Introduction to testing in Python

INTRODUCTION TO TESTING IN PYTHON

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Why is testing so important?

Common problems:

- Bugs and errors
- Hardware failures
- Unexpected or unpredictable behavior

All of the problems might lead to significant **expenses** increase for the **fixing** purposes.

Testing helps to:

- Identify defects, bugs, and errors
- Reduce risks of software failures
- Enhance reliability, functionality, and performance of the software

What is testing?

- **Testing** - a process of evaluating a system or software
- We need testing to ensure it meets specified requirements
- **Test** - a procedure to verify the correctness of a software application or system

Course prerequisites

- Advanced Python programming
- `assert` statements
- Decorators
- OOP Concepts (classes, methods, inheritance)

Testing in real life

Think of airplanes:

- Visual inspection
- Electronics and mechanics check
- Fuel check
- Passengers check
- Weather check
- Permission to take off from air traffic controller

All of the above - are **tests**! And we need them for **safety.**

Assert in Python

- `assert condition` - lets to test if `condition` is `True`.
- If `condition` is `False`, Python will raise an `AssertionError`.

Testing with pytest - a simple example

`pytest` - a popular testing framework in Python, which provides a simple way to write tests.

Example of an "assert" test written with `pytest` in Python:

```
import pytest

# A function to test
def squared(number):
    return number * number

# A test function always starts with "test"
def test_squared():
    assert squared(-2) == squared(2)
```

Context managers recap

- **Context manager** - a Python object that is used by declaring a `with` statement
- We use **context managers** to set up and tear down temporary context

```
# Writing to file example
with open("hello_world.txt", 'w') as hello_file:
    hello_file.write("Hello world \n")
```

Meet the pytest: raises

`pytest.raises` - when you expect the test to raise an `Exception`

```
import pytest

# A function to test
def division(a, b):
    return a / b

# A test function
def test_raises():
    with pytest.raises(ZeroDivisionError):
        division(a=25, b=0)
```

Summary

Testing is:

- A process of evaluating, that software works as expected
- Present in everyday life
- Essential to tackle the challenges of the software development process
- Helps to ensure that the problems are addressed properly

Tests implementation:

- `pytest` - a powerful Python framework, that simplifies the testing process
- `assert` - a Python keyword, used in `pytest` for creating basic tests by validating a condition
- `pytest.raises` - a context manager, used to create a test that is expected to result in

Let's practice!

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Invoking pytest from CLI

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Example CLI run: syntax

Command-Line Interface (CLI) - a user interface that allows to interact with a computer program by entering text commands into a terminal.

The command for running the `slides.py` from **CLI**:

```
pytest slides.py
```

Meaning: "Please, run the `pytest` framework using the tests from the `slides.py` module"

Example CLI run: output

Output of a test:

```
PS
============================================================ test session starts ============================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10 w
armup=False warmup_iterations=100000)
rootdir:
plugins: benchmark-4.0.0
collected 3 items

slides.py ...                                                                                                                      [100%]

============================================================= 3 passed in 0.01s =============================================================
PS
```

Example CLI run: output

Output of a test:

- **Modules versions**

```
PS
============================================================ test session starts ============================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10 w
armup=False warmup_iterations=100000)
rootdir:
plugins: benchmark-4.0.0
collected 3 items

slides.py ...                                                                                                                      [100%]

============================================================= 3 passed in 0.01s =============================================================
PS
```

Example CLI run: output

Output of a test:

- **Number of "collected" tests**

```
PS [redacted]
============================================================ test session starts ============================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10 w
armup=False warmup_iterations=100000)
rootdir: [redacted]
plugins: benchmark-4.0.0
collected 3 items

slides.py ...                                                                                                                      [100%]

============================================================ 3 passed in 0.01s =============================================================
PS [redacted]
```

Example CLI run: output

Output of a test:

- **Names of test scripts**

```
PS
============================================================ test session starts ============================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10
armup=False warmup_iterations=100000)
rootdir:
plugins: benchmark-4.0.0
collected 3 items

slides.py ...                                                                                                                      [100%]

============================================================ 3 passed in 0.01s =============================================================
PS
```

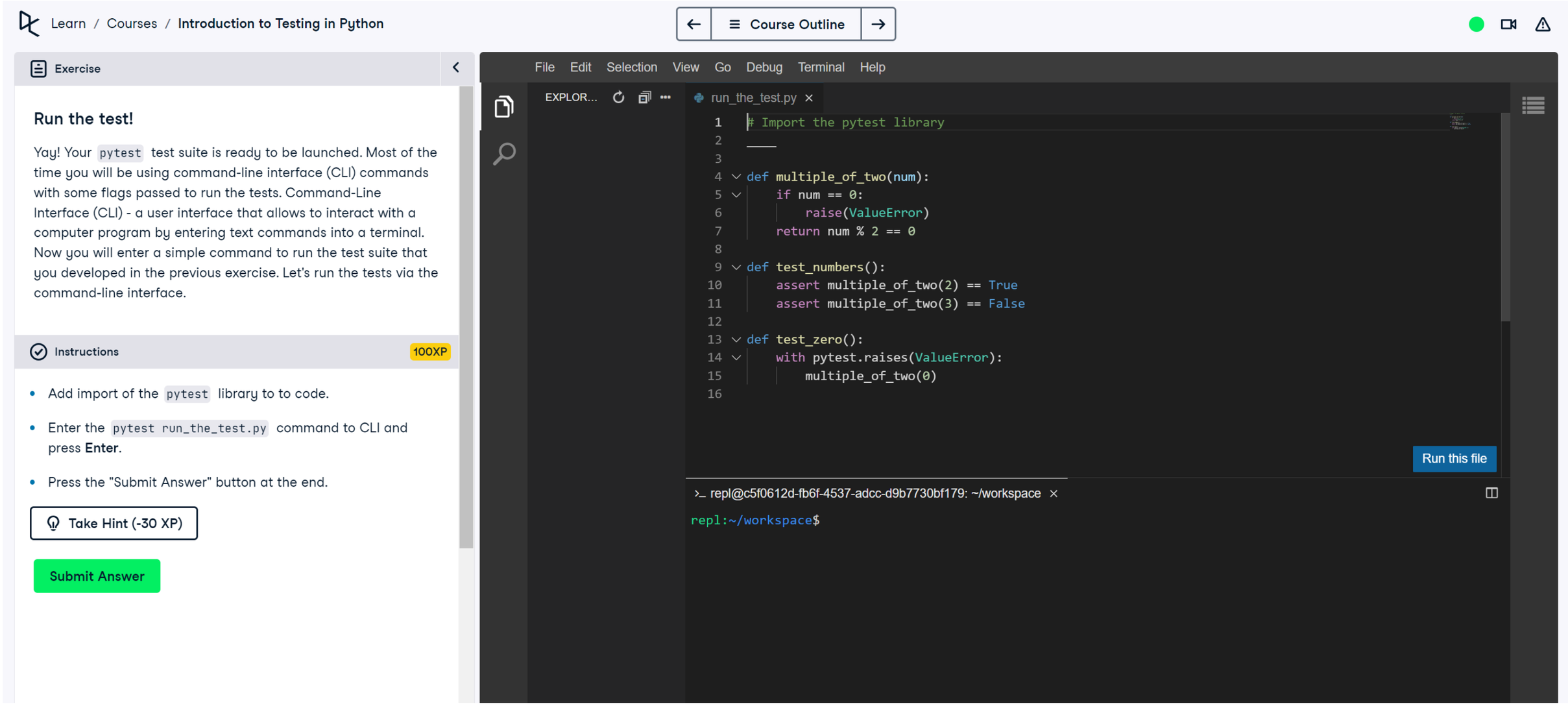
Example CLI run: output

Output of a test:

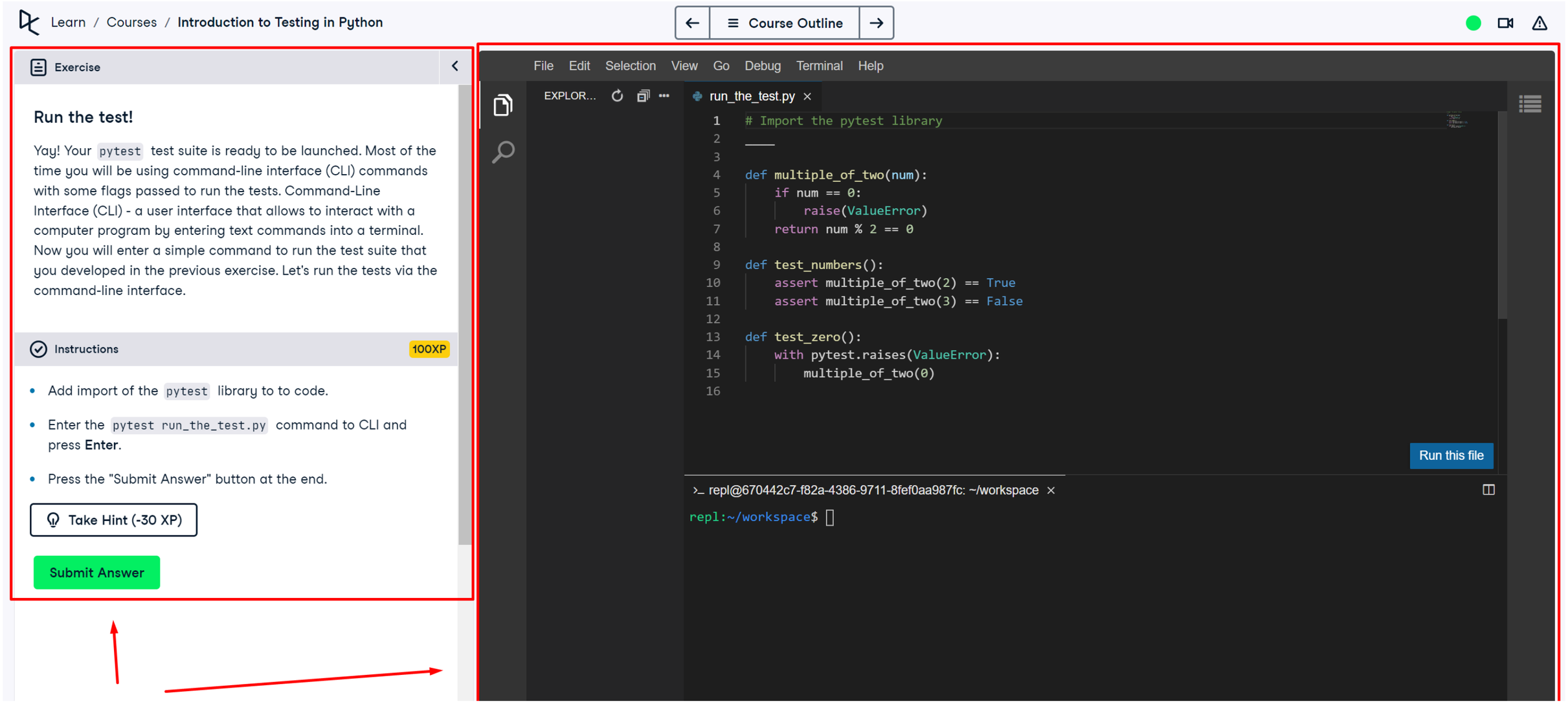
- **Test results**

```
PS
============================================================ test session starts ============================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10 w
armup=False warmup_iterations=100000)
rootdir:
plugins: benchmark-4.0.0
collected 3 items

slides.py ...                                                                                                                      [100%]

============================================================ 3 passed in 0.01s =============================================================
PS
```

IDE exercises



IDE exercises



Directory argument

The command for running all tests in `tests_dir/` :

```
pytest tests_dir/
```

Meaning: "Please, run the `pytest` framework using all found the tests from the `tests_dir` folder".

```
PS [redacted] pytest tests_directory
========================================================== test session starts ==========================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10 warm
p=False warmup_iterations=100000)
rootdir: [redacted]
plugins: benchmark-4.0.0
collected 6 items

tests_directory\test_slides_1.py ...                                                                                                  [ 50%]
tests_directory\test_slides_2.py ...                                                                                                  [100%]

========================================================== 6 passed in 0.01s ==========================================================
PS [redacted]
```

Keyword argument - filter tests by name

The command for running tests from `tests_ex.py` contains "squared":

```
pytest tests_ex.py -k "squared"
```

Meaning: "Please, run the `pytest` framework using all tests from the `tests_ex.py` script containing `squared` ".

Output:

```
PS [redacted] pytest .\keyword_tests.py -k "squared"
========================================================== test session starts ==========================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10 warm
p=False warmup_iterations=100000)
rootdir: [redacted]
plugins: benchmark-4.0.0
collected 3 items / 1 deselected / 2 selected

keyword_tests.py ..                                                                                                                [100%]

=================================================== 2 passed, 1 deselected in 0.01s ====================================================
```

Summary

- **IDE exercises** - let us to write code in an Integrated Development Environment and to use command-line interface (CLI)
- **CLI pytest command** starts with `pytest`
- **Sources of tests:**
  - One script, by passing `script_name.py`
  - A set of scripts from one folder, by passing `directory_name/`
- **Keyword argument:**
  - By passing `-k "keyword_expression"`
- **Output** of a test contains important information about the run

Let's practice!

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Applying test markers

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Overview of test markers

- **Use case 1:** skip the test if the condition met
- **Use case 2:** this test is expected to fail
- **Test marker** - a tag (a marker) of a test in the `pytest` library
- Allows to specify behavior for particular tests by tagging them (marking them)

Markers syntax

- **Decorator** - a design pattern in Python that allows a user to add new functionality to an existing object without modifying its structure
- **Test markers syntax** are started with `@pytest.mark` decorator:

```
import pytest

def get_length(string):
    return len(string)

# The test marker syntax
@pytest.mark.skip
def test_get_len():
    assert get_length('123') == 3
```

Skip and skipif markers

- Use `@pytest.mark.skip` - when you want a test to be skipped in any case
- Use `@pytest.mark.skipif` - if you want a test to be skipped if a given condition is `True`

Skip marker example

- Use `@pytest.mark.skip` - when you want a test to be skipped indefinitely.

```
import pytest
def get_length(string):
    return len(string)

# The skip marker example
@pytest.mark.skip
def test_get_len():
    assert get_length('123') == 3
```

Skip marker example: output

- Output with a skipped test:

```
PS [redacted] > pytest skip.py
========================================================== test session starts ==========================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10
armup=False warmup_iterations=100000)
rootdir: [redacted]
plugins: benchmark-4.0.0
collected 1 item

skip.py s                                                                                                                          [100%]

========================================================== 1 skipped in 0.01s ==========================================================
PS [redacted] >
```

Skipif marker example

- Use `@pytest.mark.skipif` - when you want a test to be skipped if the given condition is `True`.

```
import pytest
def get_length(string):
    return len(string)

# The skipif marker example
@pytest.mark.skipif('2 * 2 == 5')
def test_get_len():
    assert get_length('abc') == 3
```

Skipif marker example: output

- Output of a conditionally skipped test:

```
PS [redacted] > pytest .\skipif.py
========================================================== test session starts ==========================================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0 calibration_precision=10
armup=False warmup_iterations=100000)
rootdir: [redacted]
plugins: benchmark-4.0.0
collected 1 item

skipif.py .                                                                                                                    [100%]

========================================================== 1 passed in 0.02s ==========================================================
PS [redacted] >
```

Xfail marker

- Use `@pytest.mark.xfail` - when you expect a test to be failed

```
import pytest

def gen_sequence(n):
    return list(range(1, n+1))

# The xfail marker example
@pytest.mark.xfail
def test_gen_seq():
    assert gen_sequence(-1)
```

Xfail marker: output

- Output of a test, that is expected to fail:

```
========================================= test session starts =========================================
platform win32 -- Python 3.11.2, pytest-7.2.2, pluggy-1.0.0
benchmark: 4.0.0 (defaults: timer=time.perf_counter disable_gc=False min_rounds=5 min_time=0.000005 max_time=1.0
 calibration_precision=10 warmup=False warmup_iterations=100000)
rootdir: [redacted]
[redacted]
plugins: benchmark-4.0.0
collected 1 item

slides.py x                                                                          [100%]

========================================== 1 xfailed in 0.08s ==========================================
```

Summary

Test marker:

- Is an attribute of a test in the `pytest` library
- Is used to specify behavior for particular tests
- Has syntax started with `@pytest.mark.name_of_the_marker`
- Out-of-the-box implementations in pytest:
  - `@pytest.mark.xfail`
  - `@pytest.mark.skip`
  - `@pytest.mark.skipif`

Let's practice!

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