pytest

Simple, rapid and fun testing with Python

The-Compiler/pytest-basics

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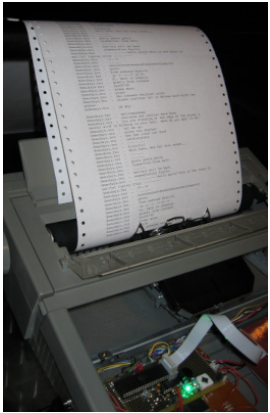
July 14th, 2025

About me

The-Compiler/pytest-basics

2011:



2013, 2015:

pytest

2019, 2020:

BRUHIN
SOFTWARE

You:

Used **pytest** before?

Used **unittest/nose/...** before?

Used pytest **fixtures**?

Used Python **decorators**?

Used **context managers**?

Used **"yield"**?

Used **virtualenv**?

Course content (I)

- **About testing**: Why and how to write tests
- **About pytest**: Why pytest, popularity, history overview
- **The basics**: Fundamental pytest features, test discovery and plain asserts
- **Configuration**: Typical directory structure, configs, options
- **Marks**: Marking/grouping tests, skipping tests
- **Parametrization**: Running tests against sets of input/output data
- **Fixtures**: Providing test data, setting up objects, modularity
- **Built-in fixtures**: Capturing output, patching, temporary files, test information
- **Fixtures advanced**: Caching, cleanup/teardown, implicit fixtures, parametrizing

Course content (II)

- **Debugging failing tests**: Controlling output, selecting tests, tracing fixtures, using breakpoints, showing durations, dealing with hanging and flaky tests
- **Migrating to pytest**: Running existing testsuites, incremental rewriting, tooling
- **Mocking**: Dealing with dependencies which are in our way, monkeypatch and unittest.mock, mocking libraries and helpers, alternatives
- **Plugin tour**: Coverage, distributed testing, test reporting, alternative test syntax, testing C libraries, asyncio integration, plugin overview
- **Property-based testing**: Using *hypothesis* to generate test data
- **Writing plugins**: Extending pytest via custom hooks, domain-specific languages

About testing

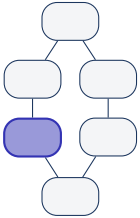
Why automated testing?

- To raise confidence that code works
- To allow for changes without fear
- To specify and document behaviour
- Collaborative and faster development cycles

Testing terminology

Different sizes of tests

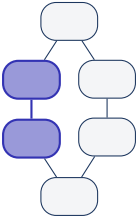
Unit tests



Units react well to input

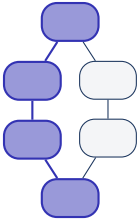
(micro-tests)

Integration tests



Multiple components co-operate nicely

Functional tests



Full code works in user environments

(end-to-end tests, system tests, acceptance tests)

Arrange, Act, Assert

A test function usually has three parts:

Arrange **Set up** objects/values needed for the test
(with pytest, often done via *fixtures* instead of in the test function)

Act **Call** the function/method to be tested

Assert **Check** the result (with pytest, using the Python `assert` statement)

Act/assert might be repeated, but it's usually good practice to only test *one* thing per test function.

pytest

Setup

Setup overview

- Download slides and example code for exercises:
  The-Compiler/pytest-basics
- We'll use Python 3.9 or newer, with pytest 8.3 ($\geq$ 7.0 is okay).
  - Use `python3 --version` or `py -3 --version` (Windows) to check your version.
- You can use whatever editor/IDE you'd like – if you don't use one yet, PyCharm (Community Edition) or VS Code are good choices.
- However, we'll first start exploring pytest on the command line, in order to see how it works "under the hood" and explore various commandline arguments.

Setup with PyCharm / VS Code

- Open `code/` folder (**not** enclosing folder!) as project, open `basic/test_calc.py`

- Select "Configure Python interpreter" when prompted
- Wait until "Install requirements" prompt appears and accept

- Ctrl-Shift-P to open command palette, run "Python: Create Environment…"
- Select `venv` and `requirements.txt` for installation
- Click in the sidebar, you should see a tree of tests (some will fail)

- Open PyCharm / VS Code terminal at the bottom
- You should be able to run `pytest --version` and see at least `7.0.0`
- Also try ▶ next to a test function (not entire file)

Virtual environments: Isolation of package installs

Virtual environments:

- Provide isolated environments for Python package installs
- Isolate different app/package-install configurations
- Are built into Python since 3.4
  (but a separate `virtualenv` tool also exists)
- Are the building blocks for high-level tools like `poetry`/`uv`

With a virtual environment, we can avoid running `sudo pip install ...`, which can mess up your system (on Linux/macOS).

Chris Warrick (`chriswarrick.com`):
"Python Virtual Environments in Five Minutes"

`pyte.st/venv`

`first-proj/.venv`

- pytest 8.3.0
- pytest-cov
- pytest-mock

`second-proj/.venv`

- pytest 7.4.4
- requests
- pytest-recording

Using virtual environments

Installing and creating

Install venv:

(Debian-based Linux distributions only, shipped with Python elsewhere)

```
apt install python3-venv
```

Create a local environment (once, can be reused):

```
py -m venv venv
```

```
python3 -m venv .venv
```

(or `virtualenv` instead of `venv`)

This will create a local Python installation in a `venv` or `.venv` folder.
Any dependencies installed with its `pip` will only be available in this environment/folder.

Using virtual environments

Running commands and activating

Run commands "inside" the environment:

```
venv\Scripts\pip
venv\Scripts\python
venv\Scripts\pytest
```

```
.venv/bin/pip
.venv/bin/python
.venv/bin/pytest
```

Alternatively, **activate** the environment:

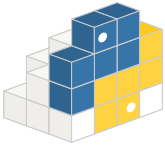
(changes `PATH` temporarily, so that `pip`, `python`, `pytest` etc. use the binaries from the virtualenv)

```
venv\Scripts\activate.bat
```

```
Set-ExecutionPolicy Unrestricted -Scope Process
venv\Scripts\Activate
```

```
source .venv/bin/activate
```

Installing pytest



Install pytest and other dependencies within the activated environment:

```
pip install -r code/requirements.txt
```

(or just `pip install pytest`, which covers most but not all of the training)

Now let's see if it works:

```
pytest --version
```

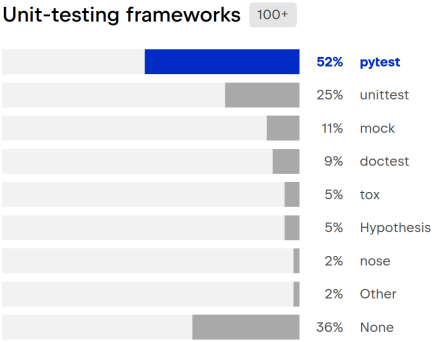
The basics

Fundamental features of pytest

Popularity

pyte.st/survey

- Automatic test discovery,
  no-boilerplate test code
  (boilerplate: repeated code without any “real” use)
- Useful information when a test fails
- Test parametrization
- Modular setup/teardown via fixtures
- Customizable: Many options,
  $>$ 1600 plugins (easy to write your own!)



JetBrains Python Developers Survey 2023
$n > 25\,000$

Cross-project test tool

pyte.st/usage

- Tests are run via `pytest` command line tool (called `py.test` before v3.0)
- Testing starts from given files/directories, or the current directory

Examples:

- `pytest`
- `pytest path/to/tests`
- `pytest test_file.py`
- `pytest test_file.py::test_func`
- `pytest test_file.py::TestClass`
- `pytest test_file.py::TestClass::test_meth`

Automatic test discovery

pyte.st/discovery

pytest walks over the filesystem and:

- Discovers `test_···.py` and `···_test.py` test files
- Discovers `test···` functions and `Test···` classes
- Discovers classes deriving from `unittest.TestCase`

Automatic discovery avoids boilerplate

Calculator project

rpncalc/utils.py

```python
def calc(a, b, op):
    if op == "+":
        return a + b
    elif op == "-":
        return a - b
    elif op == "*":
        return a * b
    elif op == "/":
        return a / b
    raise ValueError("Invalid operator")
```

No boilerplate Python test code

rpncalc/utils.py

```python
def calc(a, b, op):
    if op == "+":
        return a + b
    ...
```

basic/test_calc.py

```python
from rpncalc.utils import calc

def test_add():
    res = calc(1, 3, "+")
    assert res == 4
```

$ pytest basic/test_calc.py

```
========== test session starts =========
collected 1 item

basic/test_calc.py .

=========== 1 passed in ... ============
```

No boilerplate Python test code

rpncalc/utils.py

```python
def calc(a, b, op):
    if op == "+":
        return a + b
    ...
```

basic/ test_calc.py

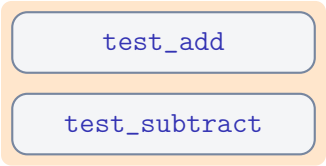
```python
from rpncalc.utils import calc

def test_add():
    res = calc(1, 3, "+")
    assert res == 4
```

```python
import unittest
from rpncalc.utils import calc


class TestCalc(unittest.TestCase):
    def test_add(self):
        res = calc(1, 3, "+")
        self.assertEqual(res, 4)


if __name__ == "__main__":
    unittest.main()
```

Test classes

pyte.st/classes

```
class TestCalc:
    def test_add(self):
        assert calc(1, 3, "+") == 4

    def test_subtract(self):
        ...
```



With pytest:

- Test classes have a `Test` prefix, are autodiscovered
- There is no need to subclass anything, test functions don't have to be in classes
- Test classes are for logical grouping of your tests
- Fixtures are typically used in place of unittest's `setUp()` and `tearDown()`

Assert introspection

pyte.st/assert

```
assert x
assert x == 1
assert x != 2
assert not x
assert x < 3 or y > 5
```

```
self.assertTrue(x)
self.assertEqual(x, 1)
self.assertNotEqual(x, 2)
self.assertFalse(x)
?
```

Demo on failure reporting (basic/failure_demo.py)

Test outcomes

Every test can have one of the following outcomes:

PASSED	`.`	All assertions passed, no exceptions occurred
FAILED	`F`	An assertion failed or an exception occurred
ERROR	`E`	An exception occurred outside of the test (e.g. in a *fixture*)
SKIPPED	`s`	The test was skipped, e.g. because of a missing optional dependency
XFAILED	`x`	An expected failure occurred
XPASS	`X`	An unexpected success occurred (expected to fail but passed)

Tracebacks

rpncalc/utils.py

```python
def calc(a, b, op):
    if op == "+":
        return a + b
    elif op == "-":
        return a - b
    elif op == "*":
        return a * b
    elif op == "/":
        return a / b
    raise ValueError("Invalid operator")
```

basic/test_traceback.py

```python
from rpncalc.utils import calc

def test_divide():
    # This will raise ZeroDivisionError
    assert calc(2, 0, "/") == 0

def test_good():
    pass
```

Some important options

pyte.st/cli

`-v` / `--verbose`	More **v**erbose output (can be given multiple times)
`-q` / `--quiet`	More **q**uiet output (negates `-v`)
`-k` *`expression`*	Run tests whose names contain the given **k**eyword

See `pytest -h` (`--help`) for many more options.

Exercise:

- Add a `test_subtract` function to `basic/test_calc.py`
- Run `pytest basic/test_calc.py` to run tests
- Add `-k` to only run your new test, play with `-v` and `-q`
- Take a first look at the `--help` output

getting-started

↑

Every exercise has a label like this on the right, which helps with finding it in the code and solutions: Search for `[getting-started]`.

Typical directory structure

pyte.st/layout

`tests/` outside of `src/`, file layout 1:1 mirroring (roughly) of `src/mypackage/`:

```
myproject/
├── pytest.ini
├── pyproject.toml
├── src/ myproject/
│   ├── __init__.py
│   ├── utils.py
│   └── export/
│       ├── __init__.py
│       ├── jsonexport.py
│       └── yamlexport.py
└── tests/
    └── ...
```

```
tests/
├── __init__.py
├── conftest.py
├── test_utils.py
└── export/
    ├── __init__.py
    ├── conftest.py
    ├── test_jsonexport.py
    └── test_yamlexport.py
```

Typical directory structure

pyte.st/layout

`conftest.py`: fixtures, plugin hooks, etc.

```
myproject/
├── pytest.ini
├── pyproject.toml
├── src/ myproject/
│   ├── __init__.py
│   ├── utils.py
│   └── export/
│       ├── __init__.py
│       ├── jsonexport.py
│       └── yamlexport.py
└── tests/
    └── ...
```

```
tests/
├── __init__.py
├── conftest.py
├── test_utils.py
└── export/
    ├── __init__.py
    ├── conftest.py
    ├── test_jsonexport.py
    └── test_yamlexport.py
```

Typical directory structure

pyte.st/layout

`pytest.ini` or `pyproject.toml`: (declarative) config

```
myproject/
├── pytest.ini
├── pyproject.toml
├── src/ myproject/
│   ├── __init__.py
│   ├── utils.py
│   └── export/
│       ├── __init__.py
│       ├── jsonexport.py
│       └── yamlexport.py
└── tests/
    └── ...
```

```
tests/
├── __init__.py
├── conftest.py
├── test_utils.py
└── export/
    ├── __init__.py
    ├── conftest.py
    ├── test_jsonexport.py
    └── test_yamlexport.py
```

Typical directory structure

pyte.st/layout

`__init__.py` files both in `src/myproject` and `tests/`

```
myproject/
├── pytest.ini
├── pyproject.toml
├── src/ myproject/
│   ├── __init__.py
│   ├── utils.py
│   └── export/
│       ├── __init__.py
│       ├── jsonexport.py
│       └── yamlexport.py
└── tests/
    └── ...
```

```
tests/
├── __init__.py
├── conftest.py
├── test_utils.py
└── export/
    ├── __init__.py
    ├── conftest.py
    ├── test_jsonexport.py
    └── test_yamlexport.py
```

Typical directory structure

pyte.st/layout

```
myproject/
├── pytest.ini
├── pyproject.toml
├── src/ myproject/
│   ├── __init__.py
│   ├── utils.py
│   └── export/
│       ├── __init__.py
│       ├── jsonexport.py
│       └── yamlexport.py
└── tests/
    └── ...
```

Based on the "src layout":

Ionel Cristian Mărieș (ionelmc.ro):
"Packaging a python library"
(also for applications!)

Hynek Schlawack (hynek.me):
"Testing & Packaging"

pytest.ini file

pyte.st/config

```
myproject/
├── pytest.ini
├── pyproject.toml
├── src/ myproject/
│   ├── utils.py
│   └── ...
└── tests/
    ├── conftest.py
    ├── test_utils.py
    └── ...
```

You can create a `pytest.ini` file:

```
[pytest]
option = value
...
```

pytest also can read a `[pytest]` section in `tox.ini` or `[tool.pytest.ini_options]` from `pyproject.toml`, in case you prefer having multiple tools configured in one file.

Available options are listed in the `pytest -h` output, or in the reference documentation:

`pytest.org` → Reference guides → API Reference → Configuration Options

Asserting expected exceptions

pyte.st/raises

rpncalc/utils.py

```python
def calc(a, b, op):
    ...
    elif op == "/":
        return a / b
    raise ValueError("Invalid operator")
```

basic/test_raises.py

```python
def test_zero_division():
    with pytest.raises(ZeroDivisionError):
        calc(3, 0, "/")
```

Exercise:

raises

- In `basic/test_raises.py`, write another test with `pytest.raises`, to ensure that `ValueError` is raised when calling `calc` with an invalid operator.
- Rerun test, but edited so that no exception or a different exception is raised, e.g. `calc(1, 2, "+")` and `calc(1, 0, "/")`.
- Pass a regex pattern to the `match` argument to check the exception message: `with pytest.raises(ValueError, match=r"...")`: **(optional)**

Marks

pytest.mark: Custom marking

pyte.st/mark

Mark functions or classes:

— marking/test_marking.py

```
@pytest.mark.slow
@pytest.mark.webtest
def test_slow_api():
    time.sleep(1)

@pytest.mark.webtest
def test_api():
    pass

def test_fast():
    pass
```

slow webtest
test_slow_api

webtest
test_api

test_fast

On a basic level, marks are *tags* / *labels* for tests.

As we'll see later, marks are also used to attach meta-information to a test, used by pytest itself (parametrize, skip, xfail, . . .), by fixtures, or by plugins.

pytest.mark: Custom marking

pyte.st/mark

Mark functions or classes:

marking/test_marking.py

```
@pytest.mark.slow
@pytest.mark.webtest
def test_slow_api():
    time.sleep(1)

@pytest.mark.webtest
def test_api():
    pass

def test_fast():
    pass
```

Register the custom markers:

pytest.ini

```
[pytest]
markers =
    slow: Tests which take some time to run
    webtest: Tests making web requests
```

Then pass e.g. `-m "slow"` to pytest to filter by marker.

Use `--markers` to show a list of all known markers.

Parametrizing tests

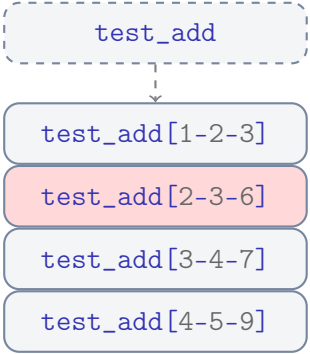
pyte.st/parametrize

Tests can be parametrized to run them with various values:

marking/test_parametrization.py

```
@pytest.mark.parametrize("a, b, expected", [
    (1, 2, 3),  # 1 + 2 = 3
    (2, 3, 6),  # 2 + 3 = 6 (?)
    (3, 4, 7),  # 3 + 4 = 7
    (4, 5, 9),  # 4 + 5 = 9
])
def test_add( a: int, b: int, expected: int ):
    assert calc( a, b , "+") == expected

@pytest.mark.parametrize(
    "op", ["+", "-", "*", "/", "@"])
def test_smoke(op: str):
    calc(1, 2, op)
```



Parametrizing tests

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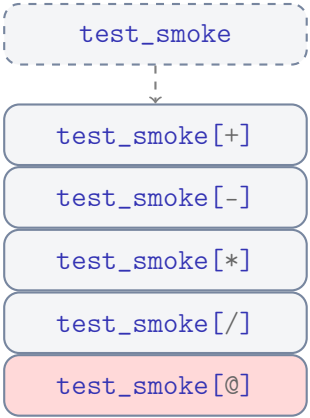

Parametrizing tests

pyte.st/parametrize

Tests can be parametrized to run them with various values:

marking/test_parametrization.py

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def test_add( a: int, b: int, expected: int ):
    assert calc( a, b , "+") == expected

@pytest.mark.parametrize(
    "op", ["+", "-", "*", "/", "@"])
def test_smoke(op: str):
    calc(1, 2, op)
```

Exercise: parametrize

- Write a `test_multiply` with a single, hardcoded value
- Parametrize the test to test multiple inputs and expected outputs
- Run pytest with `-v`

Skipping or "xfailing" tests

pyte.st/skipping

Skip a test if:

- It cannot run at all on a certain platform
- It cannot run because a dependency is missing

⇒ Test function is not run, result is "skipped" (`s`)

Use `@pytest.mark.skip` (instead of `skipif`) for unconditional skipping.

```
@pytest.mark.skipif(
    # condition
    sys.platform == "win32",
    # text shown with -v
    reason="Linux only",
)
def test_linux():
    pass
```

"xfail" ("expected to fail") a test if:

- The implementation is currently lacking
- It fails on a certain platform but should work

⇒ Test function is run, but result is "xfailed" (`x`), instead of failed (`F`). Unexpected pass: XPASS (`X`).

```
@pytest.mark.xfail(
    # condition optional
    reason="see #1234",
)
def test_new_api():
    pass
```

xfail vs. raises

`pytest.raises`

Testing a "bad case", but **intended** behavior:

⇒ When we call `calc(1, 2, "@")`, we expect a `ValueError`.

`pytest.mark.xfail`

Marking a test where the implementation behaves in **unintended** ways:

This test **should work**, but currently does not (e.g. upstream bug).

⇒ e.g. if the user asks for the result of `1 / 0` and gets an unhandled exception.

Marks summary

- At a basic level, marks let us categorize tests by using them as "tags" / "labels".
- However, marks also lets us attach "meta-information" to a test.
  This information is used by pytest in various ways:

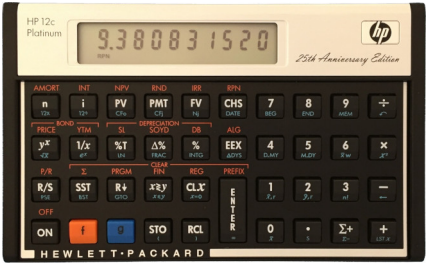
`@pytest.mark.parametrize`	Run the same test against different data
`@pytest.mark.skip`	Skip a test (not applicable)
`@pytest.mark.xfail`	Expect a test to fail (broken, out of our control)

- (In fixtures or plugin hooks, we can also access a marker's arguments to customize behavior.)
- Test IDs are auto-generated but can be overridden

Expanding the calculator example

Reverse Polish Notation (RPN)

History

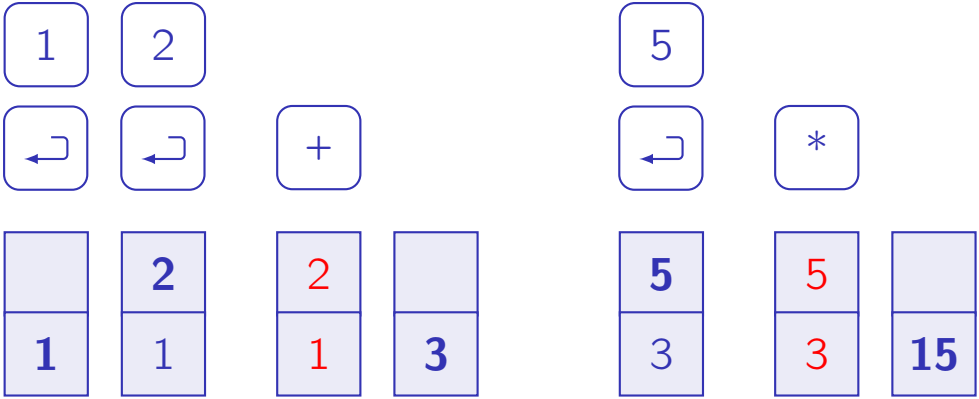


- Using a calculator without needing a = key, and without parentheses
- Makes it much easier to implement, using a stack data structure
- Used by all HP calculators in the 1970s–80s, still used by some today
- Displayed here: HP 12C financial calculator, introduced in 1981, still in production today (HPs longest and best-selling product)

Reverse Polish Notation (RPN)

Explanation

$$5 \cdot (1 + 2)$$

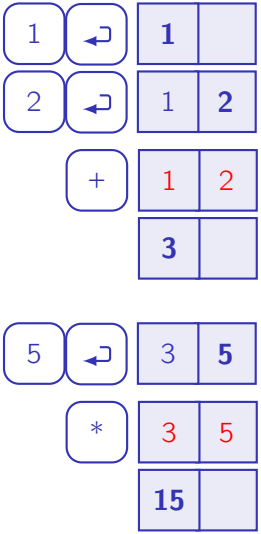


Reverse Polish Notation (RPN)

In Python

In `code/`, using `python -m rpncalc.rpn_v1`

```
> 1
> 2
> p
[1.0, 2.0]
> +
3
> 5
> *
15
> q
```



Reverse Polish Notation (RPN)

— rpncalc/rpn_v1.py

```python
from rpncalc.utils import calc

class RPNCalculator:
    def __init__(self) -> None:
        self.stack = []

    def run(self) -> None:
        while True:
            inp = input("> ")
            if inp == "q":
                return
            elif inp == "p":
                print(self.stack)
            else:
                self.evaluate(inp)

    def evaluate(self, inp: str):
        if inp.isdigit():
            n = float(inp)
            self.stack.append(n)
        elif inp in "+-*/":
            b = self.stack.pop()
            a = self.stack.pop()
            res = calc(a, b, inp)
            self.stack.append(res)
            print(res)

if __name__ == "__main__":
    rpn = RPNCalculator()
    rpn.run()
```

Reverse Polish Notation (RPN)

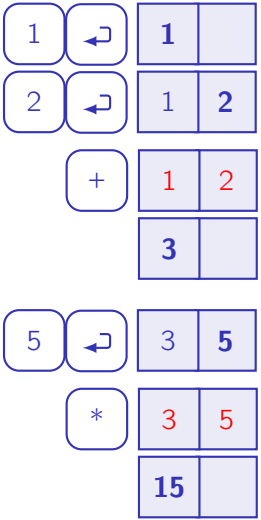
Tests: Recycling the example

rpncalc/test_rpn_v1.py

```python
def test_complex_example():
    rpn = RPNCalculator()

    rpn.evaluate("1")
    assert rpn.stack == [1]
    rpn.evaluate("2")
    assert rpn.stack == [1, 2]
    rpn.evaluate("+")
    assert rpn.stack == [3]
    rpn.evaluate("5")
    assert rpn.stack == [3, 5]
    rpn.evaluate("*")
    assert rpn.stack == [15]
```

$5 \cdot (1 + 2)$

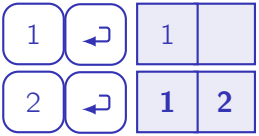


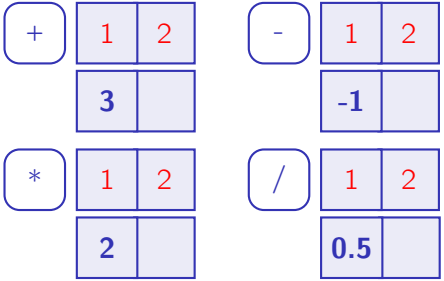
Reverse Polish Notation (RPN)

Tests: Getting a bit smaller

```python
def test_stack_push():
    rpn = RPNCalculator()
    rpn.evaluate("1")
    rpn.evaluate("2")
    assert rpn.stack == [1, 2]

@pytest.mark.parametrize("op, expected", [
    ("+", 3), ("-", -1),
    ("*", 2), ("/", 0.5),
])
def test_operations(op, expected):
    rpn = RPNCalculator()
    rpn.stack = [1, 2]
    rpn.evaluate(op)
    assert rpn.stack == [expected]
```





Reverse Polish Notation (RPN)

Towards an improved version

- Fix bugs and add additional error handling:
  - Allow negative numbers and floating-point inputs, not just `.isdigit()`
  - Fix `+-` being treated as valid input due to `elif inp in "+-*/":`
  - Print error when using an invalid operator
  - Handle `ZeroDivisionError` when dividing by zero, and `IndexError` with < 2 elements on stack
- Allow passing a `Config` object to the calculator, with a custom prompt, instead of `"> "`
- Support multiple inputs on one line, e.g. `2 ␣ 1 ␣ + ↵` (not `2 ↵ 1 ↵ + ↵`)

Reverse Polish Notation (RPN)

Fixing bugs, improving error handling

rpncalc/rpn_v1.py

```
...
def evaluate(self, inp: str):
    if inp.isdigit():
        n = float(inp)
        self.stack.append(n)
    elif inp in "+-*/":
        ...
```

rpncalc/test_rpn_v2.py

```
@pytest.mark.parametrize("n", [1.5, -1])
def test_number_input(n: float):
    rpn = RPNCalculator(Config())
    rpn.evaluate(str(n))
    assert rpn.stack == [n]
```

With rpn_v1.py:

```
E    assert [] == [1.5]
E    assert [] == [-1]
```

With rpn_v2.py:

```
...::test_number_input[1.5] PASSED
...::test_number_input[-1]  PASSED
```

Reverse Polish Notation (RPN)

Fixing bugs, improving error handling

rpncalc/rpn_v1.py

```
...
def evaluate(self, inp: str):
    if inp.isdigit():
        n = float(inp)
        self.stack.append(n)
    elif inp in "+-*/":
        ...
```

pyte.st/mathspp-error

LBYL: Look before you leap

rpncalc/rpn_v2.py

```
...
def evaluate(self, inp: str) -> None:
    try:
        self.stack.append(float(inp))
        return
    except ValueError:
        pass

    if inp not in ["+", "-", "*", "/"]:
        ...
```

EAFP: It's easier to ask for forgivenness, than for permission

Reverse Polish Notation (RPN)

Fixing bugs, improving error handling

rpncalc/rpn_v1.py

```
...
def evaluate(self, inp: str):
    if inp.isdigit():
        n = float(inp)
        self.stack.append(n)
    elif inp in "+-*/":
        ...
```

rpncalc/test_rpn_v2.py

```
@pytest.mark.parametrize(
    "op", ["@", "+-"])
def test_unknown_operator(op: str):
    rpn = RPNCalculator(Config())
    rpn.stack = [1, 2]
    rpn.evaluate(op)
```

With rpn_v1.py:

```
...::test_unknown_operator[@]  PASSED
...::test_unknown_operator[+-] FAILED
E    ValueError: Invalid operator
```

With rpn_v2.py: rpncalc/test_rpn_v2.py ..

Reverse Polish Notation (RPN)

Fixing bugs, improving error handling

rpncalc/rpn_v1.py

```
...

def evaluate(self, inp: str):
    if inp.isdigit():
        n = float(inp)
        self.stack.append(n)
    elif inp in "+-*/":
        ...
```

rpncalc/rpn_v2.py

```
...

def evaluate(self, inp: str) -> None:
    try:
        self.stack.append(float(inp))
        return
    except ValueError:
        pass

    if inp not in ["+", "-", "*", "/"]:
        ...
```

Fixtures

Reverse Polish Notation (RPN)

Adding a Config object

rpncalc/rpn_v2.py

```python
from rpncalc.utils import calc, Config

class RPNCalculator:
    def __init__(self, config):
        self.config = config
        self.stack = []

...

if __name__ == "__main__":
    config = Config()
    config.load_cwd()
    rpn = RPNCalculator( config )
    rpn.run()
```

rpncalc/utils.py

```python
class Config:
    def __init__(self, prompt=">"):
        self.prompt = prompt

...
```

Beyond simple testing: fixtures!

```
def test_example():
    config = Config()
    rpn = RPNCalculator(config)
    ...

def test_stack_push():
    config = Config()
    rpn = RPNCalculator(config)
    ...

def test_operations(...):
    config = Config()
    rpn = RPNCalculator(config)
    ...
```

A test fixture:

- Sets up objects or apps for testing
- Provides test code with “base” app objects
- Is very important to avoid repetitive test code

In pytest realized via dependency injection:

- Fixture functions create and return fixture values
- They are registered with pytest by using a `@pytest.fixture` decorator
- Test functions and classes can request and use them

Example of pytest fixture injection

pytest calls the fixture function to inject a dependency into the test function:

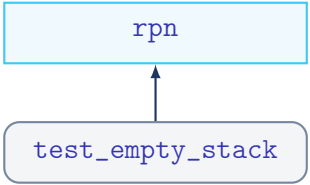
fixtures/test_fixture.py

```
@pytest.fixture
def rpn():
    return RPNCalculator(Config())


def test_empty_stack(rpn):
    assert rpn.stack == []
```

Imagine pytest running your test like:

```
test_empty_stack(rpn=rpn())
```



Exercise: fixtures

- Add an `rpn` fixture to `rpncalc/test_rpn_v2.py`
- Rewrite `test_operations` to use it

Good practices for fixtures

Consider adding type annotations:

```
@pytest.fixture
def rpn() -> RPNCalculator:
    """A RPN calculator with a default config."""
    ...

def test_rpn(rpn: RPNCalculator):
    ...
```

Your IDE will typically show an error if the type annotations aren't correct, but you should probably use a tool like `mypy` to validate them in a CI job.

mypy-lang.org

Good practices for fixtures

Consider adding type annotations, write a docstring for your fixtures:

```
@pytest.fixture
def rpn() -> RPNCalculator :
    """A RPN calculator with a default config."""
    ...
```

`--fixtures`	Show all defined fixtures with their docstrings.
`--fixtures-per-test`	Show the fixtures used, grouped by test.

Output:

```
----------------- fixtures defined from test_fixture ----------------
rpn -- fixtures/test_fixture.py:7
    A RPN calculator with a default config.
```

Modularity: Using fixtures from fixtures

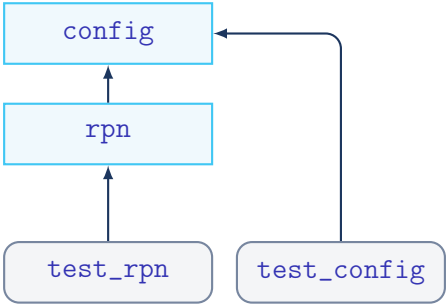
— fixtures/test_fixtures_using_fixtures.py

```python
@pytest.fixture
def config() -> Config:
    return Config()

@pytest.fixture
def rpn(config: Config) -> RPNCalculator:
    return RPNCalculator(config)

def test_config(config: Config):
    assert config.prompt == ">"

def test_rpn(rpn: RPNCalculator):
    assert rpn.stack == []
```



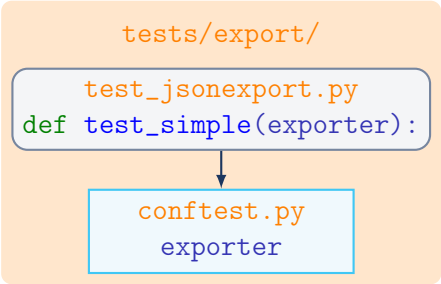
conftest.py fixtures

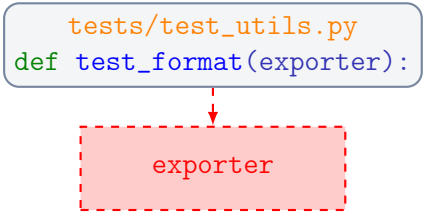
pyte.st/conftest

You can move fixture functions into `conftest.py`:

- Visible to modules in same or sub directory.
- Put hooks and cross-module used fixtures into conftest file(s) but **don't import** from them.

```
myproject/tests/
├── export/
│   ├── conftest.py
│   ├── test_jsonexport.py
│   └── test_yamlexport.py
├── conftest.py
├── test_utils.py
└── ...
```





Fixture visibility

pyte.st/fixt-override

Fixtures defined...

- ...as methods of a test class are available only to test methods on that class.
- ...in a test module are available only to tests in that module.
- ...in a `conftest.py` file are available to tests in that directory and subdirectories.
- ...in a plugin (or built into pytest) are available everywhere.

Use `pytest --fixtures` to see which fixtures have been picked up from where.

Fixtures in a more specific location shadow those in a more general location.

```
class TestConfig:
    @pytest.fixture
    def config(self):
        return Config()

    def test_config(self, config):
        ...
```

Fixture visibility

pyte.st/fixt-override

Fixtures defined...

- ...as methods of a test class are available only to test methods on that class.
- ...in a test module are available only to tests in that module.
- ...in a `conftest.py` file are available to tests in that directory and subdirectories.
- ...in a plugin (or built into pytest) are available everywhere.

Use `pytest --fixtures` to see which fixtures have been picked up from where.

Fixtures in a more specific location shadow those in a more general location.

test_config.py

```
@pytest.fixture
def config():
    return Config()


def test_config(config):
    ...
```

Fixture visibility

pyte.st/fixt-override

Fixtures defined...

- ...as methods of a test class are available only to test methods on that class.
- ...in a test module are available only to tests in that module.
- ...in a `conftest.py` file are available to tests in that directory and subdirectories.
- ...in a plugin (or built into pytest) are available everywhere.

Use `pytest --fixtures` to see which fixtures have been picked up from where.

Fixtures in a more specific location shadow those in a more general location.

conftest.py

```
@pytest.fixture
def rpn_config():
    return Config()
```

This makes `rpn_config` available for other files, **without any importing**:

test_config.py

```
def test_config(rpn_config):
    ...
```

test_rpn.py

```
def test_rpn(..., rpn_config):
    ...
```

Fixture visibility

pyte.st/fixt-override

Fixtures defined...

- ...as methods of a test class are available only to test methods on that class.
- ...in a test module are available only to tests in that module.
- ...in a `conftest.py` file are available to tests in that directory and subdirectories.
- ...in a plugin (or built into pytest) are available everywhere.

Use `pytest --fixtures` to see which fixtures have been picked up from where.

Fixtures in a more specific location shadow those in a more general location.

```
$ pip install pytest-someplugin
...
Successfully installed
pytest-someplugin-1.2.3
```

```
$ pytest
====== test session starts ======
...
plugins: someplugin-1.2.3
```

Builtin fixtures

pyte.st/fixt-builtin

pytest provides builtin fixtures:

`capsys` / `capfd`	Capturing stdout/stderr in a test
`caplog`	Capturing logging output from a test
`monkeypatch`	Temporarily modify state for test duration
`tmp_path` / `tmpdir`	A fresh empty directory for each test invocation
`request`	Get information about the current test
...	

More fixtures are provided by plugins.

Use `pytest --fixtures` to see available fixtures with docs

Builtin fixtures

Capturing

pyte.st/capturing

```python
def test_ok():
    print("This isn't printed")

def test_bad():
    print("This is printed")
    assert False
```

```
$ pytest -v basic/test_capturing.py
...

...::test_ok PASSED
...::test_bad FAILED

============== FAILURES ==============
______________ test_bad ______________
...
-------- Captured stdout call --------
This is printed
====== short test summary info =======
...
```

Builtin fixtures

Capturing

pyte.st/capturing

```python
def test_ok():
    print("This isn't printed")

def test_bad():
    print("This is printed")
    assert False
```

```
$ pytest -s -v basic/test_capturing.py
...

...::test_ok This isn't printed
PASSED
...::test_bad This is printed
FAILED

============== FAILURES ==============
_______________ test_bad _______________
...
====== short test summary info =======
...
```

Builtin fixtures

Capturing

`capsys` Capturing stdout/stderr in a test by overriding `sys.stdout` e.g. for `print(...)`.

`capfd` **Capturing stdout/stderr in a test at file descriptor level,** e.g. for subprocesses or libraries printing from C code.

Type for both: `pytest.CaptureFixture[str]`

`capsysbinary`/ `capfdbinary` Like `capsys`/`capfd`, but for binary data.
Type for both: `pytest.CaptureFixture[bytes]`

`caplog` **Capturing logging output from a test.**
Type: `pytest.LogCaptureFixture`

`capsys` vs. `capfd`: If in doubt, use `capfd` to ensure everything is captured (built-in pytest capturing also uses `fd` by default).

Builtin fixtures

pyte.st/monkeypatch

monkeypatch

The `monkeypatch` fixture allows to temporarily change state for the **duration of a test function execution**:

- Modify attributes on objects, classes or modules (`setattr`, `delattr`).
  Also works with functions/methods, as those are attributes of the respective module/class/instance too.
- Modify environment variables (`setenv`, `delenv`)
- Change current directory (`chdir`)
- Modify dictionaries (`setitem`, `delitem`)
- Prepend to `sys.path` for importing (`syspath_prepend`)

Builtin fixtures

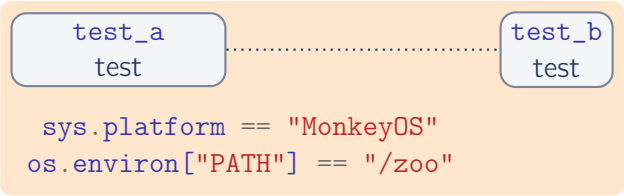
pyte.st/monkeypatch

monkeypatch: How to not do things

```python
def print_info():
    path = os.environ.get("PATH", "")
    print(f"platform: {sys.platform}")
    print(f"PATH: {path}")

def test_a():
    sys.platform = "MonkeyOS"     # don't do this!
    os.environ["PATH"] = "/zoo"   # don't do this!
    print_info()
    assert False

def test_b():
    print_info()
    assert False
```



Builtin fixtures

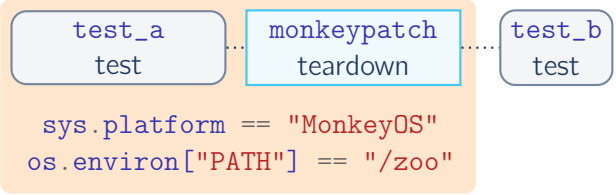
monkeypatch

fixtures/test_builtin_monkeypatch.py

```python
def print_info():
    path = os.environ.get("PATH", "")
    print(f"platform: {sys.platform}")
    print(f"PATH: {path}")

def test_a(monkeypatch: pytest.MonkeyPatch):
    monkeypatch.setattr(sys, "platform", "MonkeyOS")
    monkeypatch.setenv("PATH", "/zoo")
    print_info()
    assert False

def test_b():
    print_info()
    assert False
```



Builtin fixtures

pyte.st/monkeypatch

monkeypatch: Patching functions

fixtures/test_builtin_monkeypatch.py

```python
def get_folder_name() -> str:
    user = getpass.getuser()
    return f"pytest-of-{user}"

def fake_getuser() -> str:
    return "fakeuser"

def test_get_folder_name(monkeypatch: pytest.MonkeyPatch):
    monkeypatch.setattr(
        getpass, "getuser",  # target, "name"
        fake_getuser         # value
    )
    assert get_folder_name() == "pytest-of-fakeuser"
```

Builtin fixtures

pyte.st/monkeypatch

monkeypatch: Patching functions

fixtures/test_builtin_monkeypatch.py

```python
def get_folder_name() -> str:
    user = getpass.getuser()
    return f"pytest-of-{user}"

def test_get_folder_name_lambda(monkeypatch: pytest.MonkeyPatch):
    monkeypatch.setattr(getpass, "getuser", lambda: "fakeuser")
    assert get_folder_name() == "pytest-of-fakeuser"
```

Reverse Polish Notation (RPN)

Supporting multiple inputs

rpnalc/rpn_v1.py

```python
class RPNCalculator:
    ...

    def run(self) -> None:
        while True:
            inp = input("> ")
            ...
            self.evaluate(inp)
```

rpncalc/rpn_v2.py

```python
class RPNCalculator:
    ...

    def get_inputs(self) -> list[str]:
        inp = input(self.config.prompt + " ")
        return inp.split()

    def run(self) -> None:
        while True:
            for inp in self.get_inputs():
                ...
                self.evaluate(inp)
```

Builtin fixtures

pyte.st/monkeypatch

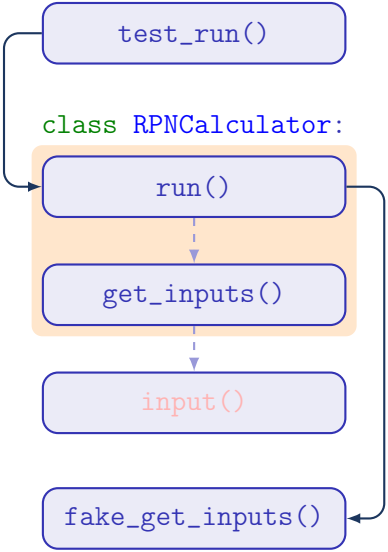
monkeypatch

rpncalc/rpn_v2.py

```
class RPNCalculator:
    ...
    def get_inputs(self) -> list[str]:
        inp = input(...)
        return inp.split()

    def run(self) -> None:
        while True:
            for inp in self.get_inputs():
                ...
```

```
monkeypatch.setattr(
        target, "name", value)
```



Builtin fixtures

pyte.st/monkeypatch

monkeypatch

rpncalc/rpn_v2.py

```
class RPNCalculator:
    ...
    def get_inputs(self) -> list[str]:
        inp = input(...)
        return inp.split()

    def run(self) -> None:
        while True:
            for inp in self.get_inputs():
                ...
```

```
monkeypatch.setattr(
        target, "name", value)
```

Exercise: monkeypatch

- Add a new test to `test_rpn_v2.py`, which will test `run`.
- Leave `rpn_v2.py` as-is!
- Use the `monkeypatch` fixture as arg, to patch the `get_inputs` method on `rpn_calc` (instance, not class).
- Replace it by a function that returns a fixed **list of strings, ending in** `"q"`. E.g. `def fake_get_inputs():` or use `lambda: ...`.
- Remember: Arrange, Act, **Assert**.

Builtin fixtures

pyte.st/tmp-path

tmp_path / tmpdir

A **fresh empty directory** for every pytest invocation and every test.

- Store generated input files for tested code
- Store output files, e.g. measurement data, screenshots, etc.
- Access data even after pytest run is done, but no need for manual cleanup

```
from pathlib import Path

def test_temp( tmp_path: Path ):
    ...
```

```
/tmp/        (system-wide temp directory)
 └─ pytest-of-florian/
     ├─ pytest-1/
     │   └─ test_temp0/
     │       └─ ...
     ├─ pytest-2/
     │   └─ test_temp0/
     │       └─ ...
     └─ ...
```

Builtin fixtures

pyte.st/tmp-path

tmp_path / tmpdir

A **fresh empty directory** for every pytest invocation and every test.

- Store generated input files for tested code
- Store output files, e.g. measurement data, screenshots, etc.
- Access data even after pytest run is done, but no need for manual cleanup

tmp_path:

Based on Python's pathlib.Path, a more object-oriented and convenient os.path alternative:

```
dir_path = pathlib.Path("output")
dir_path.mkdir(exist_ok=True)
file_path = dir_path / "output.txt"
file_path.write_text("Hello world!")
```

docs.python.org/3/library/pathlib.html

tmpdir:

Based on py.path.local from the py library (pylib) instead, since pathlib only exists since Python 3.4. Should not be used in new code.

Reverse Polish Notation (RPN)

The Config object

rpncalc/rpn_v2.py

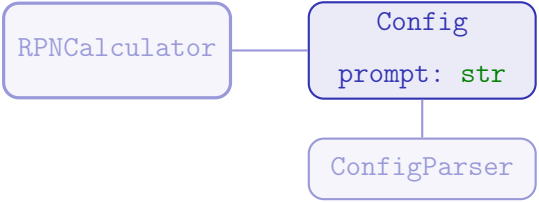
```python
from rpncalc.utils import calc, Config

class RPNCalculator:
    def __init__(self, config):
        self.config = config
        self.stack = []
...

if __name__ == "__main__":
    config = Config()
    config.load_cwd()
    rpn = RPNCalculator(config)
    rpn.run()
```

rpncalc/utils.py

```python
class Config:
    def __init__(self, prompt=">"):
        self.prompt = prompt
...
```



Reverse Polish Notation (RPN)

Changing the prompt

Imagine you could change the prompt inside rpncalc:

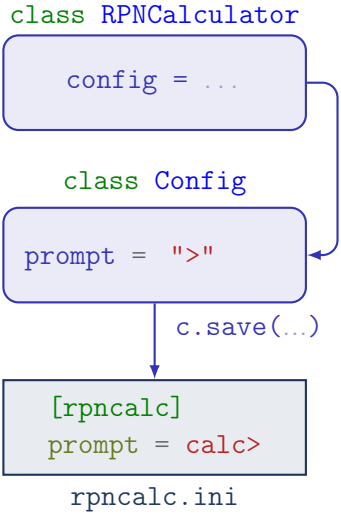
```
$ python -m rpncalc.rpn_v2
> set prompt=calc>
calc> q
```

The change would automatically be persisted in a config:

```
$ cat rpncalc.ini
[rpncalc]
prompt = calc>
```

And loaded again when running rpncalc a second time:

```
$ python -m rpncalc.rpn_v2
calc>
```



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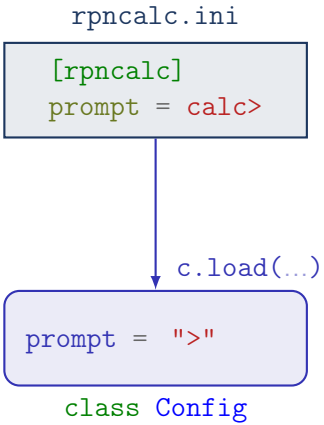
calc>
```



Reverse Polish Notation (RPN)

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$ python -m rpncalc.rpn_v2
> set prompt=calc>
calc> q
```

The change would automatically be persisted in a config:

```
$ cat rpncalc.ini
[rpncalc]
prompt = calc>
```

And loaded again when running rpncalc a second time:

```
$ python -m rpncalc.rpn_v2
calc>
```

There could be more settings in the future as well (e.g. precision or rounding), all stored by the `Config` class.

For simplicity, the `set` command is not actually implemented in `rpncalc/rpncalc_v2.py`.

However, the necessary `Config.load()` and `Config.save()` methods in `utils.py` are, and we want to test them now.

Reverse Polish Notation (RPN)

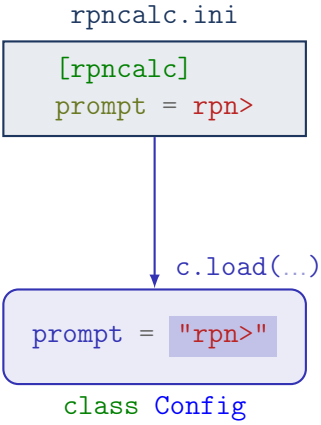
Saving and loading config

rpncalc/utils.py

```python
class Config:
    ...

    def load(self, path: pathlib.Path) -> None:
        parser = configparser.ConfigParser()
        parser.read(path)
        self.prompt = parser["rpncalc"]["prompt"]
```

Loading

```python
ini_path = Path("rpncalc.ini")
c = Config()
c.load(ini_path)
```



Reverse Polish Notation (RPN)

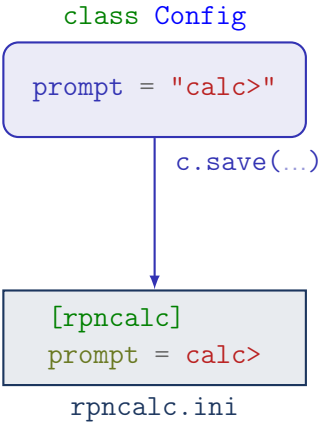
Saving and loading config

rpncalc/utils.py

```python
class Config:
    ...

    def save(self, path: pathlib.Path) -> None:
        parser = configparser.ConfigParser()
        parser["rpncalc"] = {"prompt": self.prompt}
        with path.open("w") as f:
            parser.write(f)
```

Saving

```python
ini_path = Path("rpncalc.ini")
c = Config(prompt="calc>")
c.save(ini_path)
```



Builtin fixtures

pyte.st/tmp-path

tmp_path

rpncalc/test_utils.py

```python
@pytest.fixture
def ini_path(tmp_path: Path) -> Path:
    return tmp_path / "rpncalc.ini"


def test_config_save(
    ini_path: Path, config: Config
):
    # call config.save(...), ensure that
    # the ini file is written correctly
    ...
```

```
/tmp/                    (system-wide temp directory)
└── pytest-of-florian/
    ├── pytest-0/
    │   └── test_config_save0/
    │       └── rpncalc.ini
    ├── pytest-1/
    │   └── test_config_save0/
    │       └── rpncalc.ini
    └── pytest-2/
        └── ...
```

Builtin fixtures

pyte.st/tmp-path

tmp_path

rpncalc/test_utils.py

```python
@pytest.fixture
def example_ini(ini_path: Path) -> Path:
    # creates rpncalc.ini with pathlib
    ini_path.write_text(
        "[rpncalc]\n"
        "prompt = rpn>\n")
    return ini_path

def test_config_load(
    example_ini: Path, config: Config
):
    # call config.load(...), ensure that the prompt is set to "rpn>"
    ...
```

```
/tmp/                    (system-wide temp directory)
└── pytest-of-florian/
    ├── pytest-0/
    │   └── test_config_load0/
    │       └── rpncalc.ini
    ├── pytest-1/
    │   └── test_config_load0/
    │       └── rpncalc.ini
    └── pytest-2/
        └── ...
```

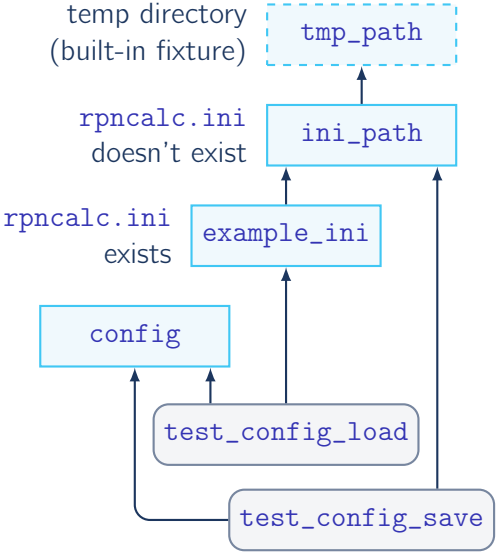
Builtin fixtures

pyte.st/tmp-path

tmp_path

rpncalc/test_utils.py

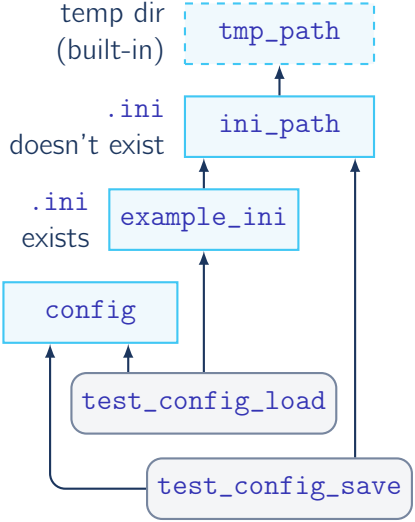
```python
@pytest.fixture
def ini_path(tmp_path: Path) -> Path:
    return tmp_path / "rpncalc.ini"


@pytest.fixture
def example_ini(ini_path: Path) -> Path:
    # creates rpncalc.ini with pathlib
    ini_path.write_text(
        "[rpncalc]\n"
        "prompt = rpn>\n")
    return ini_path
```



Builtin fixtures

pyte.st/tmp-path

tmp_path



Exercise: `rpncalc/test_utils.py` load-save

- Complete `test_config_load`:
  - Call the `load` method with the prepared config file
  - Ensure that `config.prompt` has changed from the default value (`>` → `rpn>`)
- Complete `test_config_save`:
  - Set `config.prompt` to a value
  - Call the `save` method with the non-existing ini path
  - Ensure the written file looks correct (`.exists()`, `.read_text()`, or `configparser`)
- **(optional)** Test calling `config.load` with an `ini` containing just `rpn>` (exc.: `configparser.Error`)

pytest fixtures: Where we are, what's next

We've seen how:

- Fixture values are returned from a fixture function (often just "fixture")
- Each fixture has a name (the function name)
- Test functions get its value injected as an argument by name
- Fixtures can use other fixtures
- Fixtures can be defined in a class, file, `conftest.py`, plugin, or built into pytest
- pytest provides various built-in fixtures (`monkeypatch`, `tmp_path`)

Next:

- Fixture values can be cached on a per scope basis
- `pytest.skip`/`.xfail` in fixtures
- Doing cleanup / teardown
- Using fixtures implicitly (`autouse`)
- Fixture functions can introspect calling side (`request`)
- Configuring fixtures via markers/CLI
- Fixture functions can be parametrized

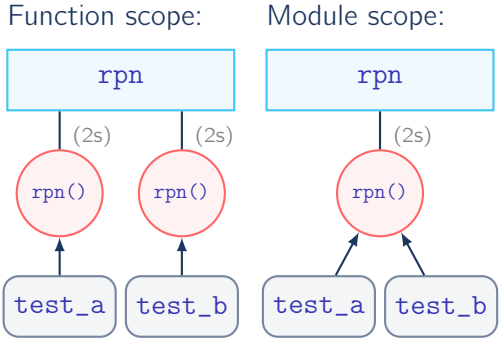
Caching fixture results

pyte.st/fixt-scope

Fixture functions can declare a caching scope:

fixtures/test_fixture_scope.py

```python
@pytest.fixture(scope="module")
def rpn() -> RPNCalculator:
    time.sleep(2)
    return RPNCalculator(Config())

def test_a(rpn: RPNCalculator):
    rpn.stack.append(42)
    assert rpn.stack == [42]

def test_b(rpn: RPNCalculator):
    assert not rpn.stack
```



Available scopes:

"function" (default), "class", "module", "package", "session"

Caching fixture results

pyte.st/fixt-scope

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```python
@pytest.fixture(scope="module")
def rpn() -> RPNCalculator:
    time.sleep(2)
    return RPNCalculator(Config())

def test_a(rpn: RPNCalculator):
    rpn.stack.append(42)
    assert rpn.stack == [42]

def test_b(rpn: RPNCalculator):
    assert not rpn.stack
```

Beware:

+ Faster tests (4s → 2s)

– Less isolation between tests:

```
...::test_a PASSED
...::test_b FAILED
```

```
def test_b(rpn: RPNCalculator):
>   assert not rpn.stack
E   assert not [42]
```

Caching fixture results

pyte.st/fixt-scope

Fixture functions can declare a caching scope:

fixtures/test_fixture_scope.py

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@pytest.fixture(scope="module")
def rpn() -> RPNCalculator:
    time.sleep(2)
    return RPNCalculator(Config())

def test_a(rpn: RPNCalculator):
    rpn.stack.append(42)
    assert rpn.stack == [42]

def test_b(rpn: RPNCalculator):
    assert not rpn.stack
```

How to avoid this pitfall?

- Can you make the return value immutable somehow?
- Can you copy it (e.g. `deepcopy`)?
- Can you reset the state between tests with a second fixture?
- ...or maybe even take a snapshot before the test and restore it after?

Doing cleanup with yield

pyte.st/fixt-yield

A fixture can use `yield` instead of `return` to run cleanup steps after the test:

fixtures/test_yield_fixture.py

```
@pytest.fixture(scope="function")
def connected_client() -> Iterator[Client]:
    client = Client()
    client.connect()
    yield client
    client.disconnect()


def test_client_1(connected_client: Client):
    print("in the test 1")
```

Demo: yield

- Observe the teardown behaviour using `-s` and/or `--setup-show`
- Modify caching scope, check how the behavior changes
- Remove caching again, call `pytest.skip(...)` before `client.connect()`, see what happens

Fixture summary

pytest fixtures are a modular, extensible mechanism to:

- Inject configurable resources into test functions
- Manage life-time / caching scope of resources
- Setup resources implicitly (autouse)
- Interact with tests requiring the resource
- Re-run tests with differently configured resources

Debugging failing tests

Arguments to control output

pyte.st/output

	`--tb`	Control traceback generation `--tb=auto` / `long` / `short` / `line` / `native` / `no`
`-l`	`--showlocals`	Show locals in tracebacks
`-s`	`--capture=no`	Disable output capturing
`-q`	`--quiet`	Decrease verbosity
`-v`	`--verbose`	Increase verbosity (can be given multiple times)

```
$ pytest --tb=short basic/test_traceback.py
...
_____________ test_divide _____________
basic/test_traceback.py:5: in test_divide
    assert calc(2, 0, "/") == 0
rpncalc/utils.py:14: in calc
    return a / b
E   ZeroDivisionError: division by zero
```

Arguments to select tests

pyte.st/mathspp-select

after (1) — (2) — (3) — (4) — (5) pass: ( ) fail: ( ) new: ( )

`--lf` `--last-failed` Run last-failed only

(2) — (4)

`--ff` `--failed-first` Run last-failed first

(2) — (4) — (1) — (3) — (5)

`--nf` `--new-first` Run new tests first

(6) — (1) — (2) — (3) — (4) — (5)

`-x` `--maxfail=`*n* Exit on first / *n*-th failure

(1) — (2)

`--sw` `--stepwise` Look at failures step by step

(1) — (2) , (2) , (2) , (2) — (3) — (4) , (4) , (4) — (5)

Tracing fixture setup/teardown

`--setup-show` Show fixtures as they are set up, used and torn down.

`--setup-only` Only setup fixtures, do not execute tests.

`--setup-plan` Show what fixtures/tests would be executed, but don't run.

Reminder: `--fixtures` and `--fixtures-per-test` can be useful as well.

Output:

```
fixtures/test_fixture.py
    SETUP    F rpn
    fixtures/test_fixture.py::test_empty_stack (fixtures used: rpn) .
    TEARDOWN F rpn
```

F: function scope, there is also Class, Module, Package, and Session

Adding information to an assert

Using a comma after `assert ...`, additional information can be printed:

```
def test_add(rpn: RPNCalculator):
    rpn.evaluate("2")
    rpn.evaluate("3")
    rpn.evaluate("1")
    rpn.evaluate("+")
    assert rpn.stack[-1] == 6 , rpn.stack
```

Output:

```
E    AssertionError: [2.0, 4.0]
E    assert 4.0 == 6
```

Some plugins

Using the coverage plugin

pyte.st/cov

Install plugin: `pip install pytest-cov`

Options:

`--cov=path`	filesystem path to generate coverage for `rpncalc/` as our code under test is there
`--cov-report=type`	type of report ("term", "html", . . .) `term-missing` to show lines not covered
`testpath`	path to tests `rpncalc/` as our tests are there too

Exercise:

coverage

- Run `pytest --cov=rpncalc/ --cov-report=term-missing rpncalc/` in the `code/` folder, take a look at the terminal output.
- Rerun with `--cov-report=html`, then open `htmlcov/index.html`, look at the report

Reporting plugins / features

- **pytest-instafail** reports failure details while tests are running.
- **pytest-html**
- **–junitxml**
- **pytest-reportlog**
- **record_property**
- **custom plugin**

```
code/plugins/reporting$ pytest --instafail
...
test_instafail.py ..............................F

____________________ test_bad ____________________

    def test_bad():
>       assert False
E       assert False

test_instafail.py:8: AssertionError

test_instafail.py ........................
```

Reporting plugins / features

- **pytest-instafail**
- **pytest-html**
  generates (customizable) HTML reports.
- **–junitxml**
- **pytest-reportlog**
- **record_property**
- **custom plugin**

Report generated on 22-Dec-2015 at 09:00:24

Environment

Driver	Firefox
Platform	Darwin-15.2.0-x86_64-i386-64bit
Python	2.7.10

Summary

4 tests ran in 21.01 seconds.
1 passed, 1 skipped, 1 failed, 0 errors.
1 expected failures, 1 unexpected passes.

Results

Result	Test	Duration	Links
Failed	test_selenium_report.py::test_home	5.08	URL Screenshot HTML Browser Log Driver Log

```
selenium = <selenium.webdriver.firefox.webdriver.WebDriver (session="19a505a7-b481-8c4d-a289-2ecf8cdcfc43")>

    def test_home(selenium):
        selenium.get('https://www.mozilla.org/')
        selenium.find_element_by_id('close_takeover').click()
>       assert selenium.title == 'We're building a better Internet - Mozilla'
E       assert 'We're buil...net - Mozilla' == "We're buildin...net - Mozilla"
E         - We're building a better Internet - Mozilla
E         ?   ^
E         + We're building a better Internet - Mozilla
E         ?   ^

test_selenium_report.py:7: AssertionError
------------------------------ pytest-selenium ------------------------------
URL: https://www.mozilla.org/en-US/
```

XFailed	test_selenium_report.py::test_firefox	4.56	URL Screenshot HTML Browser Log Driver Log

```
selenium = <selenium.webdriver.firefox.webdriver.WebDriver (session="2418e16d-4644-1f41-9be6-fc0d24c883b1")>

    @pytest.mark.xfail(reason='Test is failing due to known bug')
    def test_firefox(selenium):
        selenium.get('https://www.mozilla.org/firefox/products/')
>       assert selenium.title == 'Firefox - Desktop browser, Android - Mozilla'
E       assert 'Firefox - De...ing - Mozilla' == 'Firefox - Des...oid - Mozilla'
E         - Firefox - Desktop browser, Android, iOS, OS, Hello, Sync, Private Browsing - Mozilla
E         + Firefox - Desktop browser, Android - Mozilla

test_selenium_report.py:27: AssertionError
------------------------------ pytest-selenium ------------------------------
URL: https://www.mozilla.org/en-US/firefox/products/
```

XPassed	test_selenium_report.py::test_thunderbird	0.19	
Skipped	test_selenium_report.py::test_participate	0.00	

```
('test_selenium_report.py', 13, u'Skipped: Test is not ready yet')
```

Passed	test_selenium_report.py::test_about	0.10	

Reporting plugins / features

- **pytest-instafail**
- **pytest-html**
- **–junitxml**
  generates JUnit XML reports.
- **pytest-reportlog**
- **record_property**
- **custom plugin**

```
<?xml version="1.0" encoding="utf-8"?>
<testsuites>
  <testsuite name="pytest" errors="0" failures="1"
        skipped="0" tests="2" time="0.029" ... >
    <testcase name="test_ok" ... />
    <testcase name="test_bad" ...>
      <failure message="ZeroDivisionError: ...">
       def test_bad():
       &gt;       1/0
       E       ZeroDivisionError: division by zero

       test_reporting.py:5: ZeroDivisionError
      </failure>
    </testcase>
  </testsuite>
</testsuites>
```

Reporting plugins / features

- **pytest-instafail**
- **pytest-html**
- **–junitxml**
- **pytest-reportlog**
  JSON reports in a pytest-specific format.
- **record_property**
- **custom plugin**

```
{..., "$report_type": "SessionStart"}
{..., "$report_type": "CollectReport"}
{
    "nodeid": "test_rep.py::test_ok",
    "location": ["test_rep.py", 0, "test_ok"],
    "keywords": {...},
    "outcome": "passed", "longrepr": null,
    "when": "setup",  # setup / call / teardown
    "user_properties": [], "sections": [],
    "duration": ..., "start": ..., "stop": ...,
    "$report_type": "TestReport"
}
...
{"exitstatus": 1, "$report_type": "SessionFinish"}
```

Reporting plugins / features

- **pytest-instafail**
- **pytest-html**
- **–junitxml**
- **pytest-reportlog**
- **record_property** fixture to add custom data to XML / JSON reports.
- **custom plugin**

```python
def test_function(record_property):
    record_property("example_key", 1)
```

```
<testcase ...>
    <properties>
        <property name="example_key" value="1" />
    </properties>
</testcase>
```

```
{
    ...,
    "user_properties": [["example_key", 1]],
    "$report_type": "TestReport"
}
```

Reporting plugins / features

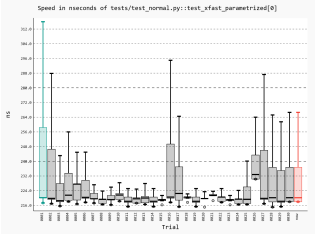
- **pytest-instafail**
- **pytest-html**
- **–junitxml**
- **pytest-reportlog**
- **record_property**
- **custom plugin**
  Hooks to get data as Python objects.

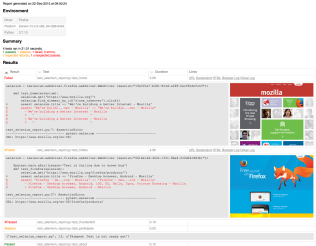
```
def pytest_sessionstart(session: Session):
    ...

def pytest_collectreport(report: CollectReport):
    ...

def pytest_runtest_logreport(report: TestReport):
    ...

def pytest_warning_recorded(...):
    ...

def pytest_sessionfinish(session, exitstatus):
    ...
```

Plugins, plugins . . .

pyte.st/plugins

- **Property-based testing:** hypothesis
- **Customized reporting:** pytest-html, pytest-rich, pytest-instafail, pytest-emoji
- **Repeating tests:** pytest-repeat, pytest-rerunfailures, pytest-benchmark
- **Framework/Language integration:** pytest-twisted, pytest-django, pytest-qt, pytest-asyncio, pytest-cpp
- **Coverage and mock integration:** pytest-cov, pytest-mock
- **Other:** pytest-bdd (behaviour-driven testing), pytest-xdist (distributed testing)
- . . . > 1600 more: https://pyte.st/plugins





Writing your own plugins

Writing pytest plugins

pyte.st/writing-plugins

Plugins come in two flavours:

- Local plugins: `conftest.py` files
- Installable plugins via packaging entry points

They can contain fixtures, plus hook implementations for:

- configuration
- collection
- test running
- reporting

A hook is auto-discovered by its `pytest_···` name.

Adding to header and summary

pytest_report_header

pyte.st/report-header

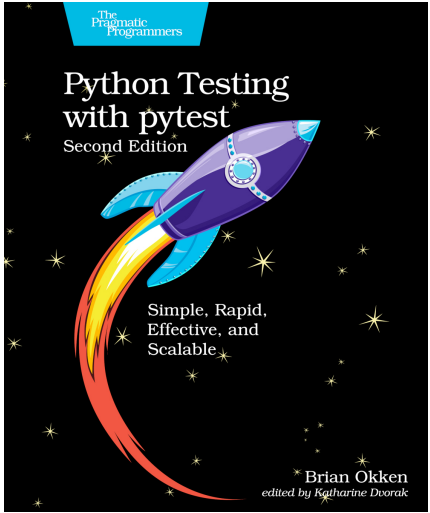
hooks/reporting/conftest.py

```python
def pytest_report_header() -> list[str]:
    return ["extrainfo: line 1"]
```

```
$ pytest
======================== test session starts ========================
platform linux -- Python ..., pytest-..., pluggy-...
extrainfo: line 1
...
======================= no tests ran in 0.00s =======================
```

Book recommendation

Brian Okken: Python Testing with pytest, Second Edition (The Pragmatic Bookshelf)



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- https://pragprog.com/titles/bopytest2/
- Discount code: **EuropythonJuly2025**
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- Full disclosure: I'm technical reviewer
  (but don't earn any money from it)

Also by Brian Okken:
"Test & Code" podcast, testandcode.com

Where to go next

aka “shameless self promotion”

pytest tips and tricks

for a better testsuite

Florian Bruhin

pytest

BRUHIN SOFTWARE

PyConDE & PyData Berlin

April 22nd, 2024

Description

2024.pycon.de/program/DSFWRC/

Repository

The-Compiler/pytest-tips-and-tricks

Recording (Youtube)

pyte.st/talk-tips

Where to go next

aka “shameless self promotion”

Property based testing with Hypothesis

The-Compiler/hypothesis-talk

Florian Bruhin

October 17th, 2024

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At Swiss Python Summit 2024:

Repository

The-Compiler/hypothesis-talk

Recording (media.ccc.de)

`pyte.st/talk-hypothesis`

Recording (Youtube)

`youtu.be/6a1RvMKj0ws`

Upcoming events

- **March 3rd – 5th 2026**
  Python Academy (python-academy.com)
  Professional Testing with Python (3 days)
  Leipzig, Germany & Remote

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- **Custom training / coaching:**
  - Python
  - pytest
  - GUI programming with Qt
  - Best Practices
    (packaging, linting, etc.)
  - Git
  - ...

  Remote or on-site
  `florian@bruhin.software`
  `https://bruhin.software/`

Feedback and questions

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The-Compiler/pytest-basics