

Functional_Programming_in_Python

March 12, 2019

Advantage of Functional Programming

- Code reusability
- To modularize the problem
- Better maintenance of the code
 - Pure functions are easier to reason about
 - Testing is easier, and pure functions lend themselves well to techniques like property-based testing
 - Debugging is easier

```
In [1]: # Function Definition
def hello():
    print("Hello world")
    #return None - default
```

```
In [2]: print(hello)
```

```
<function hello at 0x0000000005243400>
```

NOTE: Function are treated as first-class objects in Python.

```
In [3]: type(hello)
```

```
Out[3]: function
```

```
In [4]: print(dir(hello))
```

```
['__annotations__', '__call__', '__class__', '__closure__', '__code__', '__defaults__', '__del__']
```

```
In [5]: hello.__str__()
```

```
Out[5]: '<function hello at 0x0000000005243400>'
```

```
In [6]: hello.__repr__()
```

```
Out[6]: '<function hello at 0x0000000005243400>'
```

```
In [7]: hello.__qualname__      # introduced in Python 3.3
```

```
Out[7]: 'hello'
```

```
In [8]: hello.__sizeof__()
```

```
Out[8]: 112
```

```
In [9]: hello.__hash__()
```

```
Out[9]: 5391168
```

```
In [10]: hello.__code__
```

```
Out[10]: <code object hello at 0x0000000004D77C90, file "<ipython-input-1-37e6fe374419>", line
```

```
In [11]: callable(hello)
```

```
Out[11]: True
```

```
In [12]: hello.__call__()
```

```
Hello world
```

```
In [13]: hello()
```

```
Hello world
```

```
In [14]: fruit = 'apple'
         callable(fruit)
```

```
Out[14]: False
```

```
In [15]: # function Definition
         def hello_world(name):
             return f'Hello World! {name}'
```

```
In [16]: hello_world()
```

```
TypeError
```

```
Traceback (most recent call last)
```

```
<ipython-input-16-cb3310fd1801> in <module>
```

```
----> 1 hello_world()
```

```
TypeError: hello_world() missing 1 required positional argument: 'name'
```

```
In [17]: hello_world('Programmer!!!')
```

```
Out[17]: 'Hello World! Programmer!!!'
```

```
In [18]: hello_world('Programmer!!!', 'Sprinter')
```

```
TypeError                                Traceback (most recent call last)
```

```
<ipython-input-18-bc92478955e2> in <module>
----> 1 hello_world('Programmer!!!', 'Sprinter')
```

```
TypeError: hello_world() takes 1 positional argument but 2 were given
```

```
In [19]: def person_details(name, age):
         :     return f'{name}is {age} years old'
```

```
In [20]: person_details()
```

```
TypeError                                Traceback (most recent call last)
```

```
<ipython-input-20-88dad02581e5> in <module>
----> 1 person_details()
```

```
TypeError: person_details() missing 2 required positional arguments: 'name' and 'age'
```

```
In [21]: person_details('Gudo Vann Rusum')
```

```
TypeError                                Traceback (most recent call last)
```

```
<ipython-input-21-1db49b732e06> in <module>
----> 1 person_details('Gudo Vann Rusum')
```

```
TypeError: person_details() missing 1 required positional argument: 'age'
```

```
In [22]: person_details('Gudo Vann Rusum', 67)
```

```
Out[22]: 'Gudo Vann Rusumis 67 years old'
```

```
In [23]: person_details('Gudo Vann Rusum', 67, 2019)
```

```
-----  
  
TypeError                                Traceback (most recent call last)  
  
<ipython-input-23-d0c40b53f2e0> in <module>  
----> 1 person_details('Gudo Vann Rusum', 67, 2019)
```

```
TypeError: person_details() takes 2 positional arguments but 3 were given
```

NOTE: Ensure to pass the exact number of arguments in function call, as in function definition.

```
In [24]: def some_function():  
         pass  
         # default return is None type object
```

```
         result = some_function()  
         print("result =", result, type(result))  
  
result = None <class 'NoneType'>
```

```
In [25]: def some_function():  
         return None  
  
         result = some_function()  
         print("result =", result, type(result))  
  
result = None <class 'NoneType'>
```

```
In [26]: def some_function():  
         return 12  
  
         result = some_function()  
         print("result =", result, type(result))  
  
result = 12 <class 'int'>
```

```
In [27]: def some_function():  
         return 12.0  
  
         result = some_function()  
         print("result =", result, type(result))
```

```
result = 12.0 <class 'float'>
```

```
In [28]: def some_function():
         return {12:34}

         result = some_function()
         print("result =", result, type(result))

result = {12: 34} <class 'dict'>
```

```
In [29]: def some_function():
         return "%s's age is %d"%( 'Gudo', 67)

         result = some_function()
         print("result =", result, type(result))

result = Gudo's age is 67 <class 'str'>
```

```
In [30]: def some_function():
         return 12.0, # ,(comma) at the end of statement makes the difference

         result = some_function()
         print("result =", result, type(result))

result = (12.0,) <class 'tuple'>
```

```
In [31]: def some_function():
         return (12,),

         result = some_function()
         print("result =", result, type(result))

result = ((12,),) <class 'tuple'>
```

```
In [32]: def some_other_function():
         return 123, 45

         result = some_other_function()
         print("result =", result, type(result))

result = (123, 45) <class 'tuple'>
```

```
In [33]: def some_other_function():
         return 123, 45

         # tuple unpacking
         result1, result2 = some_other_function()
         print("result1      =", result1)
         print("result2      =", result2)
```

```
result1      = 123
result2      = 45
```

```
In [34]: # list unpacking
         r1, r2, r3 = [11, 22, 33]
         print(r1,r2, r3)
```

```
11 22 33
```

```
In [35]: m1, m2 = [11, 22, 33]
```

```
-----

ValueError                                Traceback (most recent call last)

<ipython-input-35-966cbe548e23> in <module>
----> 1 m1, m2 = [11, 22, 33]

ValueError: too many values to unpack (expected 2)
```

Function Overwriting

```
In [36]: lucky_number = 1111
         lucky_number = 786
         print(lucky_number)
```

```
786
```

```
In [37]: # Two functions with same name, but different number of arguments in definition
         def myfunc(var1, var2, var3):
             """
             Function to perform arithmetic Multiplication operation
             :param var1: Number
             :param var2: Number
             :param var3: Number
```

```

        :return: result of addition operation
        """
        return var1 + var2 + var3

def myfunc(num1, num2):
    """
    Function to perform arithmetic Addition operation
    :param num1: Number
    :param num2: Number
    :return: result of addition operation
    """
    return num1 + num2

print(myfunc(2, 3))
print(myfunc(2, 3, 5))

```

5

```

TypeError                                Traceback (most recent call last)

<ipython-input-37-23b16f3ef3a1> in <module>
    21
    22 print(myfunc(2, 3))
---> 23 print(myfunc(2, 3, 5))

```

TypeError: myfunc() takes 2 positional arguments but 3 were given

In [38]: # Two functions with same name, but different number of arguments in definition

```

def myfunc(num1, num2):
    """
    Function to perform arithmetic Addition operation
    :param num1: Number
    :param num2: Number
    :return: result of addition operation
    """
    return num1 + num2

def myfunc(var1, var2, var3):
    """
    Function to perform arithmetic Multiplication operation
    :param var1: Number

```

```

        :param var2: Number
        :param var3: Number
        :return: result of addition operation
        """
        return var1 + var2 + var3

print(myfunc(2, 3, 5))
print(myfunc(2, 3))

```

10

```

-----

TypeError                                Traceback (most recent call last)

<ipython-input-38-3f692b2b21a9> in <module>
    21
    22 print(myfunc(2, 3, 5))
---> 23 print(myfunc(2, 3))

TypeError: myfunc() missing 1 required positional argument: 'var3'

```

Default Arguments

```

In [39]: def greetings(name, msg = 'Birthday'):
        return f'Hi, {name}! Happy {msg}!!!'

```

```

In [40]: print(dir(greetings))

```

```

['__annotations__', '__call__', '__class__', '__closure__', '__code__', '__defaults__', '__del__']

```

```

In [41]: greetings.__defaults__

```

```

Out[41]: ('Birthday',)

```

```

In [42]: greetings()

```

```

-----

TypeError                                Traceback (most recent call last)

<ipython-input-42-73568cca93ae> in <module>

```



```
----> 1 greetings()
```

TypeError: greetings() missing 1 required positional argument: 'name'

NOTE: Non-default arguments must be passed during function call

```
In [43]: greetings('Udhay')
```

```
Out[43]: 'Hi, Udhay! Happy Birthday!!!'
```

```
In [44]: greetings('Prakash', 'Wedding Anniversary')
```

```
Out[44]: 'Hi, Prakash! Happy Wedding Anniversary!!!'
```

```
In [45]: def greetings(msg = 'Birthday', name):  
         return f'Hi, {name}! Happy {msg}!!!'
```

```
File "<ipython-input-45-360d99436798>", line 1  
def greetings(msg = 'Birthday', name):  
    ^
```

SyntaxError: non-default argument follows default argument

```
In [46]: def string_slicing(input_string, start_index = 0, final_index = None, step=1):  
         if final_index is None:  
             final_index = len(input_string)  
  
         print(start_index, final_index, step)  
         return input_string[start_index:final_index: step]
```

```
string_slicing('Honorificabilitudinitatibus')
```

```
0 27 1
```

```
Out[46]: 'Honorificabilitudinitatibus'
```

```
In [47]: def string_slicing(input_string, start_index = 0, final_index = None, step=1):  
  
         final_index = final_index or len(input_string)  
  
         print(start_index, final_index, step)  
         return input_string[start_index:final_index: step]
```

```
string_slicing('Honorificabilitudinitatibus')
```

0 27 1

Out[47]: 'Honorificabilitudinitatibus'

In [48]: string_slicing('Honorificabilitudinitatibus', 3, 19, 2)

3 19 2

Out[48]: 'oiaiaui'

In [49]: string_slicing.__defaults__

Out[49]: (0, None, 1)

Function Overloading workaround

In [50]: *# Two functions with same name, but different number of arguments in definition*

```
def myfunc(var1, var2, var3=0):  
    """  
    Function to perform arithmetic Multiplication operation  
    :param var1: Number  
    :param var2: Number  
    :param var3: Number  
    :return: result of addition operation  
    """  
    print(f'var1={var1}\t var2={var2}\t var3={var3}')  
    return var1 + var2 + var3  
  
print(myfunc(2, 3))  
print(myfunc(2, 3, 5))
```

var1=2	var2=3	var3=0
5		
var1=2	var2=3	var3=5
10		

Problem with mutable default arguments

```
In [51]: def extend_list(val, mylist= []):  
    print(f'id(mylist) = {id(mylist)} mylist={mylist} ')  
    mylist.append(val)  
    return mylist
```

In [52]: extend_list.__defaults__

Out[52]: ([],)

```
In [53]: list1 = extend_list(10)
        list1
```

```
id(mylist) = 91395208 mylist=[]
```

```
Out[53]: [10]
```

```
In [54]: list2 = extend_list(123, [])
        list2
```

```
id(mylist) = 91396168 mylist=[]
```

```
Out[54]: [123]
```

```
In [55]: list3 = extend_list('a')
        list3
```

```
id(mylist) = 91395208 mylist=[10]
```

```
Out[55]: [10, 'a']
```

```
In [56]: id(list1), id(list2), id(list3)
```

```
Out[56]: (91395208, 91396168, 91395208)
```

NOTE: Best practice is to use a sentinel value to denote an empty list or dictionary

```
In [57]: # Best practice
        def extend_list(val, mylist= None):
            if mylist is None:
                mylist=[]
            print(f'id(mylist) = {id(mylist)} mylist={mylist} ')
            mylist.append(val)
            return mylist
```

```
In [58]: extend_list.__defaults__
```

```
Out[58]: (None,)
```

```
In [59]: list1 = extend_list(10)
        print(list1)

        list2 = extend_list(123, [])
        print(list2)

        list3 = extend_list('a')
        print(list3)
```

```
id(mylist) = 91395400 mylist=[]  
[10]  
id(mylist) = 91396936 mylist=[]  
[123]  
id(mylist) = 91087816 mylist=[]  
['a']
```

```
In [60]: id(list1), id(list2), id(list3)
```

```
Out[60]: (91395400, 91396936, 91087816)
```

0.0.1 Variadic Functions

Function which can accept any number of arguments

Ex: print() function

```
In [61]: print(12)
```

```
12
```

```
In [62]: print(12, '34', None, {12:'34'}, list1)
```

```
12 34 None {12: '34'} [10]
```

```
In [63]: print(hello.__defaults__)
```

```
None
```

```
In [64]: print(hello.__kwdefaults__)
```

```
None
```

```
In [65]: hello(lucky_number=99)
```

TypeError

Traceback (most recent call last)

<ipython-input-65-959d2b7f6e8f> in <module>

----> 1 hello(lucky_number=99)

TypeError: hello() got an unexpected keyword argument 'lucky_number'

```

In [66]: # Function Definition
def hello(*given, **feed_in):
    print("\ntype(given) ", type(given))
    print("type(feed_in) ", type(feed_in))

    print("given  "+ str(given))
    print("feed_in "+ str(feed_in))
    print('-'*20)

    # works for any number of arguments & keyword arguments
    hello()
    hello(99)
    hello(99, -0.2312)
    hello(99, -0.2312, 12, '34', None, {12:'34'}, list1)

    hello(language='Python')
    hello(language='Python', env='dev')
    hello(language='Python', version=3, subversion=8)

type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given         ()
feed_in       {}
-----

type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given         (99,)
feed_in       {}
-----

type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given         (99, -0.2312)
feed_in       {}
-----

type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given         (99, -0.2312, 12, '34', None, {12: '34'}, [10])
feed_in       {}
-----

type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given         ()
feed_in       {'language': 'Python'}

```

```

-----
type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given          ()
feed_in {'language': 'Python', 'env': 'dev'}
-----

type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given          ()
feed_in {'language': 'Python', 'version': 3, 'subversion': 8}
-----

```

```

In [67]: # dictionary unpacking
         my_dict= {
             'brand': 'Ford',
             'model': 'Mustang',
             'year': 1964
         }
         hello(**my_dict)

```

```

type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given          ()
feed_in {'brand': 'Ford', 'model': 'Mustang', 'year': 1964}
-----

```

```

In [68]: hello(212.34, 'India', 798787987987975,          # variable args
               number=34, mystring='sdas', larger_number=342432, # variable keyword args
               **my_dict)                                     # variable keyword args,

```

```

type(given)    <class 'tuple'>
type(feed_in)  <class 'dict'>
given          (212.34, 'India', 798787987987975)
feed_in {'number': 34, 'mystring': 'sdas', 'larger_number': 342432, 'brand': 'Ford', 'model':
-----

```

```

In [69]: # Function Definition
         def hello(*feed_in):
             print("\ntype(feed_in)", type(feed_in))
             print("inputs are " + str(feed_in))

```

```

# works for any number of arguments
hello()
hello(99)
hello(99, -0.2312)
hello(99, -0.2312, 12, '34', None, {12:'34'}, list1)

```

```

type(feed_in) <class 'tuple'>
inputs are ()

```

```

type(feed_in) <class 'tuple'>
inputs are (99,)

```

```

type(feed_in) <class 'tuple'>
inputs are (99, -0.2312)

```

```

type(feed_in) <class 'tuple'>
inputs are (99, -0.2312, 12, '34', None, {12: '34'}, [10])

```

Function with keyword ONLY arguments (only in python 3.x)

- Named arguments appearing after '*' can only be passed by keyword

```

In [70]: # Function Definition
def recv(maxsize, *, block=True):
    print("\ntype(maxsize) ", type(maxsize))
    print("type(block) ", type(block))

    print("maxsize  "+ str(maxsize))
    print("block "+ str(block))
    print('-'*20)

# Function Call
recv(8192, block=False)

```

```

type(maxsize) <class 'int'>
type(block) <class 'bool'>
maxsize 8192
block False
-----

```

```

In [71]: recv(8192, False)

```

TypeError

Traceback (most recent call last)

```
<ipython-input-71-d5c525e308d2> in <module>
----> 1 recv(8192, False)
```

TypeError: recv() takes 1 positional argument but 2 were given

0.0.2 Scoping - Global vs Local

- Variables can be accessed within functions, without passing as args in function call

```
In [72]: alphabets = {'a':1, 'b':2}    # mutable object
```

```
def computation():
    print('in      --- alphabets', alphabets)

    computation()
    print('outside --- alphabets', alphabets)
```

```
in      --- alphabets {'a': 1, 'b': 2}
outside --- alphabets {'a': 1, 'b': 2}
```

```
In [73]: alphabets = {'a':1, 'b':2}    # mutable object
```

```
def computation():
    print('in - before - alphabets', alphabets)
    alphabets['c'] = 3
    print('in - after - alphabets', alphabets)
```

```
computation()
print('outside --- alphabets', alphabets)
```

```
in - before - alphabets {'a': 1, 'b': 2}
in - after - alphabets {'a': 1, 'b': 2, 'c': 3}
outside --- alphabets {'a': 1, 'b': 2, 'c': 3}
```

```
In [74]: alphabets = {'a':1, 'b':2}    # mutable object
```

```
def computation(alphabets):
    print('in - before - alphabets', alphabets)
```



```

    alphabets['c'] = 3
    print('in - after - alphabets', alphabets)

    computation(alphabets)
    print('outside --- alphabets', alphabets)

in - before - alphabets {'a': 1, 'b': 2}
in - after - alphabets {'a': 1, 'b': 2, 'c': 3}
outside --- alphabets {'a': 1, 'b': 2, 'c': 3}

```

```
In [75]: alphabets = {'a':1, 'b':2} # mutable object
```

```

def computation(alphabets_local):
    print('in - before - alphabets', alphabets_local)
    alphabets_local['c'] = 3
    print('in - after - alphabets', alphabets_local)
    print(f'id(alphabets_local):{id(alphabets_local)}')

    computation(alphabets)
    print('outside --- alphabets', alphabets)

    print(f'id(alphabets):{id(alphabets)}')
    print(f'id(alphabets_local):{id(alphabets_local)}')

in - before - alphabets {'a': 1, 'b': 2}
in - after - alphabets {'a': 1, 'b': 2, 'c': 3}
id(alphabets_local):91430272
outside --- alphabets {'a': 1, 'b': 2, 'c': 3}
id(alphabets):91430272

```

NameError

Traceback (most recent call last)

```

<ipython-input-75-92a84768282f> in <module>
    13
    14 print(f'id(alphabets):{id(alphabets)}')
--> 15 print(f'id(alphabets_local):{id(alphabets_local)}')
```

NameError: name 'alphabets_local' is not defined

```

In [76]: def movie_review():
         return f'{movie_watched} is good movie to watch'

         movie_watched = 'Baahubali: The Beginning'    # immutable object

         movie_review()

Out[76]: 'Baahubali: The Beginning is good movie to watch'

In [77]: def movie_review(movie_watched= 'The Prisoner'):
         return f'{movie_watched} is good movie to watch'

         movie_watched = 'Baahubali: The Beginning'    # immutable object

         movie_review()

Out[77]: 'The Prisoner is good movie to watch'

In [78]: def movie_review(movie_watched= 'The Prisoner'):    # Enclosing scope
         movie_watched = 'The Social Network'              # Local scope
         return f'{movie_watched} is good movie to watch'

         movie_watched = 'Baahubali: The Beginning'          # Global

         movie_review()

Out[78]: 'The Social Network is good movie to watch'

```

NOTE: Python scope resolution is based on the **LEGB** rule, which is shorthand for Local, Enclosing, Global, Built-in.

```

In [79]: def movie_review(movie_watched):
         movie_watched = 'The Social Network'              # Local scope
         return f'{movie_watched} is good movie to watch'

         movie_watched = 'Baahubali: The Beginning'          # Global

         print(movie_review(movie_watched))
         print(f'outside - function - movie_watched:{movie_watched}')

```

```

The Social Network is good movie to watch
outside - function - movie_watched:Baahubali: The Beginning

```

NOTE: changes made within function are not reflected globally(script level)
call by value - changes within the function will NOT reflect at the global level

```
In [80]: def movie_review(movie_watched):
    global movie_watched
    movie_watched = 'The Social Network'           # Local scope
    return f'{movie_watched} is good movie to watch'

movie_watched = 'Baahubali: The Beginning'         # Global

print(movie_review(movie_watched))
print(f'outside - function - movie_watched:{movie_watched}')
```

File "cell_name", line 5
 SyntaxError: name 'movie_watched' is parameter and global

```
In [81]: def movie_review():
    global movie_watched           # Global Scope
    movie_watched = 'The Social Network' # Local scope
    return f'{movie_watched} is good movie to watch'

movie_watched = 'Baahubali: The Beginning'         # Global

print(movie_review())
print(f'outside - function - movie_watched:{movie_watched}')
```

The Social Network is good movie to watch
 outside - function - movie_watched:The Social Network

call by reference - changes within the function will reflect at the global level

0.0.3 Partial Functions

```
In [82]: from functools import partial

def multiply(x,y):
    return x * y

# create a new function that multiplies by 2
dbl = partial(multiply,2)

print('dbl', dbl)
print('type(dbl)', type(dbl))

print(dbl(4))
print(dbl(14))
print(dbl(3))
```

```
dbl functools.partial(<function multiply at 0x0000000005718158>, 2)
type(dbl) <class 'functools.partial'>
8
28
6
```

```
In [83]: print(dir(dbl))
```

```
['_call__', '__class__', '__delattr__', '__dict__', '__dir__', '__doc__', '__eq__', '__format__']
```

```
In [84]: dbl.keywords
```

```
Out[84]: {}
```

```
In [85]: dbl.args
```

```
Out[85]: (2,)
```

```
In [86]: dbl.func
```

```
Out[86]: <function __main__.multiply(x, y)>
```

0.0.4 Recursive Functions

Three Laws of Recursion:

1. A recursive algorithm must have a base case.
2. A recursive algorithm must change its state and move toward the base case.
3. A recursive algorithm must call itself, recursively.

pseudo-code:

```
def funcName(<input paramaters>):
    <some logic>
    return funcName(<input parameters>)
```

Recursion is a programming technique in which a call to a function results in another call to that same function.

Iteration is calling an object, and moving over it.

```
In [87]: # calculating sum of a list of numbers
```

```
# Non-recursive implementation
def sumOfList(num_list): # conventional implementation
    total = 0
    for i in num_list:
        total += i
    return total

print(sumOfList([12, 23, 34, 546, 1]))
```

616

```
In [88]: # calculating sum of a list of numbers
```

```
# implementation using recursions
def sumOfListRec(num_list):
    if len(num_list) == 1:
        return num_list[0]
    else:
        return num_list[0] + sumOfListRec(num_list[1:])

print(sumOfListRec([12, 23, 34, 546, 1]))
```

616

```
In [89]: def fib(n):
```

```
    if n == 0:
        return 0
    elif n == 1:
        return 1
    else:
        return fib(n-1)+ fib(n-2)

# 5th element      # fib(4)+fib(3)
                   # fib(4) -> fib(3)+fib(2);
                   # fib(3) -> fib(2)+fib(1)
                   # fib(2) -> fib(1)+ fib(0) = 1+ 0
                   #
                   fib ...

print(fib(5))

# print '='*80
# factorial(5) = 5*4*3*2*1 =
```

5

```
In [90]: def factorial(n):
```

```
    if n == 0:
        return 1
    else:
        return abs(n) * factorial(abs(n)-1)

print(factorial(0))
print(factorial(1))
print(factorial(3))
print(factorial(5))
```

```
print(factorial(-5))
```

```
1
1
6
120
120
```

```
In [91]: def stringreverse(string):
        #print string
        if string == '':
            return ''
        else:
            #print(string[1:])
            print(string[0])
            return stringreverse(string[1:]) + string[0]
```

```
'''
1st loop
    stringreverse(string[1:]) + string[0]
                        "23456"      "1"
    stringreverse(string[1:]) + string[0]
                        "3456"      "2"
    stringreverse(string[1:]) + string[0]
                        "456"      "3"
    stringreverse(string[1:]) + string[0]
                        "56"      "4"
    stringreverse(string[1:]) + string[0]
                        "6"      "5"
    stringreverse(string[1:]) + string[0]
                        ""      "6"
'''
```

```
""+"6"+"5"+"4"+"3"+"2"+"1"
```

```
'''
print(stringreverse('123456'))
```

```
1
2
3
4
5
6
654321
```

```
In [92]: def display(name):
        print('\r', name, end='')
```

```
        return display(name)

display('Udhay')

UdhayUdhay
```

```
-----

RecursionError                                Traceback (most recent call last)

<ipython-input-92-27cc4d29d856> in <module>
      3     return display(name)
      4
----> 5 display('Udhay')

<ipython-input-92-27cc4d29d856> in display(name)
      1 def display(name):
      2     print('\r', name, end='')
----> 3     return display(name)
      4
      5 display('Udhay')

... last 1 frames repeated, from the frame below ...

<ipython-input-92-27cc4d29d856> in display(name)
      1 def display(name):
      2     print('\r', name, end='')
----> 3     return display(name)
      4
      5 display('Udhay')

RecursionError: maximum recursion depth exceeded while calling a Python object
```

```
In [93]: import sys
         print(sys.getrecursionlimit())
```

3000

```
In [94]: sys.setrecursionlimit(250)
         print(sys.getrecursionlimit())
```

250

```

In [95]: global noOfRecursions
         noOfRecursions = 0

         # Infinite loop
         def loop(noOfRecursions):
             print('Hi! I am in Loop ')
             # to get the count of number of recursions occurred
             noOfRecursions+=1
             print('This is Loop %d'%noOfRecursions)
             return loop(noOfRecursions)

         loop(noOfRecursions)

```

```

Hi! I am in Loop
This is Loop 1
Hi! I am in Loop
This is Loop 2
Hi! I am in Loop
This is Loop 3
Hi! I am in Loop
This is Loop 4
Hi! I am in Loop
This is Loop 5
Hi! I am in Loop
This is Loop 6
Hi! I am in Loop
This is Loop 7
Hi! I am in Loop
This is Loop 8
Hi! I am in Loop
This is Loop 9
Hi! I am in Loop
This is Loop 10
Hi! I am in Loop
This is Loop 11
Hi! I am in Loop
This is Loop 12
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This is Loop 13
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This is Loop 14
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This is Loop 200
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Hi! I am in Loop
This is Loop 203
```

RecursionError

Traceback (most recent call last)

```
<ipython-input-95-0bcdb2fc752b> in <module>
    10     return loop(noOfRecursions)
    11
--> 12 loop(noOfRecursions)
```



```

<ipython-input-95-0bcdb2fc752b> in loop(noOfRecursions)
      8     noOfRecursions+=1
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<ipython-input-95-0bcdb2fc752b> in loop(noOfRecursions)
      4 # Infinite loop
      5 def loop(noOfRecursions):
----> 6     print('Hi! I am in Loop ')
      7     # to get the count of number of recursions occurred
      8     noOfRecursions+=1

```

```

C:\ProgramData\Anaconda3\lib\site-packages\ipykernel\iostream.py in write(self, string)
398         is_child = (not self._is_master_process())
399         # only touch the buffer in the IO thread to avoid races
--> 400         self.pub_thread.schedule(lambda : self._buffer.write(string))
401         if is_child:
402             # newlines imply flush in subprocesses

C:\ProgramData\Anaconda3\lib\site-packages\ipykernel\iostream.py in schedule(self, f)
198         If the thread is not running, call immediately.
199         """
--> 200         if self.thread.is_alive():
201             self._events.append(f)
202             # wake event thread (message content is ignored)

C:\ProgramData\Anaconda3\lib\threading.py in is_alive(self)
1089         if self._is_stopped or not self._started.is_set():
1090             return False
-> 1091         self._wait_for_tstate_lock(False)
1092         return not self._is_stopped
1093

C:\ProgramData\Anaconda3\lib\threading.py in _wait_for_tstate_lock(self, block, timeout)
1046         if lock is None: # already determined that the C code is done
1047             assert self._is_stopped
-> 1048         elif lock.acquire(block, timeout):
1049             lock.release()
1050             self._stop()

```

RecursionError: maximum recursion depth exceeded while calling a Python object

0.0.5 mutual recursion

```

In [96]: def func1():
        print('func1')
        return func2()

        def func2():
            print('func2')
            return func1()

        func1()

```

func1

[illegible]

[illegible]

[illegible]

[illegible]

```
func2
func1
func2
func1
func2
func1
func2
func1
func2
func1
```

```
-----

RecursionError                                Traceback (most recent call last)

<ipython-input-96-f4a7ef5a03c6> in <module>
      7     return func1()
      8
----> 9 func1()

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```

```

C:\ProgramData\Anaconda3\lib\site-packages\ipykernel\iostream.py in write(self, string)
398         is_child = (not self._is_master_process())
399         # only touch the buffer in the IO thread to avoid races
--> 400         self.pub_thread.schedule(lambda : self._buffer.write(string))
401         if is_child:
402             # newlines imply flush in subprocesses

```

```

C:\ProgramData\Anaconda3\lib\site-packages\ipykernel\iostream.py in schedule(self, f)
198         If the thread is not running, call immediately.
199         """
--> 200         if self.thread.is_alive():
201             self._events.append(f)
202             # wake event thread (message content is ignored)

```

```

C:\ProgramData\Anaconda3\lib\threading.py in is_alive(self)
1089         if self._is_stopped or not self._started.is_set():
1090             return False
-> 1091         self._wait_for_tstate_lock(False)
1092         return not self._is_stopped
1093

```

```

C:\ProgramData\Anaconda3\lib\threading.py in _wait_for_tstate_lock(self, block, timeout

```

```

1046         if lock is None: # already determined that the C code is done
1047             assert self._is_stopped
-> 1048         elif lock.acquire(block, timeout):
1049             lock.release()
1050         self._stop()

```

RecursionError: maximum recursion depth exceeded while calling a Python object

0.0.6 Lambdas(or Anonymous Functions)

```

In [97]: def double(num):
        return num * 2

```

```
double(23)
```

```
Out[97]: 46
```

```

In [98]: p = lambda x: x*2

```

```
type(p)
```

```
Out[98]: function
```

```

In [99]: p

```

```
Out[99]: <function __main__.<lambda>(x)>
```

```

In [100]: p(23)

```

```
Out[100]: 46
```

```

In [101]: def calculation(x, y, z):
        return 2* x **3 + 3.4 * x - 34

```

```
calculation(9, 23, 2)
```

```
Out[101]: 1454.6
```

```

In [102]: lambda x,y,z:2* x **3 + 3.4 * x - 34

```

```
Out[102]: <function __main__.<lambda>(x, y, z)>
```

```

In [103]: (lambda x,y,z:2* x **3 + 3.4 * x - 34)(9, 23, 2)

```

```
Out[103]: 1454.6
```

```

In [104]: result = lambda x,y,z:2* x **3 + 3.4 * x - 34
        result(9, 23, 2)

```

```
Out[104]: 1454.6
```

```

In [105]: (lambda name: f'My name is {name}')( 'udhay')

```

```
Out[105]: 'My name is udhay'
```

Higher Order Functions

```
In [106]: range(9)
```

```
Out[106]: range(0, 9)
```

```
In [107]: list(range(9))
```

```
Out[107]: [0, 1, 2, 3, 4, 5, 6, 7, 8]
```

```
In [108]: range(9)[::]
```

```
Out[108]: range(0, 9)
```

```
In [109]: map(double, range(9))
```

```
Out[109]: <map at 0x635e748>
```

```
In [110]: list(map(double, range(9)))
```

```
Out[110]: [0, 2, 4, 6, 8, 10, 12, 14, 16]
```

```
In [111]: list(map(p, range(9)))
```

```
Out[111]: [0, 2, 4, 6, 8, 10, 12, 14, 16]
```

```
In [112]: list(map(lambda X:X*2, range(9)))
```

```
Out[112]: [0, 2, 4, 6, 8, 10, 12, 14, 16]
```

```
In [113]: list(map(lambda name: f'My name is {name}', ('savitha', 'Rakesh', 'krishna', 'RReddy'))
```

```
Out[113]: ['My name is savitha',  
           'My name is Rakesh',  
           'My name is krishna',  
           'My name is RReddy']
```

```
In [114]: def even_test(num):  
           return num%2 == 0
```

```
In [115]: list(map(even_test, range(9)))
```

```
Out[115]: [True, False, True, False, True, False, True, False, True]
```

```
In [116]: list(map(lambda m:m%2==0, range(9)))
```

```
Out[116]: [True, False, True, False, True, False, True, False, True]
```

```
In [117]: list(filter(even_test, range(9)))
```

```
Out[117]: [0, 2, 4, 6, 8]
```

```

In [118]: list(filter(lambda m:m%2==0, range(9)))
Out[118]: [0, 2, 4, 6, 8]

In [119]: list(filter(lambda m:m%2!=0, range(9)))
Out[119]: [1, 3, 5, 7]

In [120]: list(filter(lambda m:m%2!=0, {12, 34, 34, 45, 56, 77, 554}))
Out[120]: [77, 45]

In [121]: float(1)
Out[121]: 1.0

In [122]: list(map(float, range(9)))
Out[122]: [0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0]

In [123]: list(map(str, range(9)))
Out[123]: ['0', '1', '2', '3', '4', '5', '6', '7', '8']

In [124]: hash('0')
Out[124]: 1041798570483481553

In [125]: print(list(map(hash, ['0','1','2','3'])))
[1041798570483481553, -7704915279846337229, -7179744191360254509, 839436278355941725]

In [126]: hash(0)
Out[126]: 0

In [127]: list(map(hash, [0, 1, 2, 3]))
Out[127]: [0, 1, 2, 3]

```

What is the difference between map and itertools.reduce?

```

In [128]: from functools import reduce

In [129]: reduce(lambda p,q: p + q, range(6))
Out[129]: 15

In [130]: reduce(lambda p,q: p + q,[0, 1, 2, 3, 4, 5])
Out[130]: 15

```

```
In [131]: list(map(lambda p,q: p +q, range(6), range(6)))
```

```
Out[131]: [0, 2, 4, 6, 8, 10]
```

```
In [132]: mystrings = ('I', 'am', 'confident', 'about', 'myself')
```

```
In [133]: print(' '.join(mystrings))
```

```
I am confident about myself
```

```
In [134]: reduce(lambda ch1, ch2: ch1+ ' '+ ch2, mystrings)
```

```
Out[134]: 'I am confident about myself'
```

```
In [135]: # factorial 9 - 9 * 8 * 7 * 6 * 5 * 4 * 3 * 2 * 1
```

```
def my_factorial(given_num):
```

```
    result = 1
```

```
    for each_num in range(1, given_num + 1):
```

```
        # result = result * each_num
```

```
        result *= each_num
```

```
    return result
```

```
print(my_factorial(9))
```

```
print(reduce(lambda num1, num2: num1 * num2, range(1, 9+1)))
```

```
362880
```

```
362880
```

```
In [136]: import operator
```

```
print(reduce(operator.add,[ 1 , 3, 5, 6, 2 ] ))
```

```
print(reduce(operator.mul,[ 1 , 3, 5, 6, 2 ] ))
```

```
17
```

```
180
```

```
In [137]: print(reduce(operator.add,mystrings))
```

```
Iamconfidentaboutmyself
```

```
In [138]: reduce(lambda x,y : x+y, [ 1 , 3, 5, 6, 2])
```

```
Out[138]: 17
```

```
In [139]: import itertools
```

```
# to get the intermediate values, using reduce operation
```

```
print (list(itertools.accumulate([ 1 , 3, 5, 6, 2],lambda x,y : x+y)))
```

```
[1, 4, 9, 15, 17]
```

```
In [140]: zip([1], [3])
```

```
Out[140]: <zip at 0x62edec8>
```

```
In [141]: list(zip([1], [3]))
```

```
Out[141]: [(1, 3)]
```

```
In [142]: list(zip('aaa', 'bcd'))
```

```
Out[142]: [('a', 'b'), ('a', 'c'), ('a', 'd')]
```

```
In [143]: list(zip('aaa', 'bc'))
```

```
Out[143]: [('a', 'b'), ('a', 'c')]
```

```
In [144]: list(itertools.zip_longest('aaa', 'bc'))
```

```
Out[144]: [('a', 'b'), ('a', 'c'), ('a', None)]
```

```
In [145]: list(itertools.zip_longest('aaa', 'bc', fillvalue='-'))
```

```
Out[145]: [('a', 'b'), ('a', 'c'), ('a', '-')]
```

```
In [146]: list(map(lambda x,y:(x,y), 'aaa', 'bcd'))
```

```
Out[146]: [('a', 'b'), ('a', 'c'), ('a', 'd')]
```

```
In [147]: list(map(lambda x,y:(x,y), 'aaa', 'bc'))
```

```
Out[147]: [('a', 'b'), ('a', 'c')]
```

```
In [148]: matrix = [  
            (1, 2, 3),  
            [4, 5, 6],  
            (7, 8, 9)  
        ]  
        print('ORIGINAL matrix:', matrix)  
        for row in matrix:  
            print(row)
```

```
ORIGINAL matrix: [(1, 2, 3), [4, 5, 6], (7, 8, 9)]
```

```
(1, 2, 3)
```

```
[4, 5, 6]
```

```
(7, 8, 9)
```

```
In [149]: # transposed_matrix = zip(matrix[0], matrix[1], matrix[2])
transposed_matrix = list(zip(*matrix))

print()
print('TRANPOSED matrix:', transposed_matrix)
for row in transposed_matrix:
    print(row)
```

```
TRANPOSED matrix: [(1, 4, 7), (2, 5, 8), (3, 6, 9)]
(1, 4, 7)
(2, 5, 8)
(3, 6, 9)
```

0.0.7 Inner Functions

```
In [150]: def outer():
print('In outer function')
nnum = 786

def inner():
    print('In Inner function', nnum)

inner()
```

```
In [151]: outer()
```

```
In outer function
In Inner function 786
```

```
In [152]: inner()
```

```
-----

NameError                                Traceback (most recent call last)

<ipython-input-152-7f0b98f222e6> in <module>
----> 1 inner()

NameError: name 'inner' is not defined
```

```
In [153]: print(nnum)
```


NameError

Traceback (most recent call last)

```
<ipython-input-153-dd5d1bd7e646> in <module>
----> 1 print(nnum)
```

NameError: name 'nnum' is not defined

0.0.8 Closures

- Closures can avoid the use of global values and provides some form of **data hiding**.
- It can also provide an object oriented solution to the problem.

```
In [154]: def outer():
           print('In outer function')
           nnum = 786

           def inner():
               print('In Inner function', nnum)

           print(f'inner.__closure__: {inner.__closure__[0].cell_contents}')
           inner()

           result = outer()
           print('result', type(result), result)
```

```
In outer function
inner.__closure__:786
In Inner function 786
result <class 'NoneType'> None
```

```
In [155]: def outer():
           print('In outer function')
           nnum = 786
           num2 = 999
           def inner():
               print('In Inner function', nnum)

           print(f'inner.__closure__           : {inner.__closure__}')
           print(f'inner.__closure__[0].cell_contents: {inner.__closure__[0].cell_contents}')
           return inner

           result = outer()
           print('result', type(result), result)
```

```

In outer function
inner.__closure__          :(<cell at 0x0000000006479438: int object at 0x000000000572E
inner.__closure__[0].cell_contents:786
result <class 'function'> <function outer.<locals>.inner at 0x000000000647ABF8>

```

```
In [156]: result()
```

```
In Inner function 786
```

closure is None or a tuple of cells that contain binding for the function's free variables.
Also, it is NOT writable.

```

In [157]: def outer():
           print('In outer function')
           nnum = 786
           num2 = 333

           def inner():
               #nnum = 7869
               print('In Inner function', nnum)
               print(num2)

           print(f'inner.__closure__          :{inner.__closure__}')
           print(f'inner.__closure__[0].cell_contents:{inner.__closure__[0].cell_contents}')
           print(f'inner.__closure__[1].cell_contents:{inner.__closure__[1].cell_contents}')

           print(f'inner.__code__.co_freevars:{inner.__code__.co_freevars}')
           print(f'inner.__code__.co_cellvars:{inner.__code__.co_cellvars}')
           return inner()

           result = outer()
           print('result', type(result), result)

```

```

In outer function
inner.__closure__          :(<cell at 0x0000000006479618: int object at 0x000000000572E
inner.__closure__[0].cell_contents:786
inner.__closure__[1].cell_contents:333
inner.__code__.co_freevars:('nnum', 'num2')
inner.__code__.co_cellvars:()
In Inner function 786
333
result <class 'NoneType'> None

```

```

In [158]: def closure1():
           flist = []

```

```

    for i in range(3):
        def func(x):
            return x * i
        flist.append(func)

    for f in flist:
        print(f(2))

closure1()

```

4
4
4

```

In [159]: def closure2(msg):
           def printer():
               print(msg)
           return printer

printer = closure2('Foo!')
printer()

```

Foo!

```

In [160]: def not_closure2(msg):
           def printer(msg=msg):
               print(msg)
           return printer

printer = not_closure2('Foo!')
printer()

```

Foo!

```

In [161]: def generate_power_func(n):
           def nth_power(x):
               return x ** n
           return nth_power

raised_to_4 = generate_power_func(4)
del generate_power_func
print(raised_to_4(2))

```

16

```
In [162]: def outer():
           d = {'y': 0}

           def inner():
               d['y'] += 1
               return d['y']
           return inner

           outer = outer()
           outer()
```

Out[162]: 1

```
In [163]: def foo():
           a = [1, ]

           def bar():
               a[0] = a[0] + 1
               return a[0]
           return bar

           foo = foo()
           foo()
```

Out[163]: 2

0.1 Decorators

Without decorators

```
In [164]: def div(a, b):
           try:
               a / b
           except Exception as e:
               return e
           else:
               return a / b

           def add(a, b):
               try:
                   a + b
               except Exception as e:
                   return e
               else:
                   return a + b

           print(div(4, 2))
```

```

print(div(4, 0))

print(add(2, 3))
print(add('a', 3))

```

2.0
division by zero
5
can only concatenate str (not "int") to str

```

In [165]: def outer(func):
            def inner(num1, num2): ##args, **kwargs:
                try:
                    func(num1, num2) ##args, **kwargs
                except Exception as e:
                    return e
                else:
                    return func(num1, num2) ##args, **kwargs

            return inner

def div(a, b):
    return a / b

# print div(4, 0)
foo = outer(div)
print(foo(4, 2))
print(foo(4, 0))

```

2.0
division by zero

```

In [166]: def addition(m,n):
            return m + n

            result = outer(addition)
            print(result(2, 4))
            print(result('2', 4))

```

6
can only concatenate str (not "int") to str

Decorator syntactic sugar

```

In [167]: @outer # comment this line and observe difference
            def div(a, b):

```

```

        return a / b

    print(div(4, 2))
    print(div(4, 0))

```

2.0
division by zero

```

In [168]: @outer
def add(a, b):
    return a + b

print(add(2, 3))
print(add('a', 3))

```

5
can only concatenate str (not "int") to str

NOTE: Decorators slow down the function call. Keep that in mind.

```

In [169]: def makebold(fn):
    def wrapped(*args, **kwargs):
        print("makebold - args", args)
        print("makebold - kwargs", kwargs)
        print()
        return "<b>" + fn(*args, **kwargs) + "</b>"

    return wrapped

def makeitalic(fn):
    def wrapped(*args, **kwargs):
        print("makeitalic - args", args)
        print("makeitalic - kwargs", kwargs)
        print()
        return "<i>" + fn(*args, **kwargs) + "</i>"

    return wrapped

```

```

In [170]: @makeitalic
@makebold
def hello(name, salary=20000000):
    return "hello world:{}\t salary:{}".format(name, salary)

```

```

    print(hello('udhay', 9000000))  ## returns "<b><i>hello world</i></b>"
    print('-'* 20)
    print(hello('udhay', salary=9000000))  ## returns "<b><i>hello world</i></b>"

makeitalic - args ('udhay', 9000000)
makeitalic - kwargs {}

makebold - args ('udhay', 9000000)
makebold - kwargs {}

<i><b>hello world:udhay          salary:9000000</b></i>
-----
makeitalic - args ('udhay',)
makeitalic - kwargs {'salary': 9000000}

makebold - args ('udhay',)
makebold - kwargs {'salary': 9000000}

<i><b>hello world:udhay          salary:9000000</b></i>

In [171]: @makebold
          @makeitalic
          def hello(name, salary=20000000):
              return "hello world:{}\t salary:{}".format(name, salary)

    print(hello('udhay', 9000000))  ## returns "<b><i>hello world</i></b>"
    print('-'* 20)
    print(hello('udhay', salary=9000000))  ## returns "<b><i>hello world</i></b>"

makebold - args ('udhay', 9000000)
makebold - kwargs {}

makeitalic - args ('udhay', 9000000)
makeitalic - kwargs {}

<b><i>hello world:udhay          salary:9000000</i></b>
-----
makebold - args ('udhay',)
makebold - kwargs {'salary': 9000000}

makeitalic - args ('udhay',)
makeitalic - kwargs {'salary': 9000000}

<b><i>hello world:udhay          salary:9000000</i></b>

In [172]: def addition(num1, num2):
          print('function -start ')

```

```

        result = num1 + num2
        print('function - before end')
        return result

def multiplication(num1, num2):
    print('function -start ')
    result = num1 * num2
    print('function - before end')
    return result

print(addition(12, 34))
print(multiplication(12, 34))

function -start
function - before end
46
function -start
function - before end
408

In [173]: print('\n===USING DECORATORS')

def print_statements(func):
    def inner(*args, **kwargs):
        print('function -start ')
        # print 'In print_statemenst decorator', func
        myresult = func(*args, **kwargs)
        print('function - before end')
        return myresult

    return inner

@print_statements
def addition11111(num1, num2):
    result = num1 + num2
    return result

@print_statements
def multiplication1111(num1, num2):
    result = num1 * num2
    return result

```



```

print(multiplication1111(12, 3))
print(addition11111(12, 34))

```

===USING DECORATORS

```

function -start
function - before end
36
function -start
function - before end
46

```

In [174]: `import time`

```

def function_logger(func):
    def wrapper(*args, **kwargs):
        start_time, temp = time.time(), func(*args, **kwargs)
        elapsed = time.time() - start_time
        print("{} took {:.3f} sec, returning {}, arguments {} and {}".format(
            func.__code__.co_name, elapsed, temp, args, kwargs) )
        return temp
    return wrapper

```

```

@function_logger
def function(*args, **kwargs):
    for i in range(int(args[0])):
        for j in range(int(args[0])):
            pass

```

```

function(1000)

```

function took 0.093 sec, returning None, arguments (1000,) and {}

In [175]: `from functools import wraps`

```

def beg(target_function):
    @wraps(target_function)
    def wrapper(*args, **kwargs):
        msg, say_please = target_function(*args, **kwargs)
        if say_please:
            return "{} {}".format(msg, "Please! I am poor :(")
        return msg

    return wrapper

```

```
@beg
def say(say_please=False):
    msg = "How about party today?"
    return msg, say_please

print(say()) # How about party today?
print(say(say_please=True)) # How about party today? Please! I am poor :(
```

How about party today?

How about party today? Please! I am poor :(