Functional Programing

May 10, 2022

You have probably heard this term a lot:

Object Oriented Programming

O.O.P. is a Paradigm

or a “way or programming”

Object Oriented Programming

The programmer defines a series of objects, and control flow is defined as a series of operations on these objects.

There are other paradigms

- **Imperative**
- **Declarative**
- **Structured**
- **Procedural**
- **Functional**
- **Function-Level**
- **Object-Oriented**
- **Flow-Driven**
- **Logic**
- **Constraint**
- **Aspect-Oriented**
- **Reflective**
- **Array**

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Functional Programming

The Functional paradigm is based on the philosophy of expressing program control flow through a series of (often nested) function calls, rather than through loops, variables, or classes.

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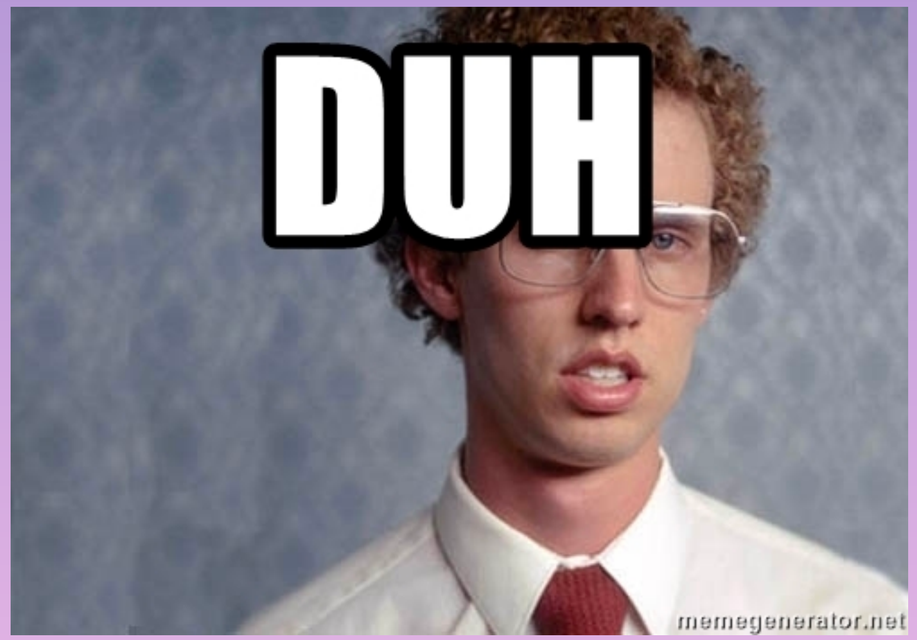
Python has a lot of features that allow for functional programming!

Code Comparisons: Multiple Paradigms

```
def squared_divisible_by_2_9(lst):
    ret_lst = []
    for elem in lst:
        if elem**2 % 2 == 0 and elem**2 % 9 == 0:
            ret_lst.append(elem**3)
    return ret_lst
```

Code Comparisons: Functional Programming

```
def squared_divisible_by_2_9(lst):
    return list(map(
        lambda x: x**3,
        filter(
            lambda x: x**2 % 2 == 0 and x**2 % 9 == 0,
            lst
        )
    ))
```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Code Comparisons

```
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```

Python has many features that allow for Functional Programming

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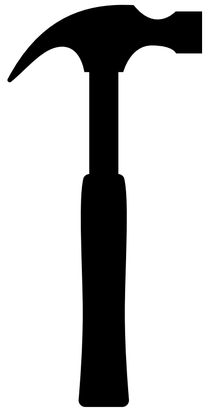
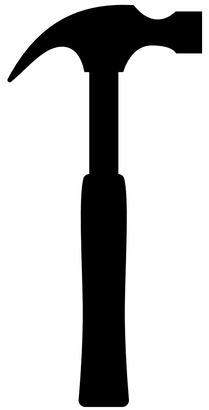


Functions

We already have some of these tools



Functions

Functions as
Parameters and
Return Values

Recap of Decorators

```
def print_arguments(fn):
    def fn_prime(*args, **kwargs):
        print("Arguments: {}, {}".format(args, kwargs))
        fn(*args, **kwargs)
    return fn_prime
```

Recap of Decorators

```
def foo(a, b, c=1):
    print((a + b) * c)

foo = print_arguments(foo)
foo(2, 1, c=3)

# Arguments: (2, 1) {'c': 3}
# 9
```

Recap of Decorators

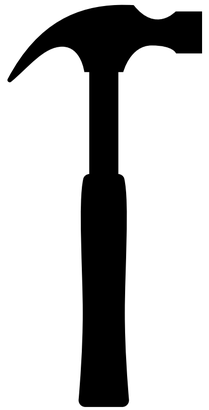
```
def print_arguments(fn):
    def fn_prime(*args, **kwargs):
        print("Arguments: {}, {}".format(args, kwargs))
        fn(*args, **kwargs)
    return fn_prime

@print_arguments
def foo(a, b, c=1):
   print((a + b) * c)

foo(2,1,c=3)

# Arguments: (2, 1) {'c': 3}
# 9
```

We already have some of these tools

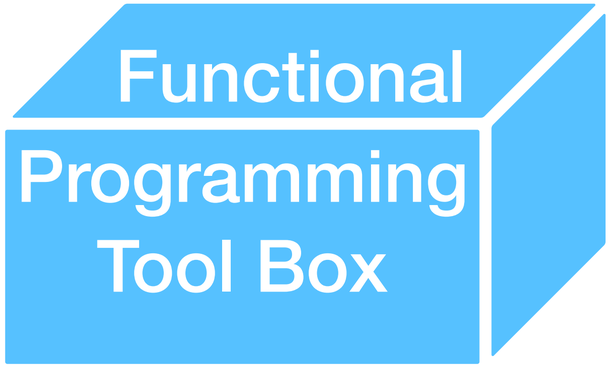


Functions

Functions as
Parameters and
Return Values

We already have some of these tools

But we need more to get to this code




```
def squared_divisible_by_2_9(lst):
    return list(map(
        lambda x: x**3,
        filter(
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        )
    ))
```
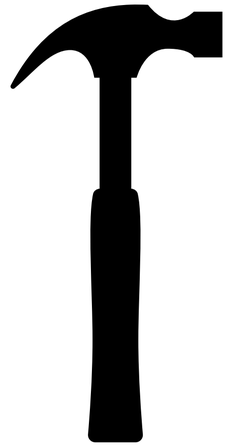

Functional Programming Basics

New Tool!

New Tool!



Iterators

Iterables

```
lst = ["Parth", "Unicorns", "Tara", "Horses"]
tup = ("CS41", "BIO101")
dctnry = {"CS": [41,106], "BIO": [82, 101, 190]}
```

Collections of objects that we can iterate over. We can use “for” or “while” loops through the contents and obtain something useful.

Iterators

```
lst = ["Parth", "Unicorns", "Tara", "Horses"]
tup = ("CS41", "BIO101")
dctnry = {"CS": [41, 106], "BIO": [82, 101, 190]}

lst_iter = lst.__iter__()
tup_iter = tup.__iter__()
dctnry_iter = dctnry.__iter__()
```

Iterators

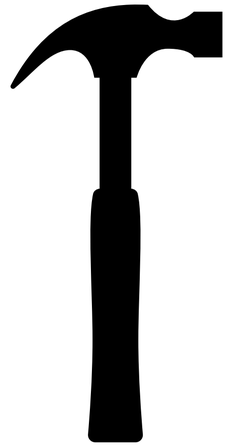
```
lst = ["Parth", "Unicorns", "Tara", "Horses"]

#functionally same code
for elem in lst:
    print(elem)


#functionally same code
lst_iter = lst.__iter__()
while True:
    try:
        print(lst_iter.__next__())
    except StopIteration:
        break
```

Why is this useful?

Allows us to get next item in a data set one at a time, and only when we need it

Allows for us to access iterable data outside of being in a loop

New Tool!



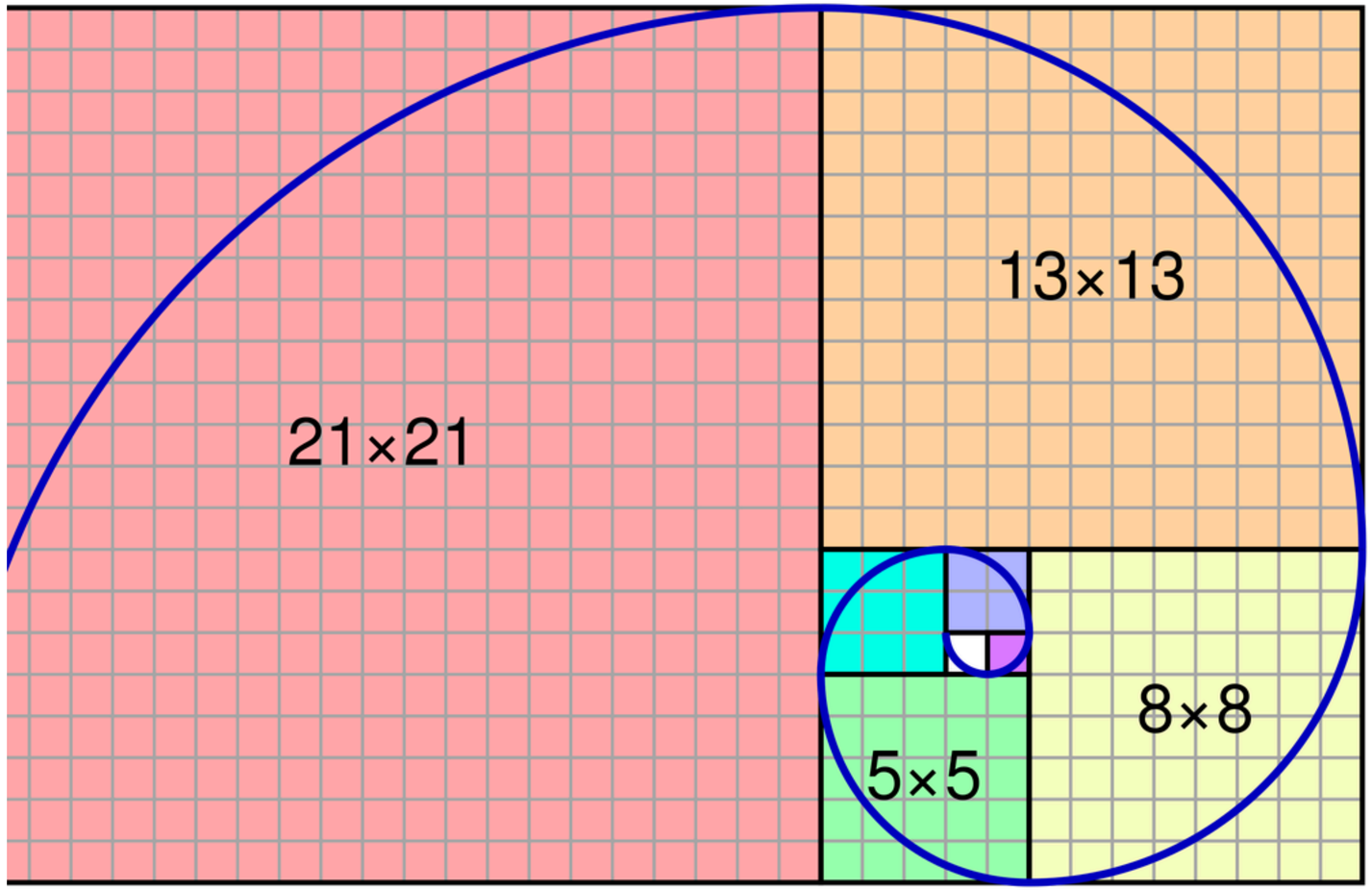
Iterators

New Tool!

Iterators

New Tool!

Let’s use this to deal with some infinite data



Fibonacci Sequence

$$0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987 \ldots$$

Each number is the sum of the previous two numbers.

How could you write code that generates this sequence and then iterates through it?

$$0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, 233, 377, 610, 987 \ldots$$

Each number is the sum of the previous two numbers.

Fib Code

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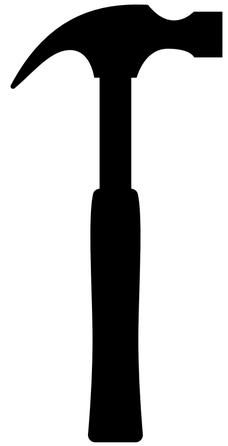


Generators

Generators Introduce “Yield”

-When next is called on a generator, it runs until a yield statement is reached, at which point the value referenced by the yield will be returned to the caller, and execution of the generator will pause.

-The next time that the __next__() method is called, execution of the generator will resume, until a yield statement is reached - at that point, again, execution will pause and the value referenced by the yield will be returned to the caller

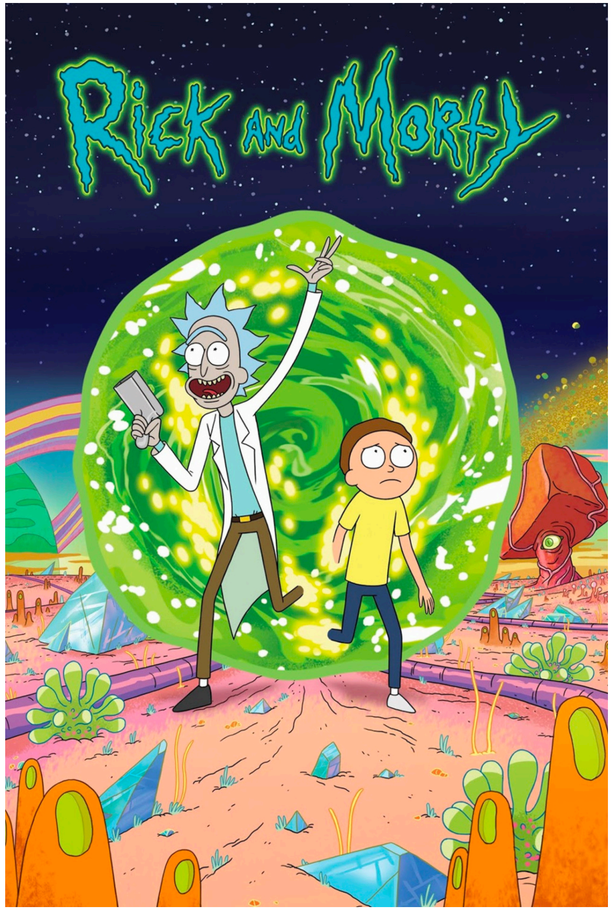
Generator Fib Code

Generators

```
#functionally the same as
for elem in generator:
    print(elem)

#functionally the same as
while True:
    try:
        print(generator.__next__())
    except StopIteration:
        break
```

Generators API mix!!



Generators API mix!!

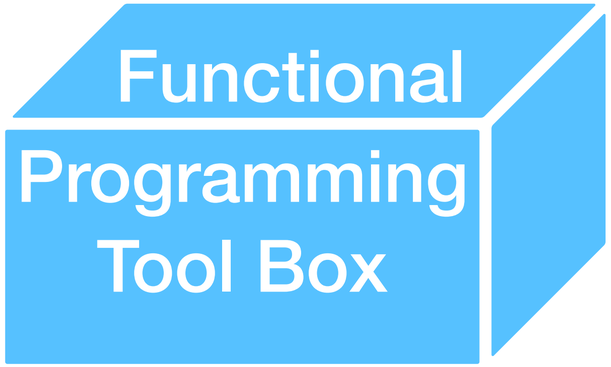
Your goal:

-Write code that goes through characters in order of IDS

-Gives them one at a time based on user input

-Uses a generator

Now let’s get back to the terms seen here

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        )
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```

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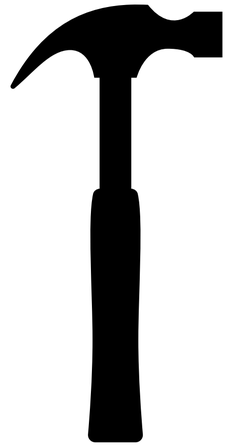

Lambda

Lambda: Anonymous Inline Functions

```
lambda params : expression
```

Let’s see how these are used

```
def square_add_two(x,y):
    return  x**2 + y**2
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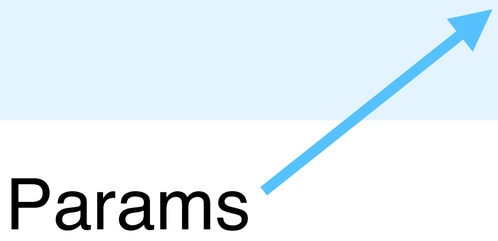
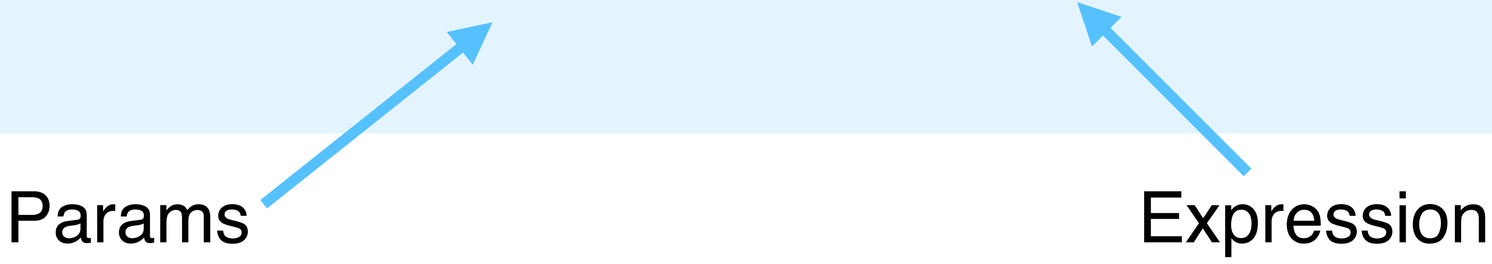


Let’s see how these are used

```
def square_add_two(x,y):
    return  x**2 + y**2
```

```
lambda x, y : x**2 + y**2
```



To call a lambda, you can put the arguments in parenthesis after the definition (also in paraenthesis)

```
(lambda x, y : x**2 + y**2)(8,5)
```

How was this used in our example code?

```
def squared_divisible_by_2_9(lst):
    return list(map(
        lambda x: x**3,
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        )
    ))
```
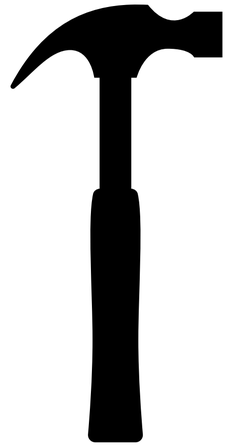

Add that to your tools!



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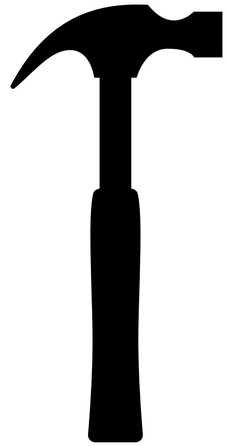

Map and
Filter

Map and Filter

These allow you to change arrays in streamline way

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These allow you to change arrays in streamline way

```
map(fn, iterable)
```

In Python, the map function takes in two parameters, a function and an iterable, and it applies each the function to each element of that iterable.

Map in Action

```
lst = [1, 2, 3]
map(lambda x : x**2, lst)
# => <map object at 0x104885310>
```

By why this map object?

```
map_obj = map(lambda x : x**2, lst)
map_obj.__next__()                      # => 1
map_obj.__next__()                      # => 4
map_obj.__next__()                      # => 9
map_obj.__next__()                      # => StopIteration
```

Map can take in finite (list, tuple, ect) or infinite (generator) objects. Because infinite and finite objects can be represented by generators, it returns a map object, which acts as a generator.

But tbh this is not always helpful

```
map_obj = map(lambda x : x**2, lst)
list(map_obj)                                  # => [1, 4, 9]
```

We can use the list(), tup(), constructors to turn this map object into our input type

Map and Filter

These allow you to change arrays in streamline way

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```
filter(predicate, iterable)
```

The filter function behaves similarly to the map function: it takes in two arguments, a predicate, and an iterable, and it returns only the elements of the iterable for which the predicate is True.

How are these used in our example code?

```
def squared_divisible_by_2_9(lst):
    return list(map(
        lambda x: x**3,
        filter(
            lambda x: x**2 % 2 == 0 and x**2 % 9 == 0,
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        )
    ))
```

Let’s try out map and filter

[‘3600’, ’41’, ’84’]	[3600, 41, 84]
[‘Tara’, ‘Parth’, ‘Theo’]	[4,5,4]
[‘CS41’, ‘CS106A’, ‘BIO84’, ‘CHEM18’, ‘CS161’]	[‘CS41’, ‘CS106A’, ‘CS161’]