

FUNCTIONAL PROGRAMMING IN PYTHON

ABOUT ME

DATA SCIENTIST @ IDALAB (MAINLY PYTHON)
USED RUBY, JS, PYTHON, HASKELL FOR NONTRIVIAL PROJECTS
PLAYED WITH CLOJURE, SCALA, ERLANG, ELIXIR

[HTTP://KIRELABS.ORG/FUN-JS](http://kirelabs.org/fun-js)

ABOUT THIS TALK

- > **NOT** A MOTIVATION OF FUNCTIONAL PROGRAMMING
 - > **HOW** CAN FP BY USED IN PYTHON

DISCLAIMER

- THERE SHOULD BE ONE
- AND PREFERABLY ONLY ONE –
- OBVIOUS WAY TO DO IT.
- PEP 20 – THE ZEN OF PYTHON

DISCLAIMER (CONT)

THE FATE OF `reduce()` IN PYTHON 3000

NOT HAVING THE CHOICE STREAMLINES THE THOUGHT PROCESS
– GUIDO VAN ROSSUM

FUNCTIONAL PROGRAMMING (IN PYTHON)

- > FIRST CLASS FUNCTIONS
- > HIGHER ORDER FUNCTIONS
 - > PURITY
 - > IMMUTABILITY
 - > COMPOSITION
- > PARTIAL APPLICATION & CURRYING
 - > RECURSION

FUNCTIONAL PROGRAMMING (IN PYTHON)

- > FIRST CLASS FUNCTIONS
- > HIGHER ORDER FUNCTIONS
 - > PURITY
- > ~~IMMUTABILITY~~ (NOT TODAY)
 - > COMPOSITION
- > PARTIAL APPLICATION & CURRYING
 - > ~~RECURSION~~ (NEITHER)

PURITY

FUNCTIONS WITHOUT SIDE-EFFECTS

```
def add(a, b):  
    return a + b
```

```
additions_made = 0
```

```
def add(a, b):  
    additions_made += 1  
    return a + b
```


FIRST CLASS FUNCTIONS

```
def add(a, b):  
    return a + b
```

```
add_function = add
```

```
add = lambda a,b: a + b
```

HIGHER ORDER FUNCTIONS

```
def timer(fn):  
    def timed(*args, **kwargs):  
        t = time()  
        fn(*args, *kwargs)  
        print "took {time}".format(time=time()-t)  
  
    return timed  
  
def compute():  
    #...  
  
timed_compute = timer(compute)  
timed_compute()
```

DECORATORS

```
@timer  
def compute():  
    sleep(1)
```

```
compute()
```

PARTIAL FUNCTION APPLICATION

```
def add1(num):  
    return add(1, num)  
add1(1)
```

```
# simpler  
from functools import partial  
add1 = partial(add, 1)  
add1(1)
```

CURRYING

[...] TRANSFORMING A FUNCTION THAT TAKES MULTIPLE ARGUMENTS IN SUCH A WAY THAT IT CAN BE CALLED AS A CHAIN OF FUNCTIONS, EACH WITH A SINGLE ARGUMENT (PARTIAL APPLICATION)

– WIKIPEDIA

CURRYING

```
def curried_add(a):  
    def inner(b):  
        return add(a,b)
```

```
add(1)      # => <function ...>
```

```
add(1)(1)   # => 2
```

INTERLUDE: CLOSURES

```
def curried_add(a):  
    def inner(b):  
        return add(a,b)
```

```
add(1)      # => <function ...>
```

```
add(1)(1)   # => 2
```

CURRYING EXAMPLE FROM THE STDLIB

```
from operator import itemgetter, attrgetter, methodcaller
```

```
obj.method()
```

```
from operator import methodcaller  
methodcaller("method")(obj)
```


FUNCTIONAL COLLECTION TRANSFORMATIONS

MAP

```
map(f, iter)
```

```
[f(e1) for e1 in seq]
```

FILTER

```
filter(p, seq)
```

```
[el for el in seq if p(el)]
```

REDUCE

```
from functools import reduce  
reduce(f, seq, initial)
```

```
result = initial  
for el in seq:  
    result = f(result, el)
```

$$f: (\square, \circ) \rightarrow \square \quad \square \quad [\circ \quad \text{green oval} \quad \text{blue oval} \quad \text{dark blue circle} \quad \text{light green oval}]$$

$$f(\square, \circ) \rightarrow \text{dark red square} \quad [\text{green oval} \quad \text{blue oval} \quad \text{dark blue circle} \quad \text{light green oval}]$$

$$f(\text{dark red square}, \text{green oval}) \rightarrow \text{yellow square} \quad [\text{blue oval} \quad \text{dark blue circle} \quad \text{light green oval}]$$

...

$$f(\text{orange square}, \text{light green oval}) \rightarrow \text{pink square}$$

FUNCTION COMPOSITION

```
[f(x) for x in seq if p(x)]
```

```
map(f, filter(p, seq))
```

```
from toolz.curried import compose, map, filter  
compute = compose(map(f), filter(p))  
compute(seq)
```

EXAMPLE: A BAD CSV PARSER (1/3)

```
csv = """firstName;lastName  
Jim;Drake  
Ben;James  
Tim;Banes"""
```

```
target = [{'firstName': 'Jim', 'lastName': 'Drake'},  
          {'firstName': 'Ben', 'lastName': 'James'},  
          {'firstName': 'Tim', 'lastName': 'Banes'}]
```

EXAMPLE: IMPERATIVE PYTHON (2/3)

```
lines = csv.split("\n")
matrix = [line.split(';') for line in lines]
header = matrix.pop(0)
records = []
for row in matrix:
    record = {}
    for index, key in enumerate(header):
        record[key] = row[index]
    records.append(record)
```


EXAMPLE: FUNCTIONAL PYTHON (3/3)

```
from toolz.curried import compose, map
from functools import partial
from operator import methodcaller

split = partial(methodcaller, 'split')
split_lines = split("\n")
split_fields = split(';')
dict_from_keys_vals = compose(dict, zip)
csv_to_matrix = compose(map(split_fields), split_lines)

matrix = csv_to_matrix(csv)
keys = next(matrix)
records = map(partial(dict_from_keys_vals, keys), matrix)
```

EXAMPLE: PYSPARK

```
docker run --rm -v ${PWD}:/home/jovyan/work -p 8888:8888 jupyter/pyspark-notebook
```

```
def sample(p):  
    x, y = random(), random()  
    return 1 if x*x + y*y < 1 else 0  
  
count = sc.parallelize(range(0, NUM_SAMPLES)) \  
    .map(sample) \  
    .reduce(lambda a, b: a + b)  
print("Pi is roughly %f" % (4.0 * count / NUM_SAMPLES))
```

EXAMPLE: K-MEANS

(STOLEN AND MODIFIED FROM JOEL GRUS)

```
def kmeans(points, k):  
    return until_convergence(  
        iterate(  
            find_new_means(points),  
            random.sample(points, k)))
```

```
def until_convergence(it):  
    return last(accumulate(no_repeat, it))  
  
def no_repeat(prev, curr):  
    if prev == curr: raise StopIteration  
    else: return curr
```

```
import random
from toolz.curried import iterate, accumulate, curry, groupby, last, compose

def kmeans(k, points):
    return until_convergence(iterate(find_new_means(points), random.sample(points, k)))

@curry
def find_new_means(points, old_means):
    k = len(old_means)
    clusters = groupby(compose(str, closest_mean(old_means)), points).values()
    return list(map(cluster_mean, clusters))
```

```
@curry
```

```
def closest_mean(means, point):  
    return min(means, key=squared_distance(point))
```

```
@curry
```

```
def squared_distance(p, q):  
    return sum((p_i - q_i)**2 for p_i, q_i in zip(p, q))
```

```
def cluster_mean(points):  
    num_points = len(points)  
    dim = len(points[0]) if points else 0  
    sum_points = [sum(point[j] for point in points)  
                  for j in range(dim)]  
    return [s / num_points for s in sum_points]
```

MAIN TAKEAWAYS

- > FP IS POSSIBLE IN PYTHON (TO A DEGREE)
- > SMALL COMPOSABLE FUNCTIONS ARE GOOD
- > FP == BUILD GENERAL TOOLS AND COMPOSE THEM

WHATS MISSING IN PYTHON (OR WHAT I AM MISSING)

- > MORE LIST FUNCTIONS
- > NICER LAMBDA SYNTAX
- > AUTOMATIC CURRYING, COMPOSITION SYNTAX
 - > ADTS (SUM TYPES)*
 - > PATTERN MATCHING

* POSSIBLE BUT UGLY [HTTP://STUPIDPYTHONIDEAS.BLOGSPOT.DE/2014/08/ADTS-FOR-PYTHON.HTML](http://stupidpythonideas.blogspot.de/2014/08/adts-for-python.html)

FUNCTIONAL LIBRARIES

(MORE LIST FUNCTIONS)

- [HTTP://TOOLZ.READTHEDOCS.IO/EN/LATEST/](http://toolz.readthedocs.io/en/latest/)
 - [HTTPS://GITHUB.COM/KACHAYEV/FN.PY](https://github.com/kachayev/fn.py)
- [HTTP://PEDRORODRIGUEZ.IO/PYFUNCTIONAL/](http://pedrorodriguez.io/pyfunctional/)

NICER LAMBDA SYNTAX

```
map(lambda x: x**2, range(5)) # => [0, 1, 4, 9, 16]
```

```
from fn import _  
map(_**2, range(5)) # => [0, 1, 4, 9, 16]
```

OTHER INTERESTING STUFF

- > SEPARATION OF PURE CODE AND SIDE EFFECTS:
[HTTPS://PYPI.PYTHON.ORG/PYPI/EFFECT/](https://pypi.python.org/pypi/effect/)
- > PERSISTENT IMMUTABLE DATA STRUCTURES
[HTTPS://PYPI.PYTHON.ORG/PYPI/PYRSISTENT/](https://pypi.python.org/pypi/persistent/)
- > [HTTPS://DOCS.PYTHON.ORG/3/HOWTO/FUNCTIONAL.HTML](https://docs.python.org/3/howto/functional.html)

OTHER TALKS (WHERE I HAVE STOLEN MATERIAL)

- > [HTTP://KACHAYEV.GITHUB.IO/TALKS/UAPYCON2012/](http://kachayev.github.io/talks/uapycon2012/)
 - > [HTTPS://VIMEO.COM/80096814](https://vimeo.com/80096814)
- > [HTTPS://GITHUB.COM/JOELGRUS/STUPID-ITERTOOLS-TRICKS-PYDATA](https://github.com/joelgrus/stupid-itertools-tricks-pydata)
 - > [HTTP://KIRELABS.ORG/FUN-JS](http://kirelabs.org/fun-js)

MORE FP?

- > SICP ([HTTP://DEPTINFO.UNICE.FR/~ROY/SICP.PDF](http://deptinfo.unice.fr/~roy/sicp.pdf))
 - > [HTTP://LEARNYOUAHASKELL.COM/](http://learnyouahaskell.com/)
 - > REAL WORLD HASKELL ([HTTP://BOOK.REALWORLDHASKELL.ORG/READ/](http://book.realworldhaskell.org/read/))

THANK YOU

DANIEL KIRSCH
DANIEL.KIRSCH@IDALAB.DE
@KIREL

[HTTPS://GITHUB.COM/KIREL/FUNCTIONAL-PYTHON](https://github.com/kirel/functional-python)