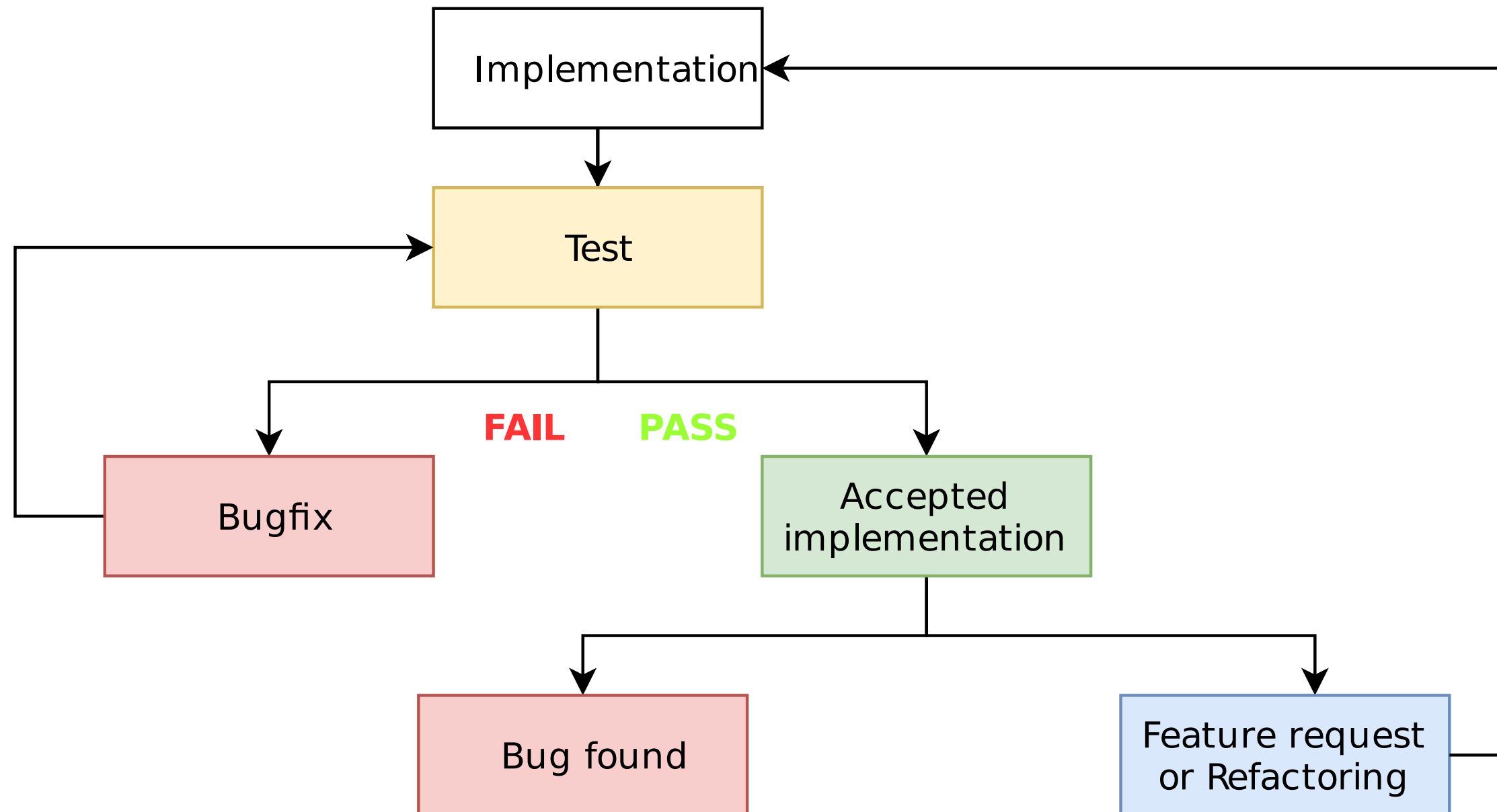
Life cycle of a function



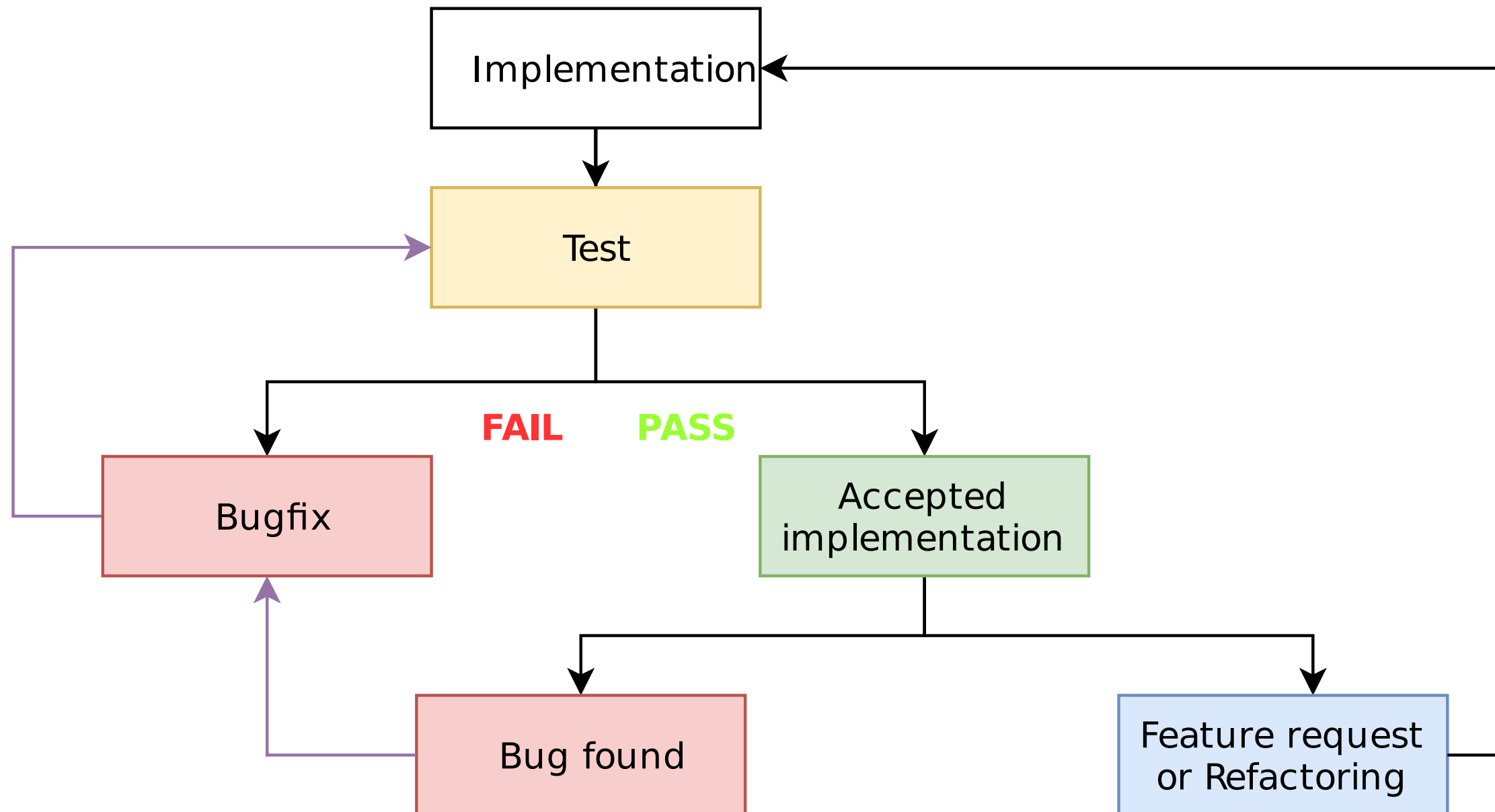
Life cycle of a function



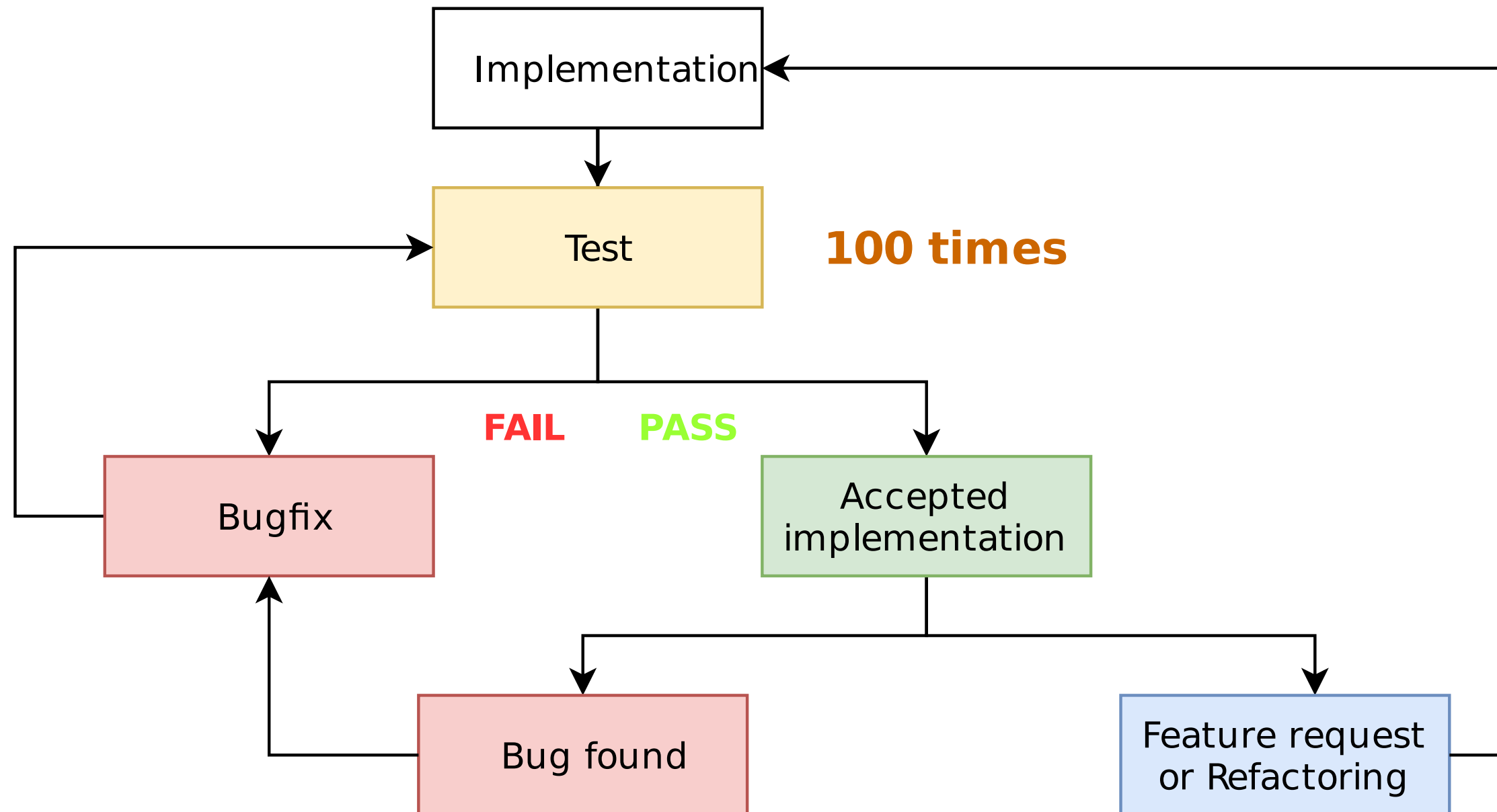
Life cycle of a function



Life cycle of a function



Life cycle of a function



Example

```
def row_to_list(row):  
    ...
```

```
area (sq. ft.)  price (dollars)  
2,081          314,942  
1,059          186,606  
                293,410  
1,148          206,186  
1,506          248,419  
1,210          214,114  
1,697          277,794  
1,268          194,345  
2,318          372,162  
1,463238,765  
1,468          239,007
```

File: housing_data.txt

Data format

```
def row_to_list(row):  
    ...
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081" "314,942"]

```
area (sq. ft.)  price (dollars)  
2,081          314,942  
1,059          186,606  
                293,410  
1,148          206,186  
1,506          248,419  
1,210          214,114  
1,697          277,794  
1,268          194,345  
2,318          372,162  
1,463238,765  
1,468          239,007
```

File: housing_data.txt

Data isn't clean

```
def row_to_list(row):  
    ...
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]
"\t293,410\n"	Invalid	None

```
area (sq. ft.)  price (dollars)  
2,081          314,942  
1,059          186,606  
                293,410    <-- row with missing area  
1,148          206,186  
1,506          248,419  
1,210          214,114  
1,697          277,794  
1,268          194,345  
2,318          372,162  
1,463238,765  
1,468          239,007
```

File: housing_data.txt

Data isn't clean

```
def row_to_list(row):  
    ...
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]
"\t293,410\n"	Invalid	None
"1,463238,765\n"	Invalid	None

```
area (sq. ft.)  price (dollars)  
2,081          314,942  
1,059          186,606  
                293,410      <-- row with missing area  
1,148          206,186  
1,506          248,419  
1,210          214,114  
1,697          277,794  
1,268          194,345  
2,318          372,162  
1,463238,765   <-- row with missing tab  
1,468          239,007
```

File: housing_data.txt

Time spent in testing this function

```
def row_to_list(row):  
    ...
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]
"\t293,410\n"	Invalid	None
"1,463238,765\n"	Invalid	None

```
row_to_list("2,081\t314,942\n")
```

```
["2,081", "314,942"]
```

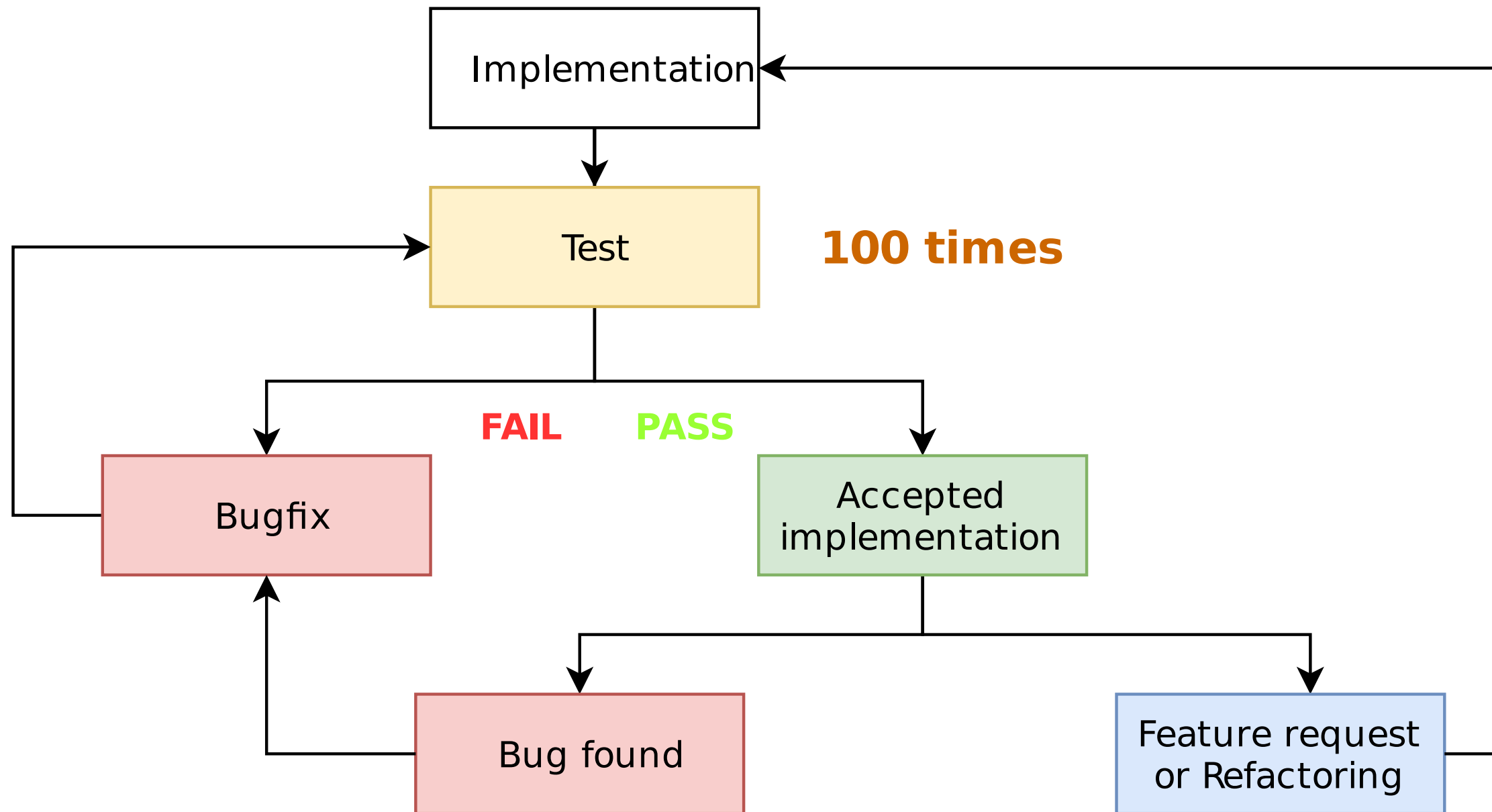
```
row_to_list("\t293,410\n")
```

```
None
```

```
row_to_list("1,463238,765\n")
```

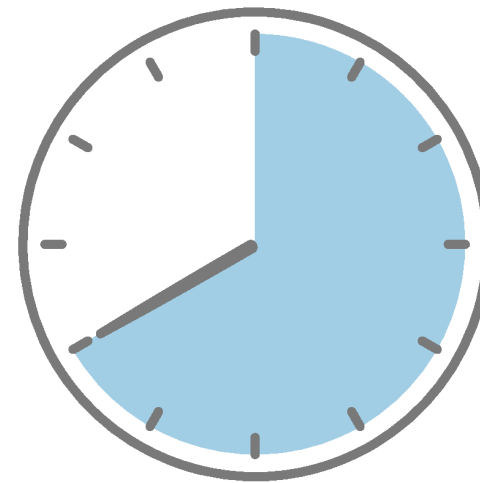
```
None
```


Time spent in testing this function



Time spent in testing this function

5 mins x 100 ~

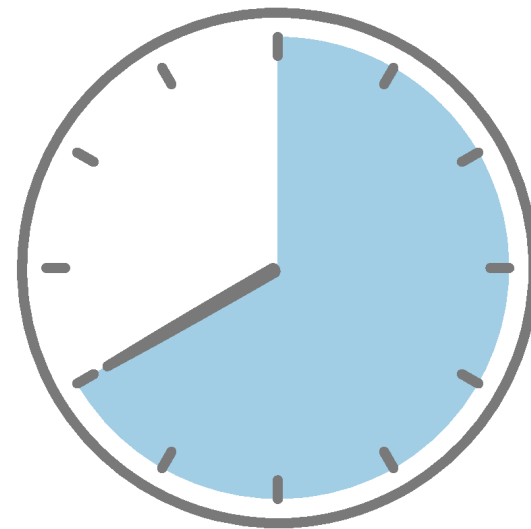


8 hours

Manual testing vs. unit tests

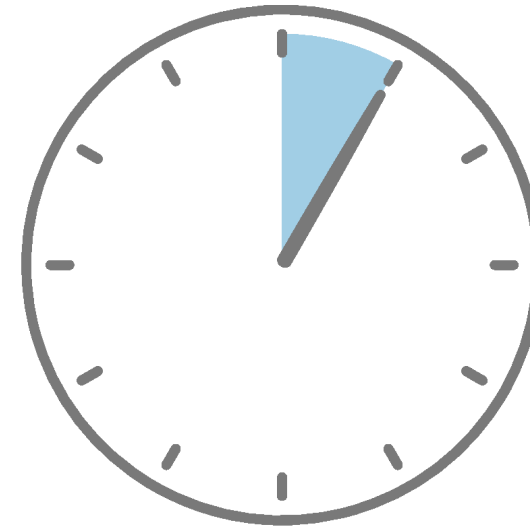
- Unit tests automate the repetitive testing process and saves time.

Manually testing on
the interpreter



8 hours

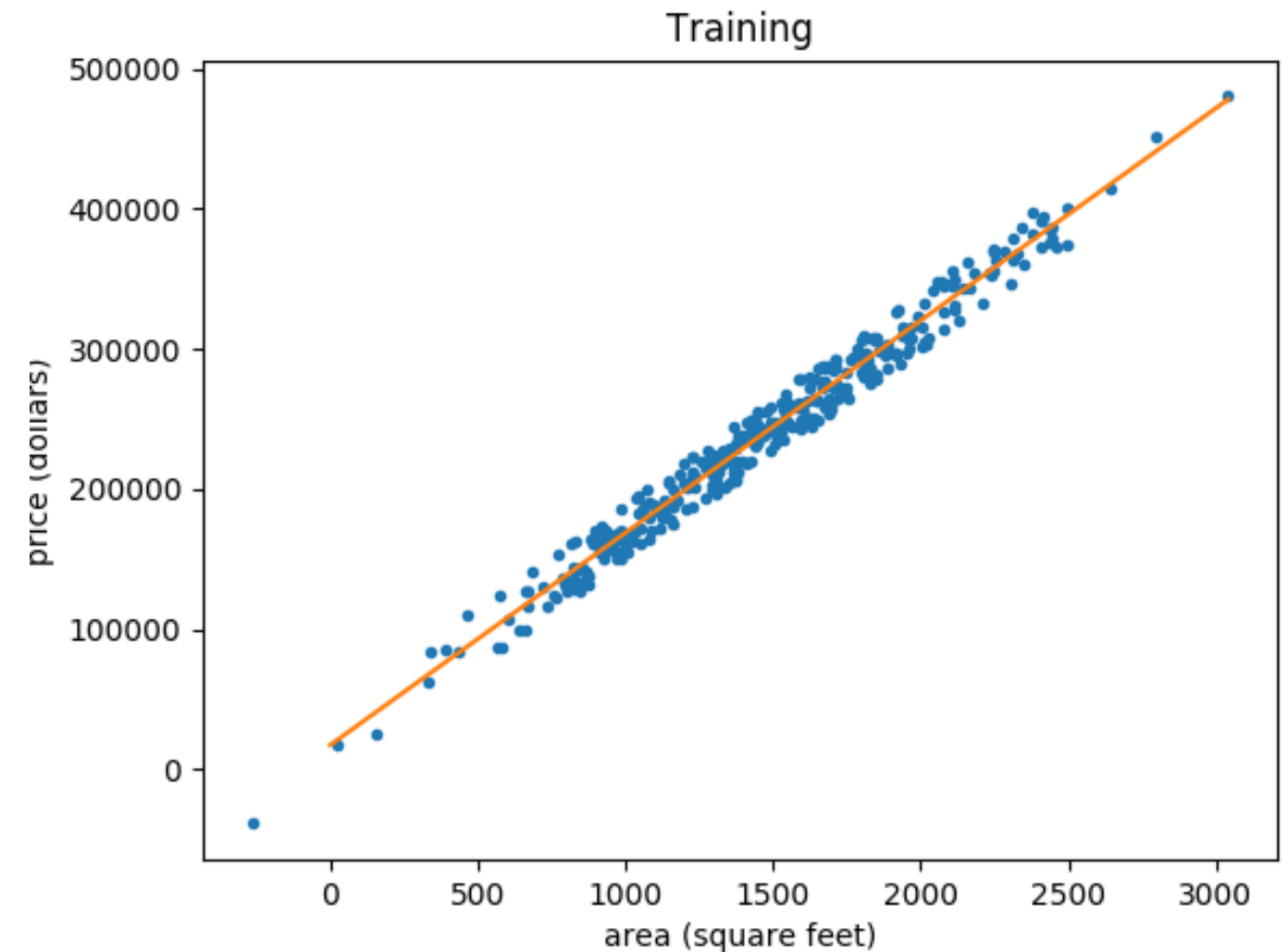
Unit tests



1 hour

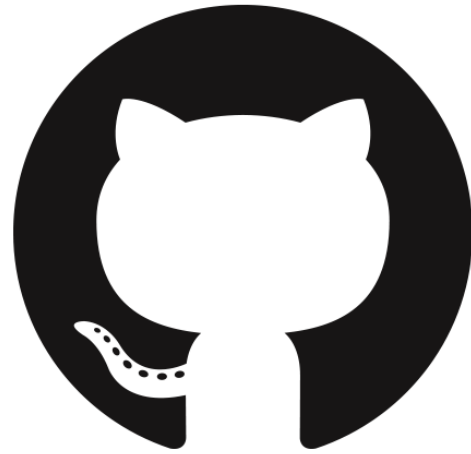
Learn unit testing - with a data science spin

area (sq. ft.)	price (dollars)
2,081	314,942
1,059	186,606
	293,410
1,148	206,186
1,506	248,419
1,210	214,114
1,697	277,794
1,268	194,345
2,318	372,162
1,463	238,765
1,468	239,007



Linear regression of housing price against area

GitHub repository of the course



- Implementation of functions like `row_to_list()` .

Develop a complete unit test suite

```
data/  
src/  
|-- data/  
|-- features/  
|-- models/  
|-- visualization/
```

Develop a complete unit test suite

```
data/  
src/  
|-- data/  
|-- features/  
|-- models/  
|-- visualization/  
tests/                                # Test suite  
|-- data/  
|-- features/  
|-- models/  
|-- visualization/
```

- Write unit tests for your own projects.

Let's practice these concepts!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Write a simple unit test using pytest

UNIT TESTING FOR DATA SCIENCE IN PYTHON



Dibya Chakravorty
Test Automation Engineer

Testing on the console

```
row_to_list("2,081\t314,942\n")
```

```
["2,081", "314,942"]
```

```
row_to_list("\t293,410\n")
```

```
None
```

```
row_to_list("1,463238,765\n")
```

```
None
```

- Unit tests improve this process.

Python unit testing libraries

- pytest
- unittest
- nosetests
- doctest

We will use pytest!

- Has all essential features.
- Easiest to use.
- **Most popular.**



Step 1: Create a file

- Create `test_row_to_list.py` .
- `test_` indicate unit tests inside (naming convention).
- Also called **test modules**.

Step 2: Imports

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list
```

Step 3: Unit tests are Python functions

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list

def test_for_clean_row():
```

Step 3: Unit tests are Python functions

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list

def test_for_clean_row():
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]

Step 4: Assertion

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list
```

```
def test_for_clean_row():
    assert ...
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]

Theoretical structure of an assertion

```
assert boolean_expression
```

```
assert True
```

```
assert False
```

```
Traceback (most recent call last):  
  File "<stdin>", line 1, in <module>  
AssertionError
```

Step 4: Assertion

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list

def test_for_clean_row():
    assert row_to_list("2,081\t314,942\n") == \
           ["2,081", "314,942"]
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]

A second unit test

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list

def test_for_clean_row():
    assert row_to_list("2,081\t314,942\n") == \
        ["2,081", "314,942"]

def test_for_missing_area():
    assert row_to_list("\t293,410\n") is None
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]
"\t293,410\n"	Invalid	None

Checking for None values

Do this for checking if `var` is `None` .

```
assert var is None
```

Do *not* do this.

```
assert var == None
```

A third unit test

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list

def test_for_clean_row():
    assert row_to_list("2,081\t314,942\n") == \
        ["2,081", "314,942"]

def test_for_missing_area():
    assert row_to_list("\t293,410\n") is None

def test_for_missing_tab():
    assert row_to_list("1,463238,765\n") is None
```

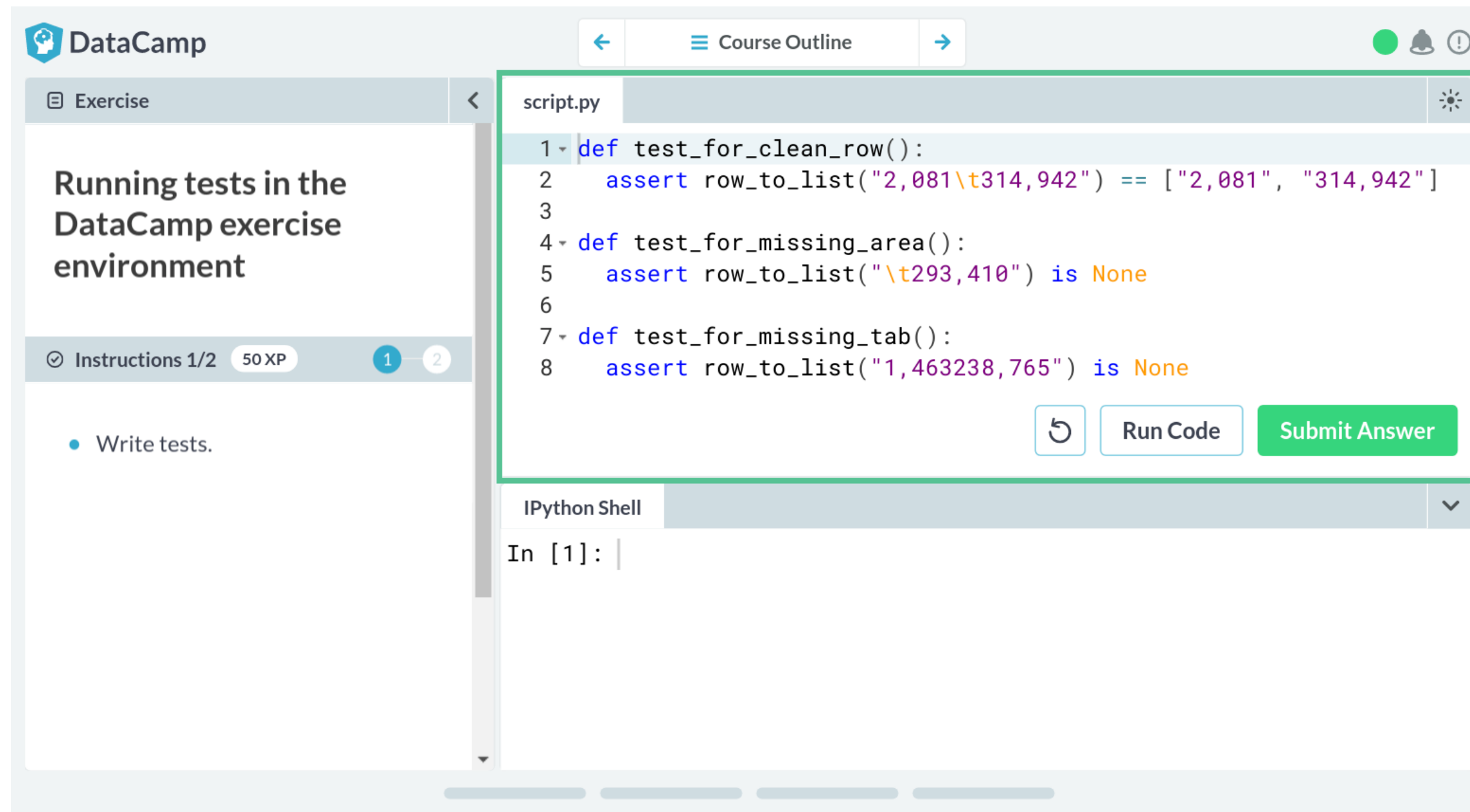
Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]
"\t293,410\n"	Invalid	None
"1,463238,765\n"	Invalid	None

Step 5: Running unit tests

- Do this in the command line.

```
pytest test_row_to_list.py
```

Running unit tests in DataCamp exercises



The screenshot shows the DataCamp exercise environment. On the left, the exercise title is "Running tests in the DataCamp exercise environment". Below the title, it shows "Instructions 1/2" and "50 XP". The first instruction is "Write tests." The main area on the right is a code editor for a file named "script.py". It contains three test functions: `test_for_clean_row()`, `test_for_missing_area()`, and `test_for_missing_tab()`. Each function uses `assert` to check the output of `row_to_list()`. Below the code editor are buttons for "Run Code" and "Submit Answer". At the bottom, there is an "IPython Shell" area with the prompt "In [1]: |".

DataCamp

Course Outline

Exercise

Running tests in the DataCamp exercise environment

Instructions 1/2 50 XP

- Write tests.

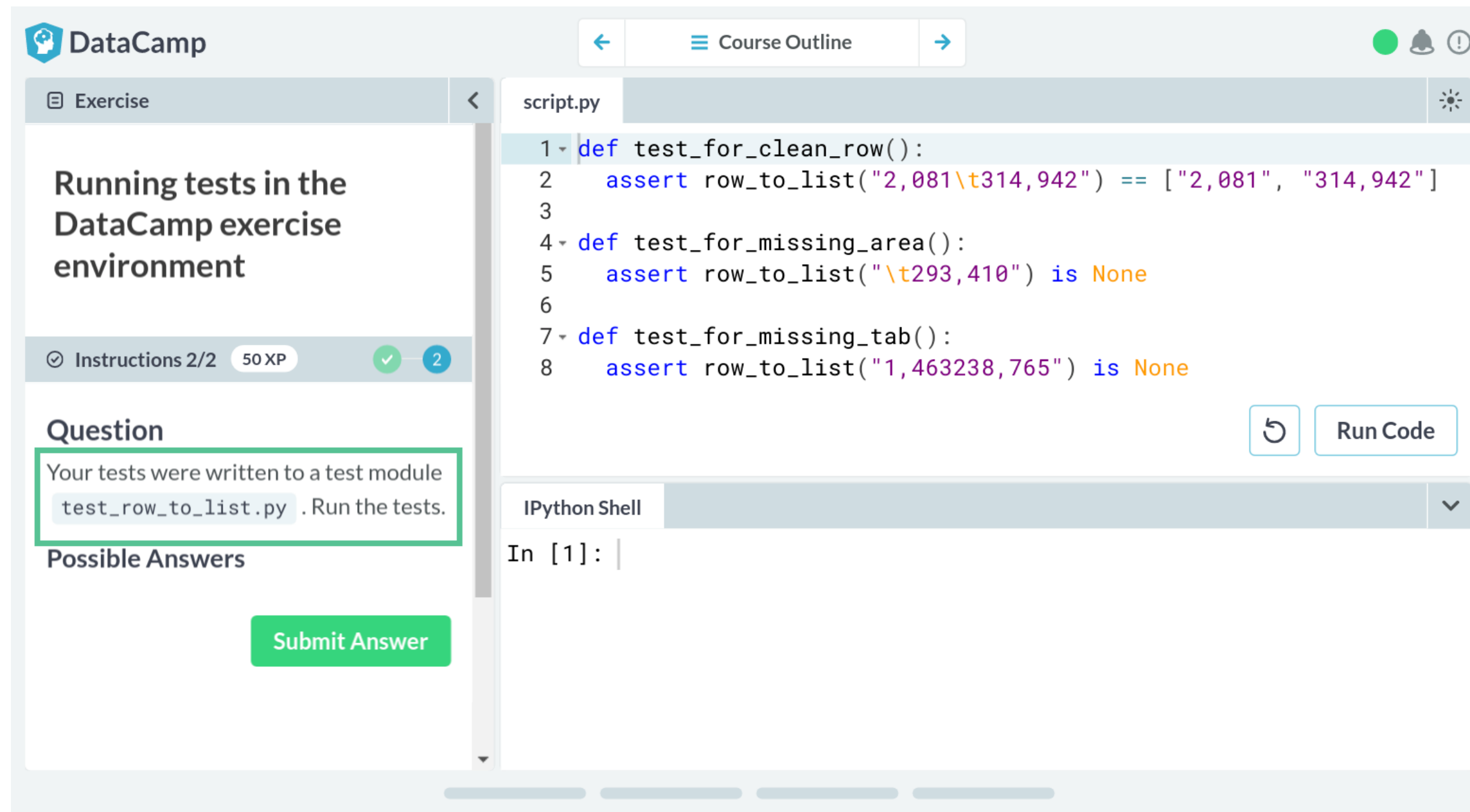
```
1 def test_for_clean_row():
2     assert row_to_list("2,081\t314,942") == ["2,081", "314,942"]
3
4 def test_for_missing_area():
5     assert row_to_list("\t293,410") is None
6
7 def test_for_missing_tab():
8     assert row_to_list("1,463238,765") is None
```

Run Code Submit Answer

IPython Shell

In [1]: |

Running unit tests in DataCamp exercises



The screenshot shows the DataCamp exercise interface. On the left, the 'Exercise' panel displays the title 'Running tests in the DataCamp exercise environment', progress 'Instructions 2/2' with '50 XP', and a 'Question' box stating: 'Your tests were written to a test module `test_row_to_list.py`. Run the tests.' Below the question is a 'Possible Answers' section with a green 'Submit Answer' button.

The main area on the right contains a code editor for 'script.py' with the following Python code:

```
1 def test_for_clean_row():
2     assert row_to_list("2,081\t314,942") == ["2,081", "314,942"]
3
4 def test_for_missing_area():
5     assert row_to_list("\t293,410") is None
6
7 def test_for_missing_tab():
8     assert row_to_list("1,463238,765") is None
```

Below the code editor is an 'IPython Shell' with the prompt 'In [1]: |'. To the right of the code editor are buttons for a refresh icon and 'Run Code'.

Running unit tests in DataCamp exercises

The screenshot shows the DataCamp exercise environment. On the left, the exercise title is "Running tests in the DataCamp exercise environment". Below it, the instructions section shows "Instructions 2/2" and "50 XP". The question section states: "Your tests were written to a test module `test_row_to_list.py`. Run the tests." Below the question is a "Possible Answers" section with a green "Submit Answer" button.

On the right, the code editor shows a file named `script.py` with the following Python code:

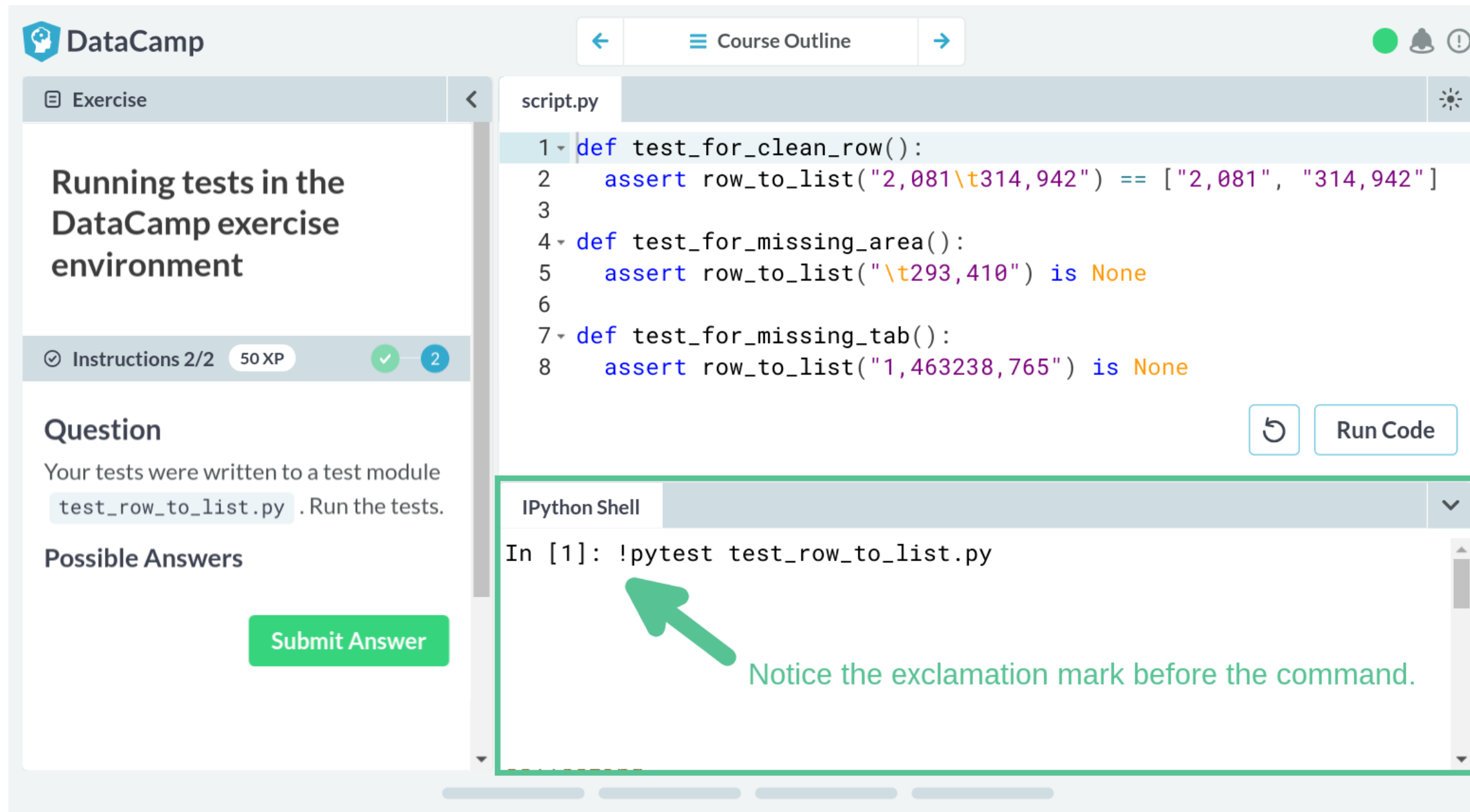
```
1 def test_for_clean_row():
2     assert row_to_list("2,081\t314,942") == ["2,081", "314,942"]
3
4 def test_for_missing_area():
5     assert row_to_list("\t293,410") is None
6
7 def test_for_missing_tab():
8     assert row_to_list("1,463238,765") is None
```

Below the code editor is an IPython Shell with the command:

```
In [1]: !pytest test_row_to_list.py
```

Buttons for "Run Code" and a refresh icon are located to the right of the code editor.

Running unit tests in DataCamp exercises



The screenshot shows the DataCamp exercise environment. On the left, the exercise title is "Running tests in the DataCamp exercise environment". Below it, the instructions section shows "Instructions 2/2" and "50 XP". The question section states: "Your tests were written to a test module `test_row_to_list.py`. Run the tests." Below the question, there is a "Possible Answers" section with a "Submit Answer" button.

On the right, the code editor shows a file named `script.py` with the following Python code:


```
1 def test_for_clean_row():
2     assert row_to_list("2,081\t314,942") == ["2,081", "314,942"]
3
4 def test_for_missing_area():
5     assert row_to_list("\t293,410") is None
6
7 def test_for_missing_tab():
8     assert row_to_list("1,463238,765") is None
```

Below the code editor is the IPython Shell. It contains the command:

```
In [1]: !pytest test_row_to_list.py
```

A green arrow points to the exclamation mark in the command, with the text "Notice the exclamation mark before the command." next to it.

Next lesson: test result report

 DataCamp

Exercise

Running tests in the DataCamp exercise environment

Instructions 2/2 50 XP

Question

Your tests were written to a test module `test_row_to_list.py`. Run the tests.

Possible Answers

Submit Answer

script.py

```
1 def test_for_clean_row():
2     assert row_to_list("2,081\t314,942") == ["2,081", "314,942"]
3
4 def test_for_missing_area():
5     assert row_to_list("\t293,410") is None
6
7 def test_for_missing_tab():
8     assert row_to_list("1,463238,765") is None
```

↶

Run Code

IPython Shell

```
In [1]: !pytest test_row_to_list.py
===== test session starts
=====
platform linux -- Python 3.6.7, pytest-4.0.1, py-1.8.0, pluggy-0.9
.0
rootdir: /tmp/tmpf4bvxdw_, inifile:
plugins: mock-1.10.0
collecting
```

Let's write some unit tests!

UNIT TESTING FOR DATA SCIENCE IN PYTHON

Understanding test result report

UNIT TESTING FOR DATA SCIENCE IN PYTHON



Dibya Chakravorty
Test Automation Engineer

Unit tests for row_to_list()

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list

def test_for_clean_row():
    assert row_to_list("2,081\t314,942\n") == \
        ["2,081", "314,942"]

def test_for_missing_area():
    assert row_to_list("\t293,410\n") is None

def test_for_missing_tab():
    assert row_to_list("1,463238,765\n") is None
```

Argument	Type	Return value
"2,081\t314,942\n"	Valid	["2,081", "314,942"]
"\t293,410\n"	Invalid	None
"1,463238,765\n"	Invalid	None

Test result report

```
!pytest test_row_to_list.py
```

```
===== test session starts =====
platform linux -- Python 3.6.7, pytest-4.0.1, py-1.8.0, pluggy-0.9.0
rootdir: /tmp/tmpvdb1q9g7, inifile:
plugins: mock-1.10.0
collecting ...
collected 3 items

test_row_to_list.py .F.                                     [100%]

===== FAILURES =====
----- test_for_missing_area -----

def test_for_missing_area():
```

Section 1: general information

```
===== test session starts =====  
platform linux -- Python 3.6.7, pytest-4.0.1, py-1.8.0, pluggy-0.9.0  
rootdir: /tmp/tmpvdblq9g7, inifile:  
plugins: mock-1.10.0
```


Section 2: Test result

```
collecting ...  
collected 3 items
```

```
test_row_to_list.py .F.
```

```
[100%]
```

Section 2: Test result

```
collecting ...  
collected 3 items
```

```
test_row_to_list.py .F. [100%]
```

Character	Meaning	When	Action
F	Failure	An exception is raised when running unit test.	Fix the function or unit test.

Section 2: Test result

```
collecting ...  
collected 3 items
```

```
test_row_to_list.py .F. [100%]
```

Character	Meaning	When	Action
F	Failure	An exception is raised when running unit test.	Fix the function or unit test.

- assertion raises `AssertionError`

```
def test_for_missing_area():  
    assert row_to_list("\t293,410") is None    # AssertionError from this line
```

Section 2: Test result

```
collecting ...  
collected 3 items
```

```
test_row_to_list.py .F. [100%]
```

Character	Meaning	When	Action
F	Failure	An exception is raised when running unit test.	Fix the function or unit test.

- another exception

```
def test_for_missing_area():  
    assert row_to_list("\t293,410") is none    # NameError from this line
```

Section 2: Test result

```
collecting ...  
collected 3 items
```

```
test_row_to_list.py .F. [100%]
```

Character	Meaning	When	Action
F	Failure	An exception is raised when running unit test.	Fix the function or unit test.
.	Passed	No exception raised when running unit test	Everything is fine. Be happy!

Section 3: Information on failed tests

```
===== FAILURES =====
----- test_for_missing_area -----

def test_for_missing_area():
>     assert row_to_list("\t293,410\n") is None
E     AssertionError: assert ['', '293,410'] is None
E     + where ['', '293,410'] = row_to_list('\t293,410\n')

test_row_to_list.py:7: AssertionError
```

- The line raising the exception is marked by `>`.

```
>     assert row_to_list("\t293,410\n") is None
```

Section 3: Information on failed tests

```
===== FAILURES =====
----- test_for_missing_area -----

def test_for_missing_area():
>     assert row_to_list("\t293,410\n") is None
E     AssertionError: assert ['', '293,410'] is None
E     + where ['', '293,410'] = row_to_list('\t293,410\n')

test_row_to_list.py:7: AssertionError
```

- the exception is an `AssertionError` .

```
E     AssertionError: assert ['', '293,410'] is None
```

Section 3: Information about failed tests

```
===== FAILURES =====
----- test_for_missing_area -----

def test_for_missing_area():
>     assert row_to_list("\t293,410\n") is None
E     AssertionError: assert ['', '293,410'] is None
E     + where ['', '293,410'] = row_to_list('\t293,410\n')

test_row_to_list.py:7: AssertionError
```

- the line containing `where` displays return values.

```
E     + where ['', '293,410'] = row_to_list('\t293,410\n')
```


Section 4: Test result summary

```
===== 1 failed, 2 passed in 0.03 seconds =====
```

- Result summary from all unit tests that ran: **1 failed, 2 passed tests.**
- Total time for running tests: **0.03 seconds.**
 - Much faster than testing on the interpreter!

Let's practice reading test result reports

UNIT TESTING FOR DATA SCIENCE IN PYTHON

More benefits and test types

UNIT TESTING FOR DATA SCIENCE IN PYTHON



Dibya Chakravorty
Test Automation Engineer

Unit tests serve as documentation

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list

def test_for_clean_row():
    assert row_to_list("2,081\t314,942\n") == \
        ["2,081", "314,942"]

def test_for_missing_area():
    assert row_to_list("\t293,410\n") is None

def test_for_missing_tab():
    assert row_to_list("1,463238,765\n") is None
```

Unit tests serve as documentation

Test module: `test_row_to_list.py`

```
import pytest
import row_to_list

def test_for_clean_row():
    assert row_to_list("2,081\t314,942\n") == \
        ["2,081", "314,942"]

def test_for_missing_area():
    assert row_to_list("\t293,410\n") is None

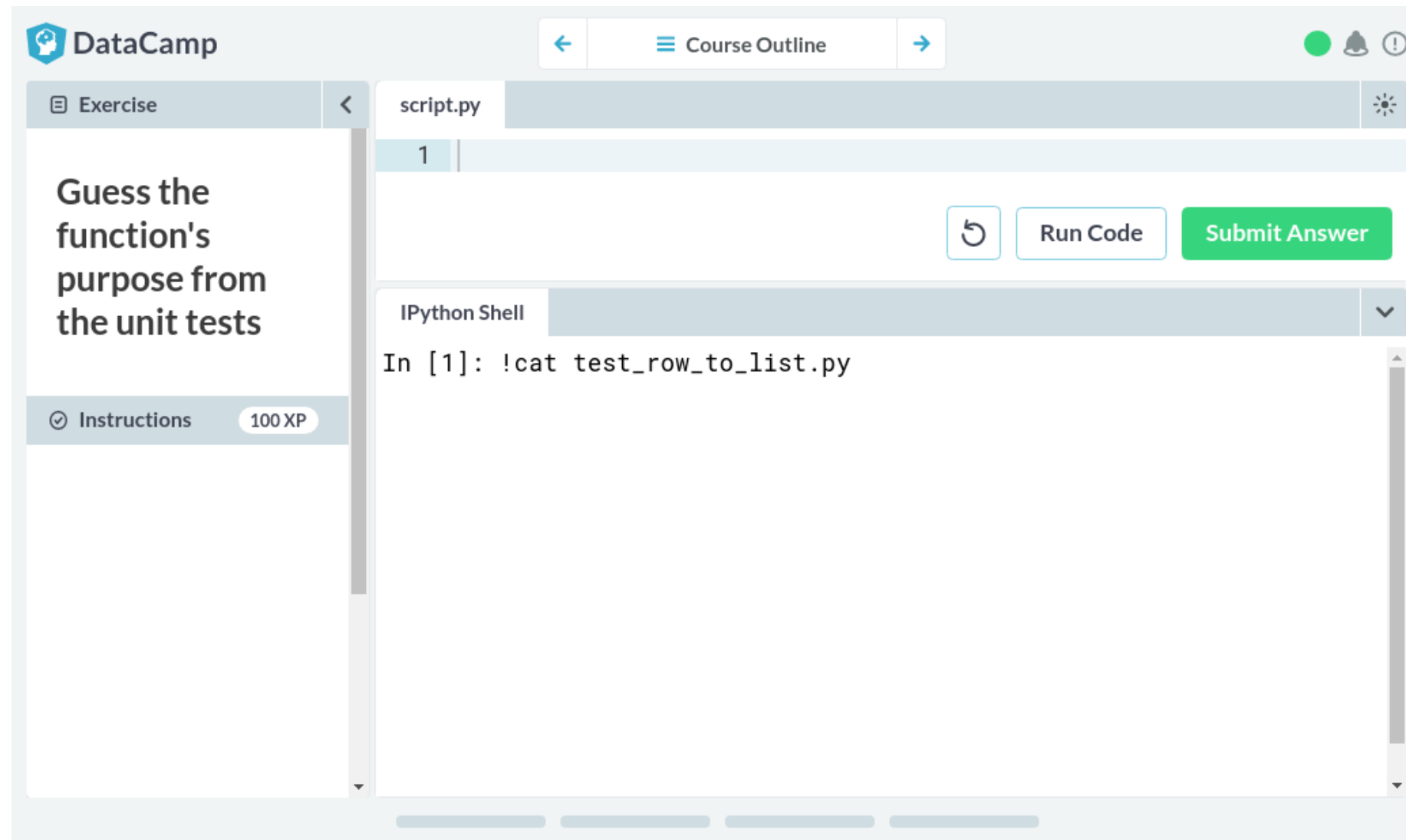
def test_for_missing_tab():
    assert row_to_list("1,463238,765\n") is None
```

- Created from the test module

Argument	Return value
"2,081\t314,942\n"	["2,081", "314,942"]
"\t293,410\n"	None
"1,463238,765\n"	None

Guess function's purpose by reading unit tests

```
!cat test_row_to_list.py
```



The screenshot shows the DataCamp exercise interface. On the left, the exercise title is "Guess the function's purpose from the unit tests" with a "100 XP" badge. The main area is a terminal window titled "script.py" showing the command `!cat test_row_to_list.py` entered in the IPython Shell. The terminal also displays a "Run Code" button and a "Submit Answer" button. The interface includes a "Course Outline" link at the top and a "DataCamp" logo in the top left corner.

Guess function's purpose by reading unit tests

```
!cat test_row_to_list.py
```

DataCamp

Exercise

Guess the function's purpose from the unit tests

Instructions 100 XP

script.py

```
1
```

Run Code Submit Answer

IPython Shell

```
In [1]: !cat test_row_to_list.py

import pytest
import row_to_list

def test_for_clean_row():
    assert row_to_list("2,081\t314,942\n") == ["2,081", "314,942"]


def test_for_missing_area():
    assert row_to_list("\t293,410\n") == None

def test_for_missing_tab():
    assert row_to_list("1,463238,765\n") == None
```

More trust

- Users can run tests and verify that the package works.



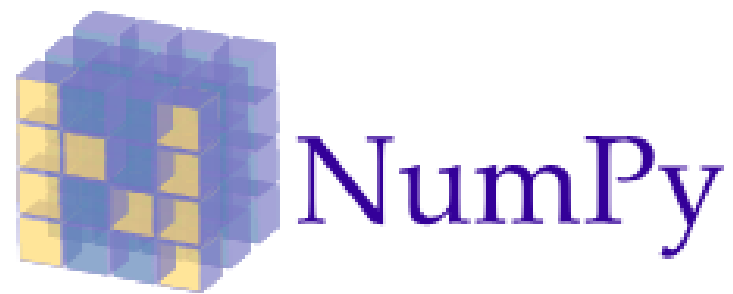
Travis CI **passing** AppVeyor **passing**  Azure Pipelines **succeeded**  codecov **85%**

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

- **Website (including documentation):** <https://www.numpy.org>

More trust

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Travis CI passing

AppVeyor passing

Azure Pipelines succeeded

codecov 85%

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More trust

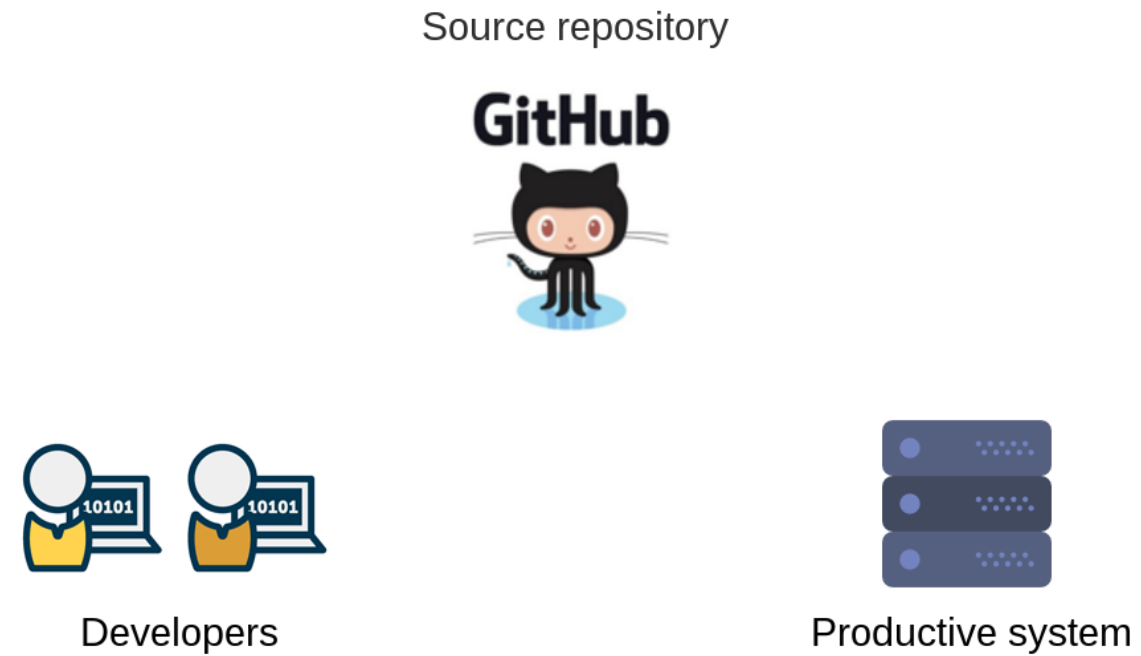
- Users can run tests and verify that the package works.



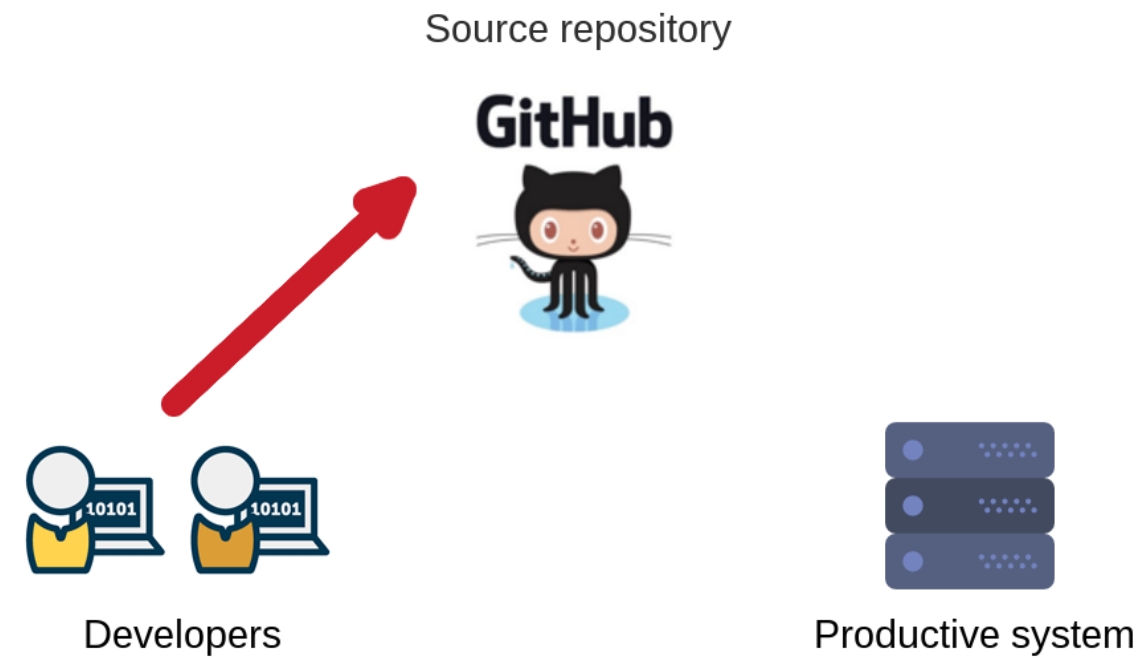
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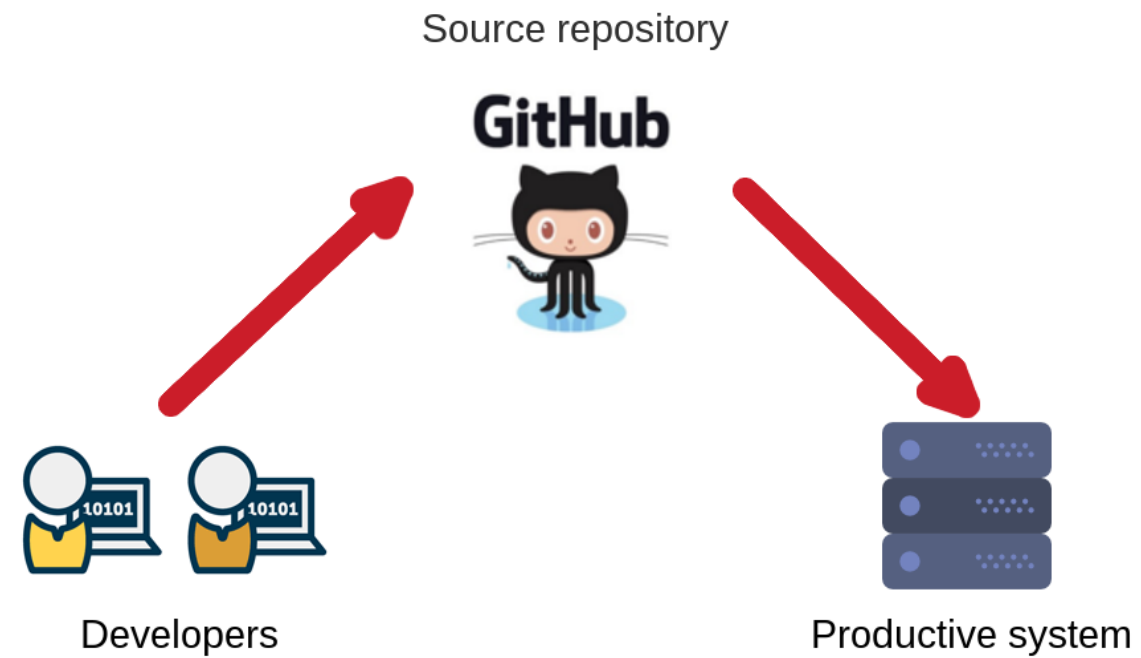
Reduced downtime



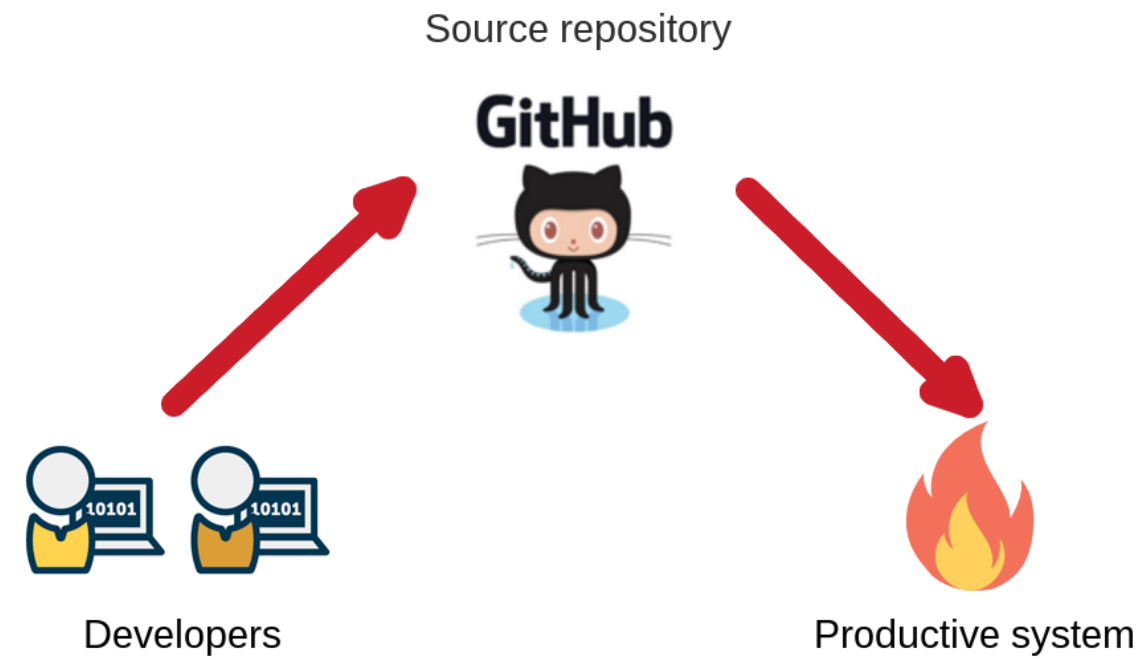
Reduced downtime



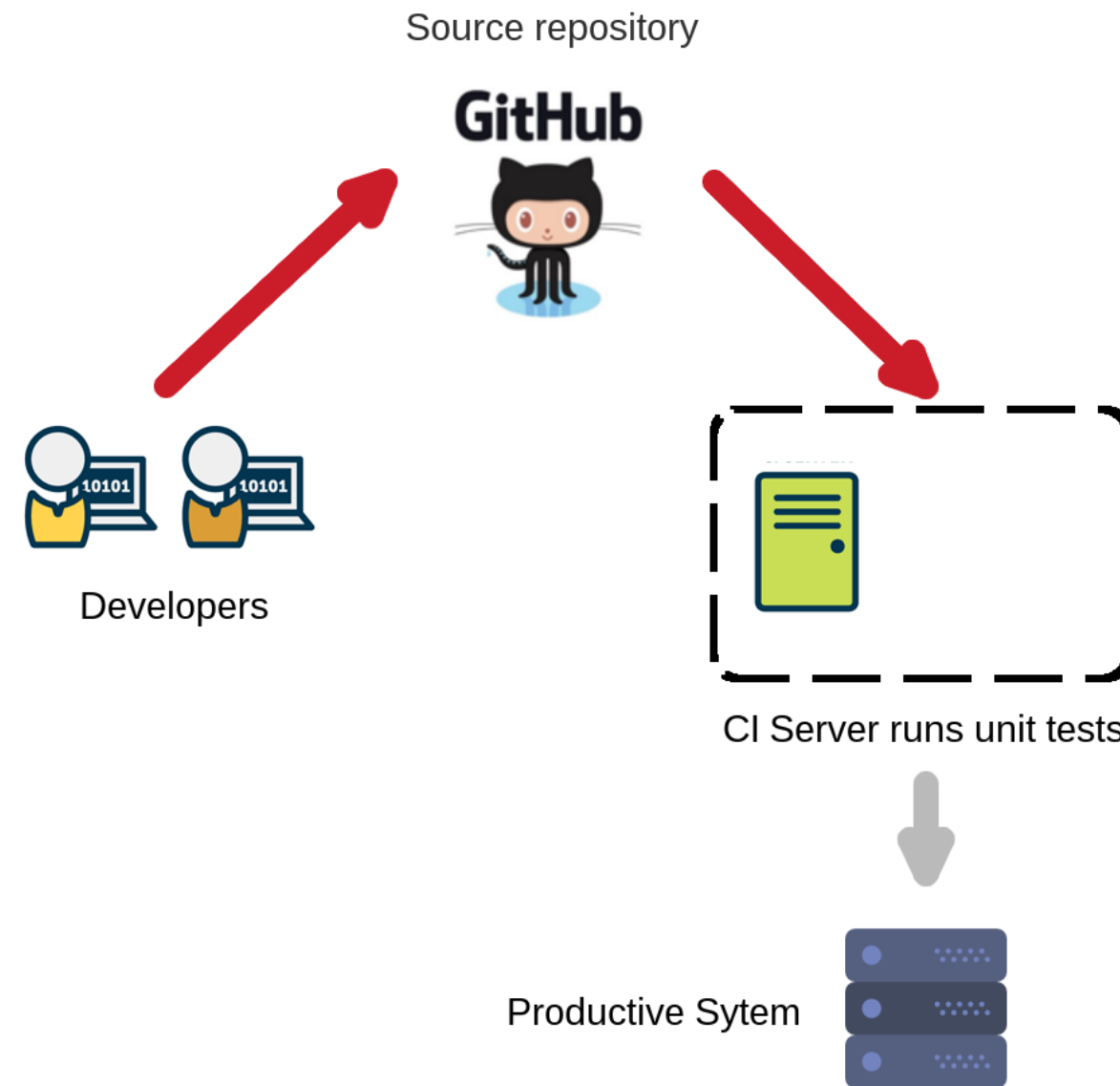
Reduced downtime



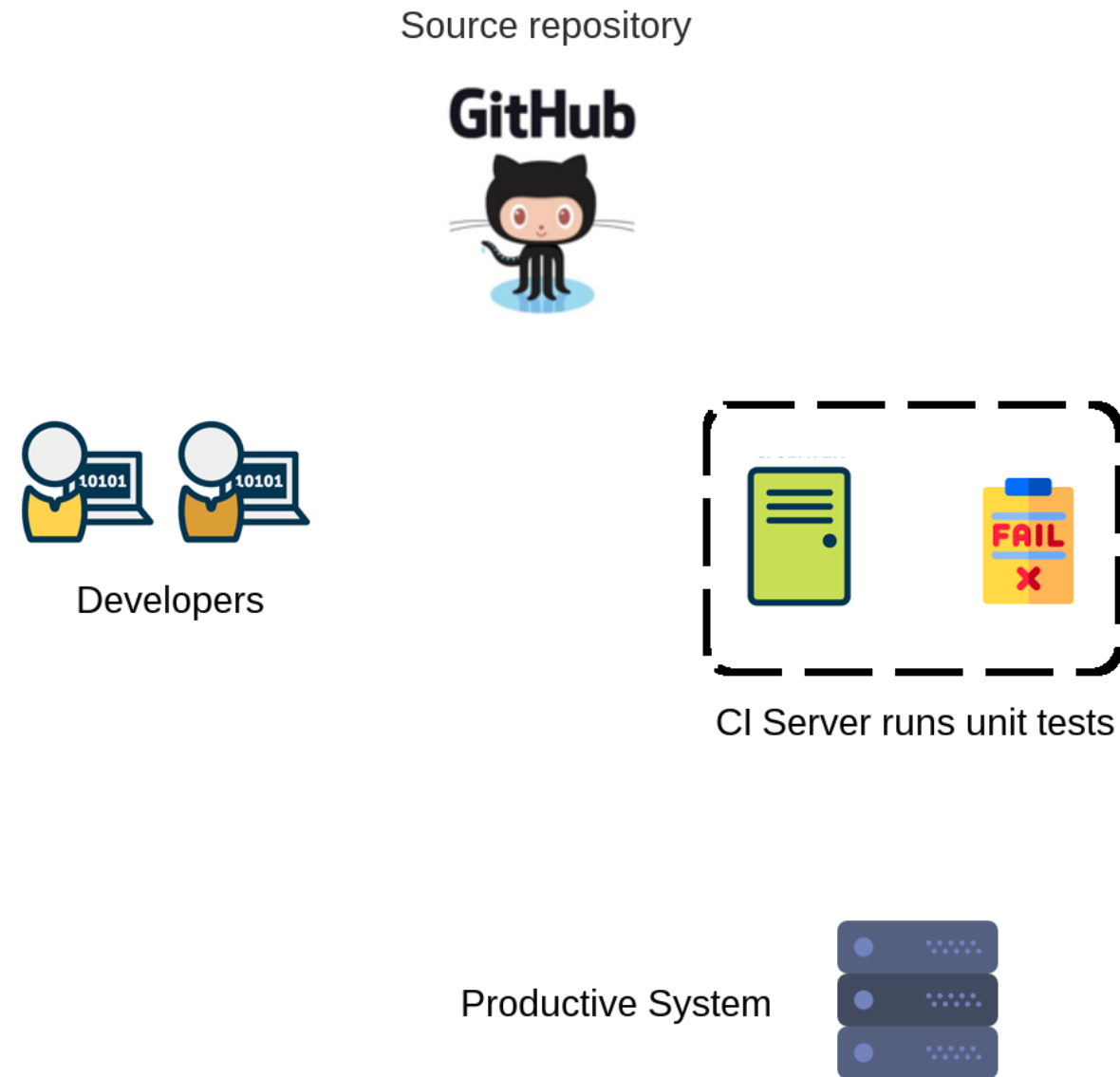
Reduced downtime



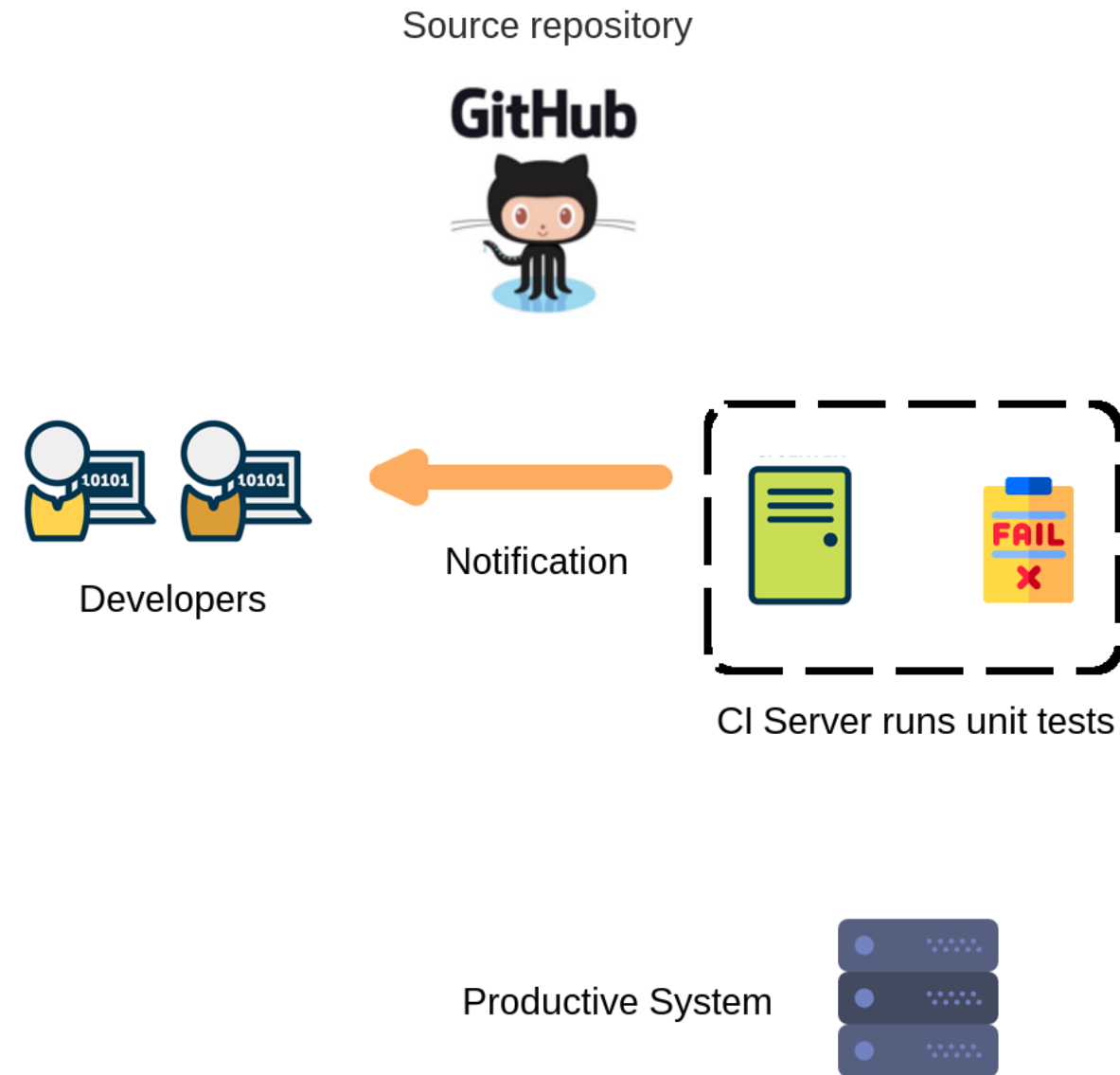
Reduced downtime



Reduced downtime



Reduced downtime



All benefits

- Time savings.
- Improved documentation.
- More trust.
- Reduced downtime.

Tests we already wrote

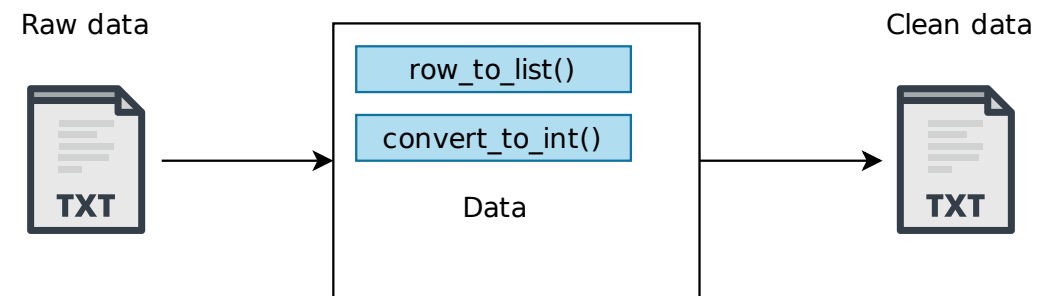
```
row_to_list()
```

Tests we already wrote

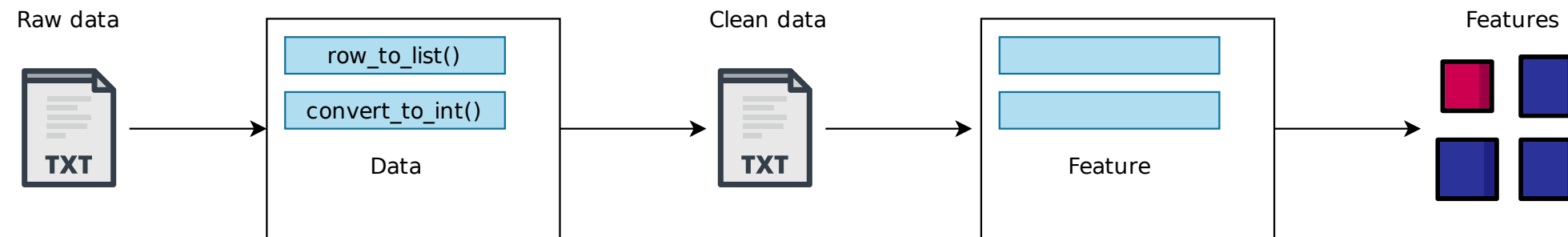
```
row_to_list()
```

```
convert_to_int()
```

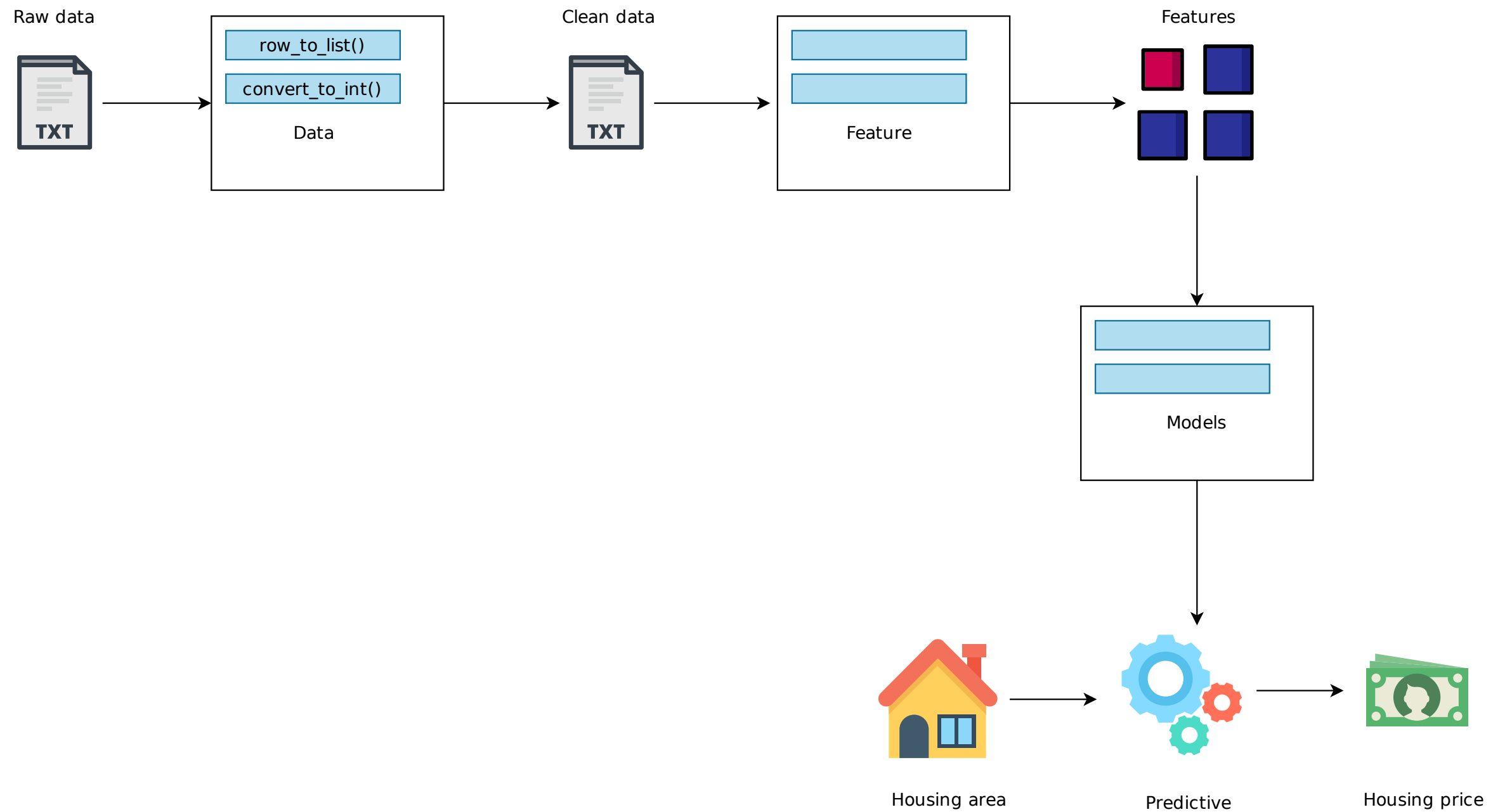
Data module



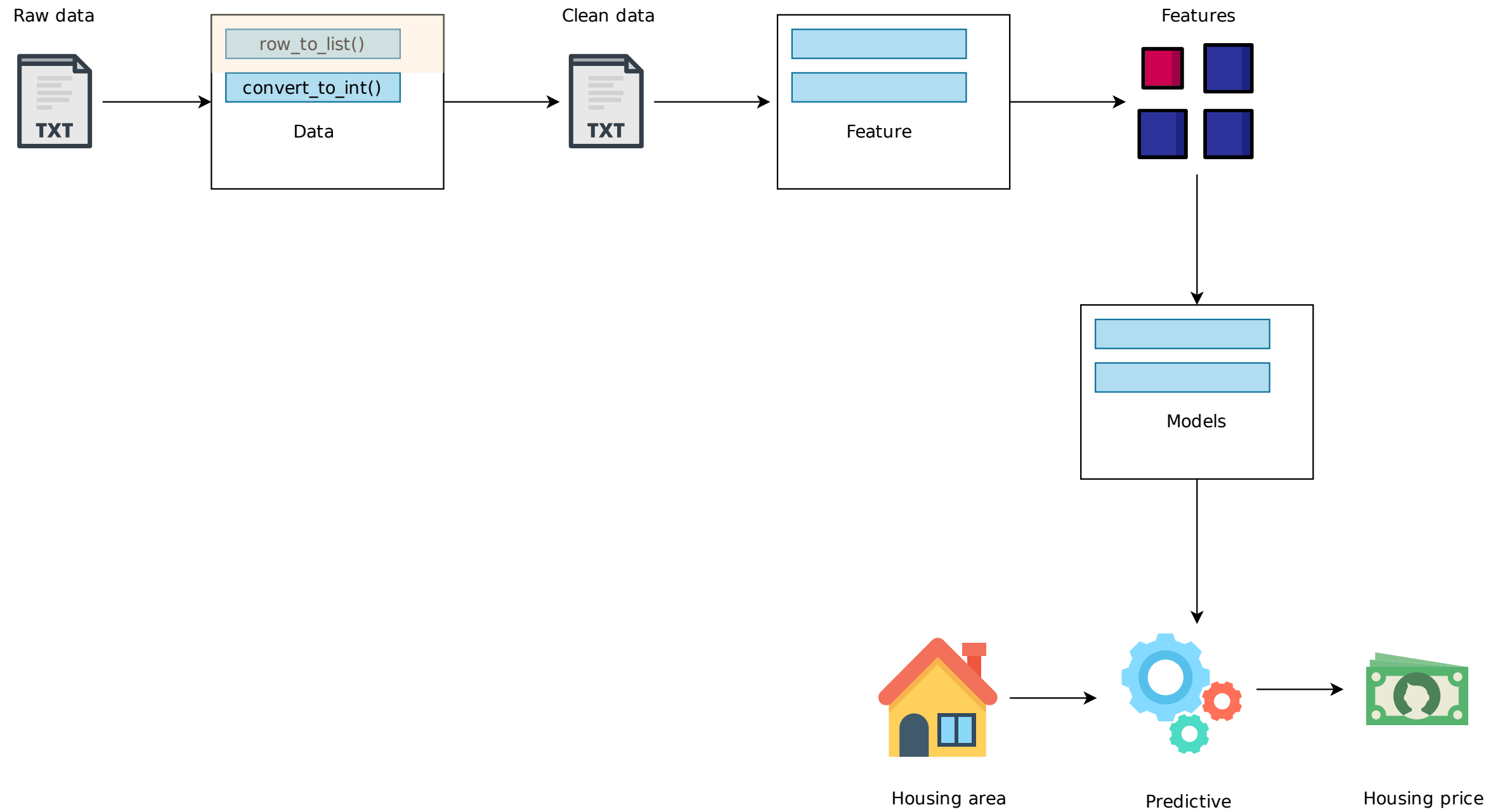
Feature module



Models module



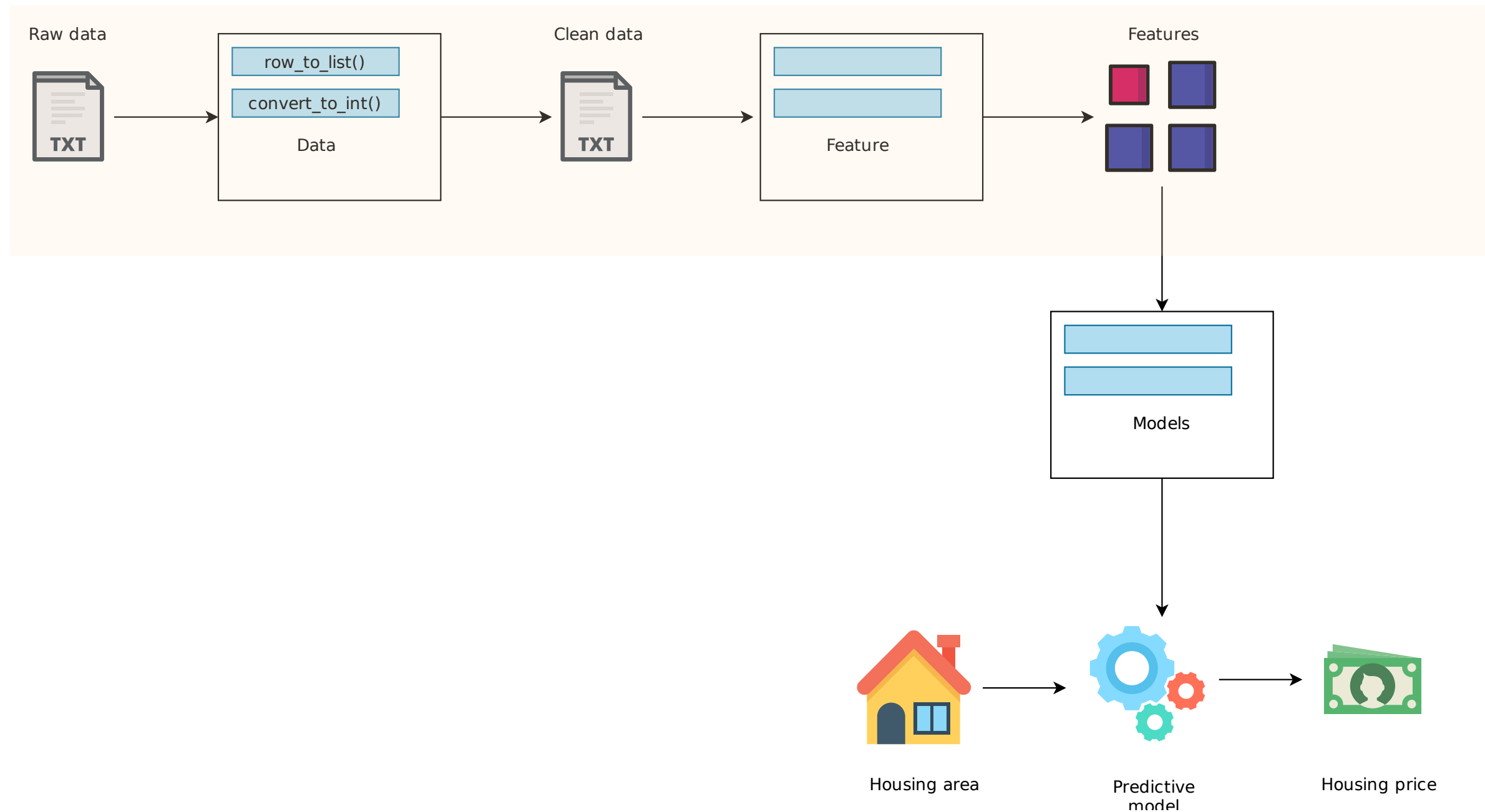
Unit test



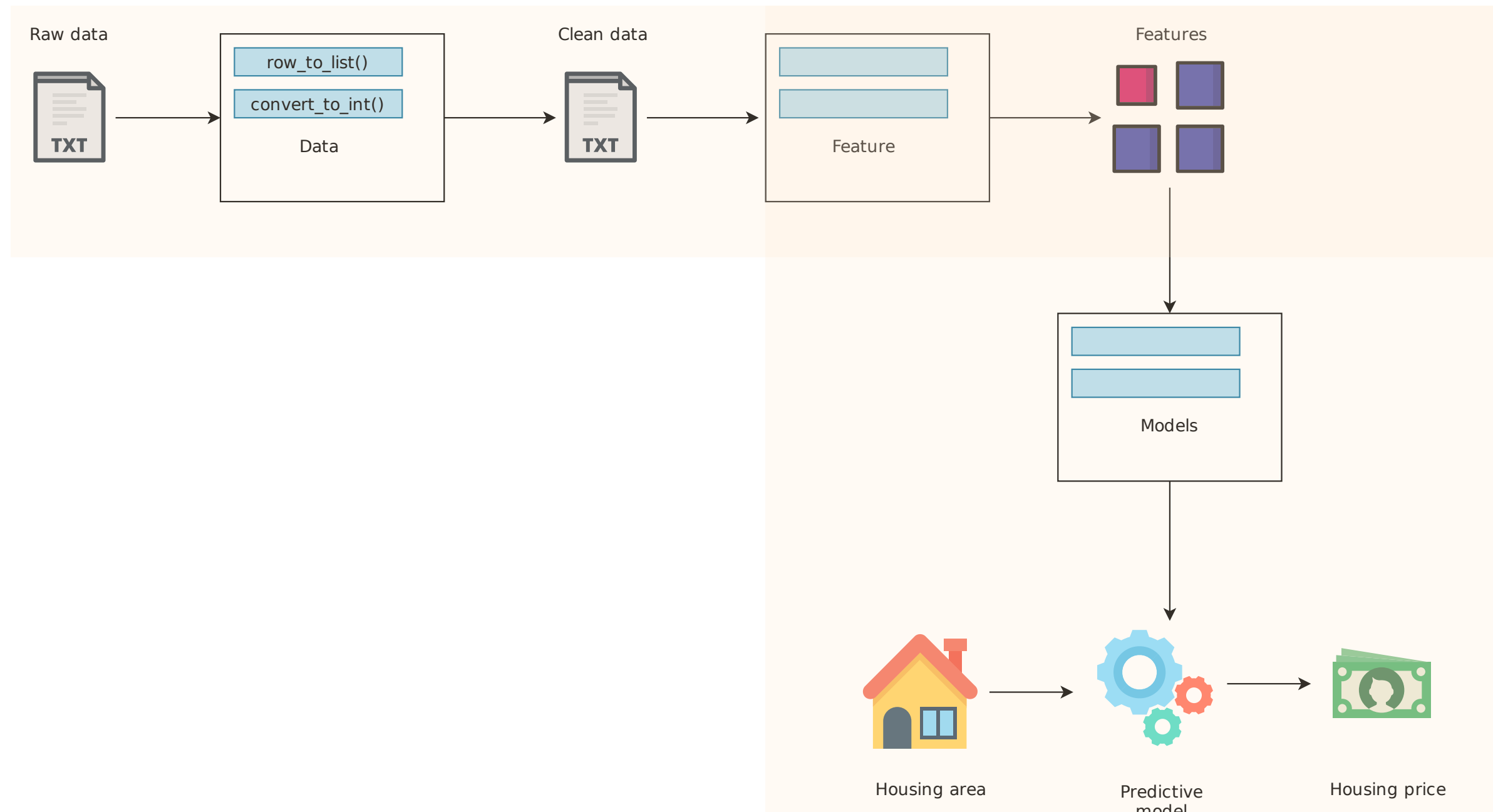
What is a unit?

- Small, independent piece of code.
- Python function or class.

Integration test



End to end test



This course focuses on unit tests

- Writing unit tests is the best way to learn pytest.

In Chapter 2...

- Learn more pytest.
- Write more advanced unit tests.
- Work with functions in the `features` and `models` modules.



Let's practice these concepts!

UNIT TESTING FOR DATA SCIENCE IN PYTHON