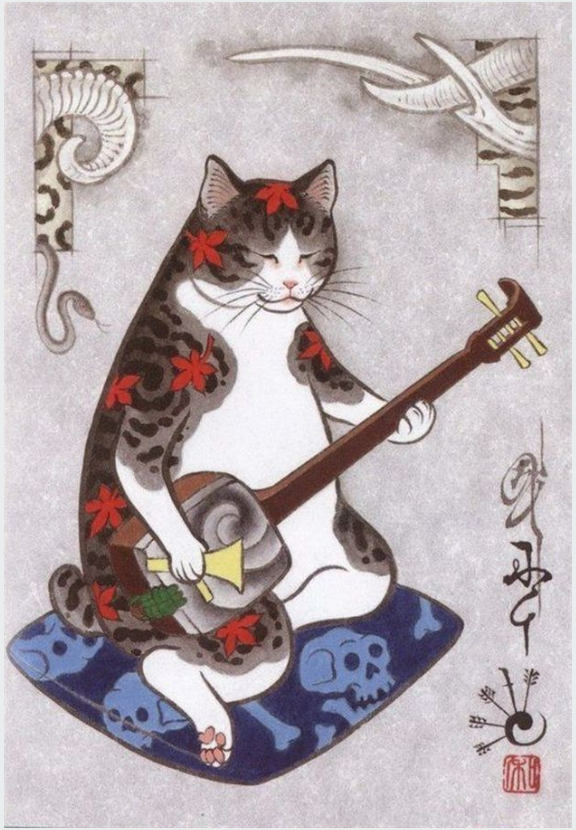
Functional Programming inside OOP?

It’s possible with Python

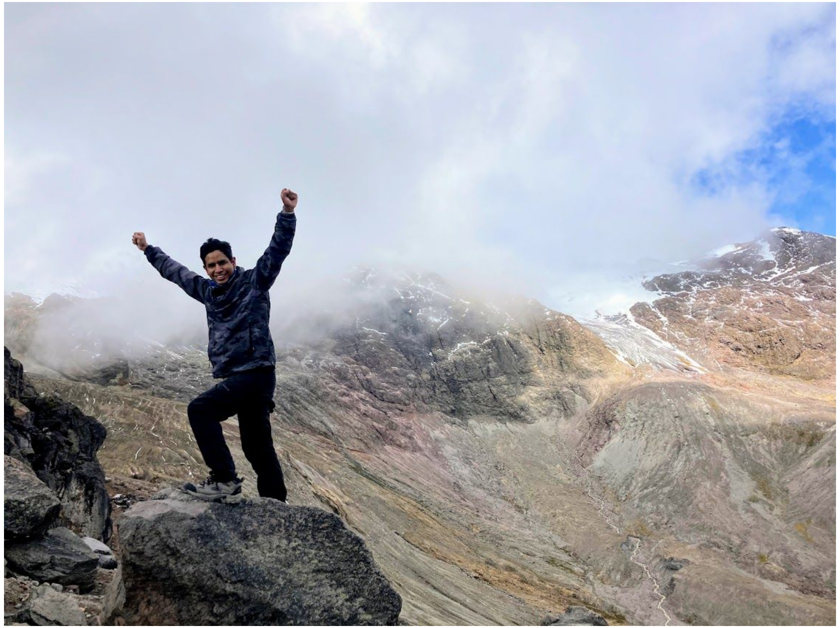


>>>whoami()

Carlos Villavicencio

- Ecuadorian 🇪🇨
- Currently: Python & TypeScript
- Community leader
- Martial arts: 剣道、居合道
- Nature photography enthusiast

po5i



Cayambe Volcano, 2021.

>>>why_functional_programming

- Easier and efficient
- Divide and conquer
- Ease debugging
- Makes code simpler and readable
- Also easier to test

>>>history()

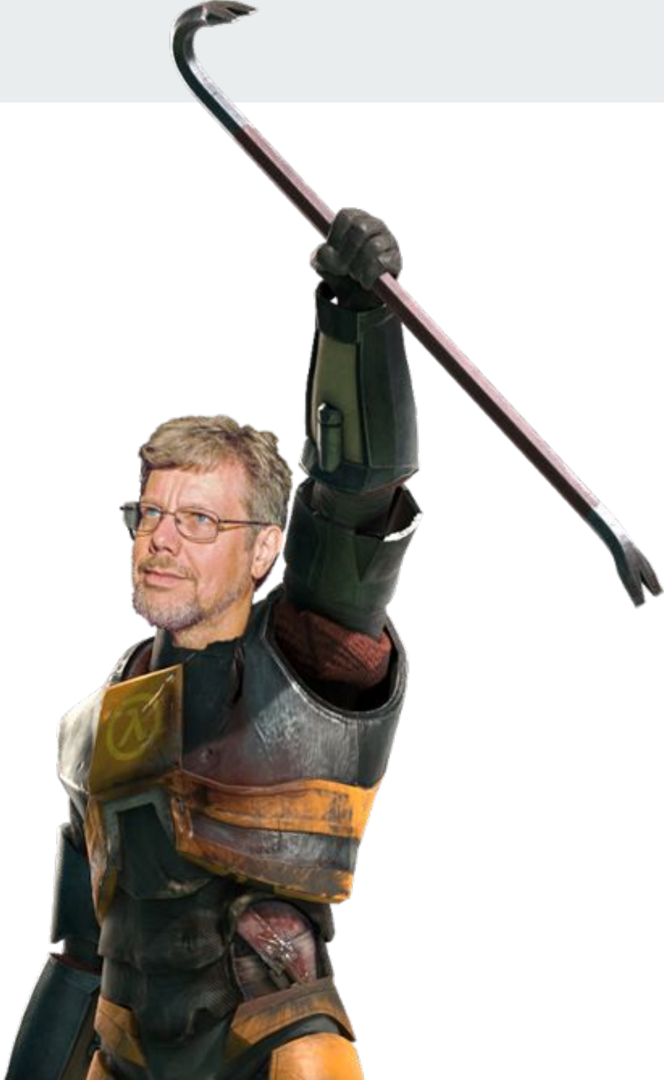
- Functions were first-class objects from design.
- Users wanted more functional solutions.
- 1994: map, filter, reduce and lambdas were included.
- In Python 2.2, lambdas have access to the outer scope.

“Not having the choice streamlines the thought process.”

- Guido van Rossum.

The fate of reduce() in Python 3000

https://python-history.blogspot.com/2009/04/origins-of-pythons-functional-features.html



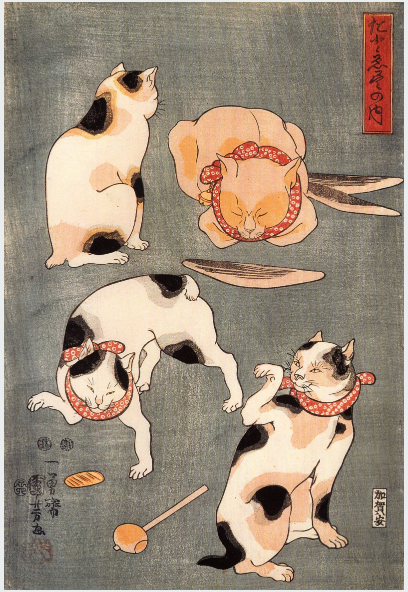
>>>has_django_fp()

```python
def is_valid(self):
    """
    Returns True if form.errors is empty for every form in self.forms.
    """
    if not self.is_bound:
        return False
    # We loop over every form.errors here rather than short circuiting on the
    # first failure to make sure validation gets triggered for every form.
    forms_valid = True
    for errors in self.errors:
        if bool(errors):
            forms_valid = False
    return forms_valid and not bool(self.non_form_errors())
```

```python
def is_valid(self):
    """Return True if every form in self.forms is valid."""
    if not self.is_bound:
        return False
    # Accessing errors triggers a full clean the first time only.
    self.errors
    # List comprehension ensures is_valid() is called for all forms.
    # Forms due to be deleted shouldn't cause the formset to be invalid.
    forms_valid = all([
        form.is_valid() for form in self.forms
        if not (self.can_delete and self._should_delete_form(form))
    ])
    return forms_valid and not self.non_form_errors()
```

https://github.com/django/django/blob/46786b4193e04d398532bbfc3dcf63c03c1793cb/django/forms/formsets.py#L201-L213
https://github.com/django/django/blob/ca9872905559026af82000e46cde6f7dedc897b6/django/forms/formsets.py#L316-L328

Immutability



An immutable object is an object whose state cannot be modified after it is created.

Booleans, strings, and integers are immutable objects.

List and dictionaries are mutable objects.

Thread safety

>>>immutability

```python
def update_list(value: list) -> None:
    value += [10]
```

```python
def update_number(value: int) -> None:
    value += 10
```

```python
>>> foo = [1, 2, 3]
>>> id(foo)
4479599424
>>> update_list(foo)
>>> foo
[1, 2, 3, 10]
>>> id(foo)
4479599424
```

```python
>>> foo = 10
>>> update_number(foo)
>>> foo
10
```

🤔

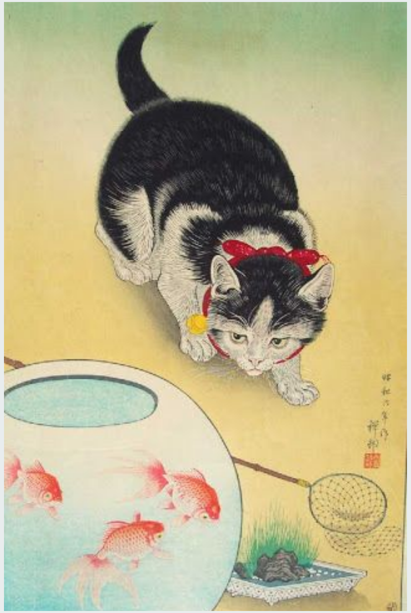
>>>immutability

```python
def update_number(value: int) -> None:
    print(value, id(value))
    value += 10
    print(value, id(value))
```

```
>>> foo = 10
>>> update_number(foo)
10 4478220880  🙅
20 4478221200
>>> foo
10
```

https://medium.com/@meghamohan/mutable-and-immutable-side-of-python-c2145cf72747

Decorators



They are functions which modify the functionality of other functions.

Higher order functions.

Closures?

>>>decorators

```
def increment(x: int) -> int:
    return x + 1

>>> increment(2)
3
```

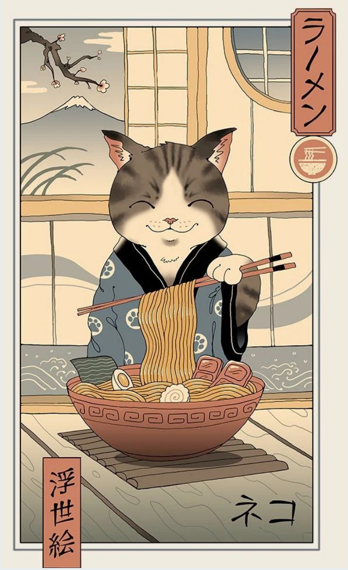
>>>decorators

```
def increment(x: int) -> int:
    return x + 1

def double_increment(func: Callable) -> Callable:
    def wrapper(x: int):
        r = func(x)   # func is saved in __closure__
        y = r * 2
        return y
    return wrapper
```

>>>decorators

```
@double_increment
def increment(x: int) -> int:
    return x + 1


>>> increment(2)
6
>>> increment.__closure__[0].cell_contents
<function increment at 0x7eff362cf940>
>>> increment.__closure__[0].cell_contents(2)
3
```

Partial application of functions



They reduce the number of arguments that any function takes.

Makes functions easier to compose with others.

>>>partial_application

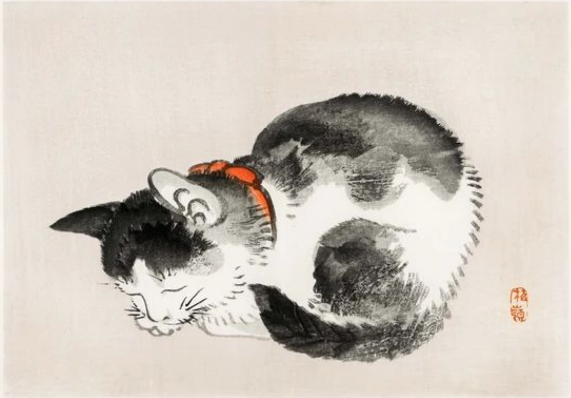
```python
def get_url(url: str, role: str) -> str:
    pass
```

```python
from functools import partial

get_admin_url = partial(get_url, "admin")
```

>>>partial_application

```
import re
from functools import partial

email_match = partial(re.match, r"^(\w|\.|\_|\-)+[@](\w|\_|\-|\.)+[.]\w{2,3}$")

url_match = partial(re.match,
r"(?i)\b((?:https?://|www\d{0,3}[.]|[a-z0-9.\-]+[.][a-z]{2,4}/)(?:[^\s()<>]+|\(([^\s()<>
]+|(\([^\s()<>]+\)))*\))+(?:\(([^\s()<>]+|(\([^\s()<>]+\)))*\)|[^\s`!()\[\]{};:'\".,<>?
«»“”‘’]))")
```

Lazy Evaluation



It holds the evaluation of an expression until the value is finally needed.

Reduce the memory footprint.

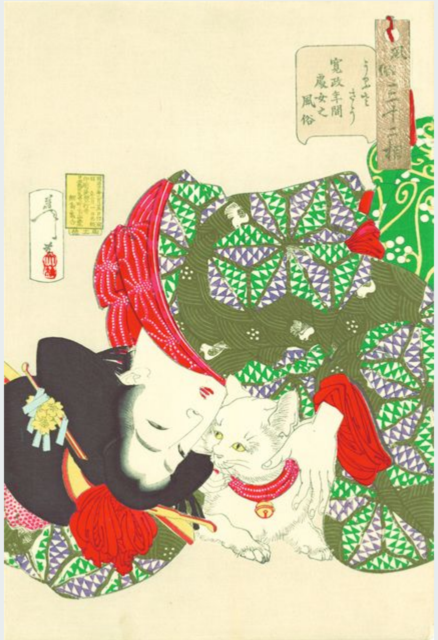
>>>lazy_evaluation

```
def generator():
    i = 1
    while True:
        yield i
        i += 1
```

>>>lazy_evaluation

```python
with open(filename, 'r') as f:
    for line in f:
        process(line)
```

Type Annotations



PEP 484

Available since Python 3.5

Reduce bugs at runtime

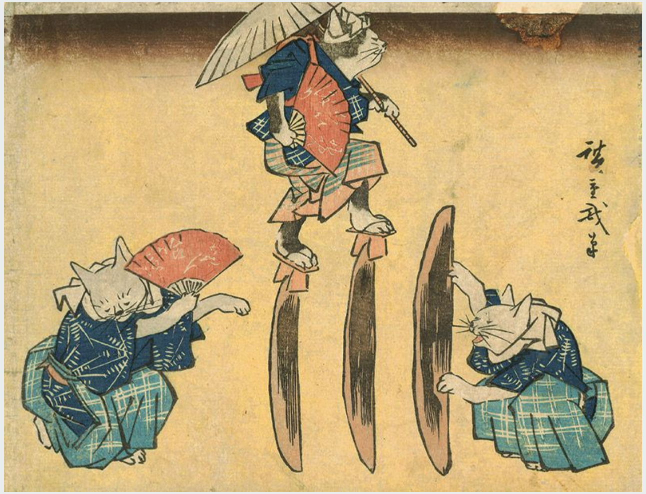
Improves readability

>>>__annotations__

Read tutorial at
stackbuilders.com

Watch my talk at
PyCon China 2020

Structural Pattern Matching



PEP-634

Available since Python 3.10

It doesn’t work as C or JavaScript

It’s a declarative approach!

>>>structural_pattern_matching

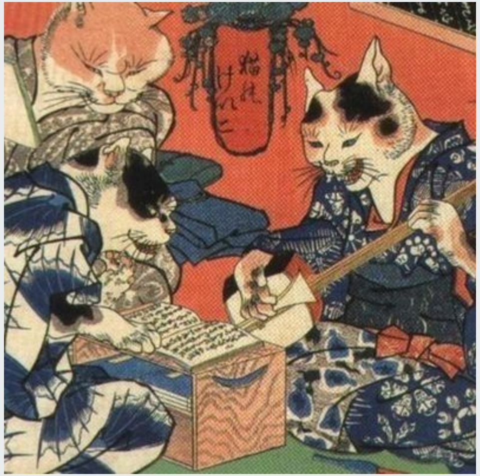
```python
# point is an (x, y) tuple[int, int]
match point:
    case (0, 0):
        print("Origin")
    case (0, y):
        print(f"Y={y}")
    case (x, 0):
        print(f"X={x}")
    case (x, y) if x == y:  # guard
        print(f"X=Y={x}")
    case (x, y):
        print(f"X={x}, Y={y}")
    case _:  # wildcard
        raise ValueError("Not a point")
```

https://docs.python.org/3.10/whatsnew/3.10.html#pep-634-structural-pattern-matching

>>>structural_pattern_matching

```python
# test_variable is a tuple[str, Any, int]
match test_variable:
    case ('warning', code, 40):
        print("A warning has been received.")
    case ('error', code, _):
        print(f"An error {code} occurred.")
```

Other Functional Programming Patterns



When Python doesn’t offer a way to do it, you can always implement it.

Currying

Composition

>>>currying

If a function f_n takes n arguments, then you can turn that into a function c_n which takes one argument and returns a function c_{n-1} that takes $n-1$ arguments, and has access to the argument that was passed to c_n (hence c_{n-1} is a closure)

https://sagnibak.github.io/blog/python-is-haskell-currying/

>>>currying

```python
def f_5(a: int, b: int, c: int, d: int, e: int) -> int:
    return a + b + c + d + e
```

>>>currying

```
def c_5(a: int) -> Callable:
    def c_4(b: int) -> Callable:
        def c_3(c: int) -> Callable:
            def c_2(d: int) -> Callable:
                def c_1(e: int): int:
                    return f_5(a, b, c, d, e)
                return c_1
            return c_2
        return c_3
    return c_4
```

Then, `f_5(1, 2, 3, 4, 5) == c_5(1)(2)(3)(4)(5)`

>>>currying

```python
@curry(num_args=5)
def c_5(a: int, b: int, c: int, d: int, e: int) -> int:
    a + b + c + d + e
```

https://sagnibak.github.io/blog/python-is-haskell-currying/

>>>composition

```
▸ cat .env|grep DEBUG
ASSETS_DEBUG=True
SENTRY_DEBUG=False
```

>>>composition

```
sortByDateDescending = reverse . sortByDate
```

>>>composition

```python
def compose2(f, g):
    return lambda x: f(g(x))
```

https://mathieularose.com/function-composition-in-python

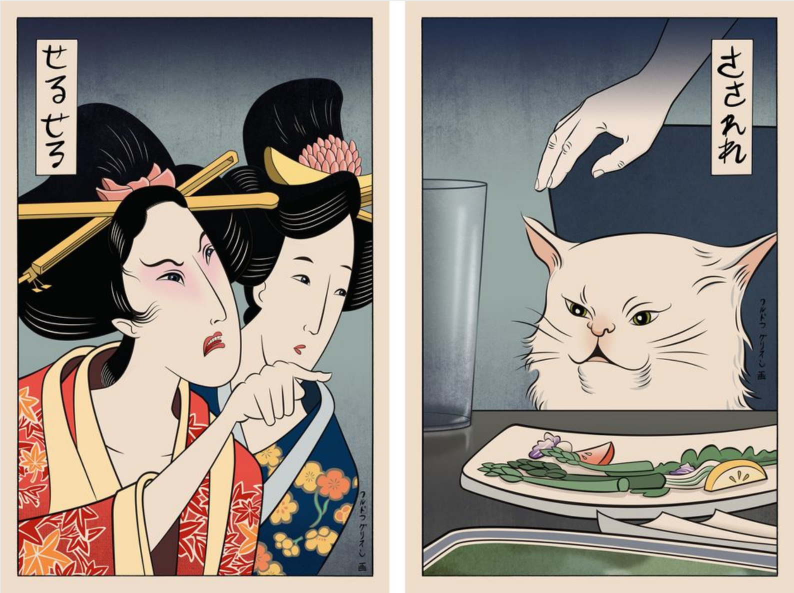
>>>composition

```
import functools

def compose(*functions):
    def compose2(f, g):
        return lambda x: f(g(x))
    return functools.reduce(compose2, functions, lambda x: x)
```

>>>composition

```
def td(val: str) -> str:
  return f"<td>{val}</td>"

def tr(val: str) -> str:
  return f"<tr>{val}</tr>"

def table(val: str) -> str:
  return f"<table>{val}</table>"

>>> one_cell_table = compose(table, tr, td)
>>> one_cell_table("something")
'<table><tr><td>something</td></tr></table>'
```

Testing



Everything we covered before makes our tests easier.

>>>import unittest

“Code that is hard to test is not good code”

- Joe Eames.

https://dev.to/leolanese/making-unit-test-fun-again-with-functional-programming-4g8m

>>>import unittest

“The outcome of a function is dependent only on the input and nothing else”

- Unknown author.

https://dev.to/leolanese/making-unit-test-fun-again-with-functional-programming-4g8m

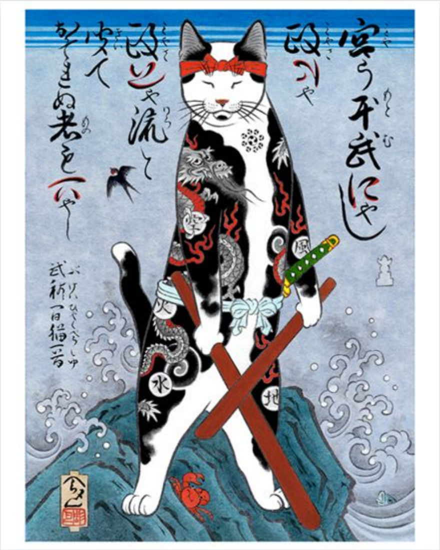
>>>import unittest

“OO makes code understandable by encapsulating moving parts.
FP makes code understandable by minimizing moving parts.”

- Michael Feathers.

https://dev.to/leolanese/making-unit-test-fun-again-with-functional-programming-4g8m

Thank you for your attention 😊



Questions?

Feedback?

Suggestions?

po5i