

# Functional\_Programming\_in\_Python

March 11, 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 0x0000000005071B70>
```

**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 0x0000000005071B70>'
```

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

```
Out[6]: '<function hello at 0x0000000005071B70>'
```

```
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]: 5271991
```

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

```
Out[10]: <code object hello at 0x0000000004D76C90, 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 [98]: 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[98]: 'Honorificabilitudinitatibus'

In [47]: string\_slicing('Honorificabilitudinitatibus', 3, 19, 2)

3 19 2

Out[47]: 'oiaiaui'

In [48]: string\_slicing.\_\_defaults\_\_

Out[48]: (0, None, 1)

## Function Overloading workaround

In [49]: *# 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 [50]: def extend_list(val, mylist= []):  
    print(f'id(mylist) = {id(mylist)} mylist={mylist} ')  
    mylist.append(val)  
    return mylist
```

In [51]: extend\_list.\_\_defaults\_\_

Out[51]: ([],)

```
In [52]: list1 = extend_list(10)
        list1
```

```
id(mylist) = 87069640 mylist=[]
```

```
Out[52]: [10]
```

```
In [53]: list2 = extend_list(123, [])
        list2
```

```
id(mylist) = 87069128 mylist=[]
```

```
Out[53]: [123]
```

```
In [54]: list3 = extend_list('a')
        list3
```

```
id(mylist) = 87069640 mylist=[10]
```

```
Out[54]: [10, 'a']
```

```
In [55]: id(list1), id(list2), id(list3)
```

```
Out[55]: (87069640, 87069128, 87069640)
```

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

```
In [56]: # 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 [57]: extend_list.__defaults__
```

```
Out[57]: (None,)
```

```
In [58]: list1 = extend_list(10)
        print(list1)

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

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

```
id(mylist) = 87072264 mylist=[]  
[10]  
id(mylist) = 87069896 mylist=[]  
[123]  
id(mylist) = 87070600 mylist=[]  
['a']
```

```
In [59]: id(list1), id(list2), id(list3)
```

```
Out[59]: (87072264, 87069896, 87070600)
```

### 0.0.1 Variadic Functions

Function which can accept any number of arguments

Ex: print() function

```
In [60]: print(12)
```

```
12
```

```
In [61]: 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 [112]: # 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 [113]: 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 [67]: # 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 [68]: # 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 [69]: recv(8192, False)

```

TypeError

Traceback (most recent call last)

```
<ipython-input-69-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 [70]: 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 [71]: 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 [72]: 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 [73]: 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):87109208
outside --- alphabets {'a': 1, 'b': 2, 'c': 3}
id(alphabets):87109208

```

---

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

```

<ipython-input-73-92a84768282f> 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 [74]: def movie_review():
         return f'{movie_watched} is good movie to watch'

         movie_watched = 'Baahubali: The Beginning'    # immutable object

         movie_review()
```

```
Out[74]: 'Baahubali: The Beginning is good movie to watch'
```

```
In [75]: 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[75]: 'The Prisoner is good movie to watch'
```

```
In [76]: 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[76]: '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 [77]: 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 [78]: 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 [79]: 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 [80]: 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 0x00000000052F7E18>, 2)
type(dbl) <class 'functools.partial'>
8
28
6
```

```
In [81]: print(dir(dbl))
```

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

```
In [82]: dbl.keywords
```

```
Out[82]: {}
```

```
In [83]: dbl.args
```

```
Out[83]: (2,)
```

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

```
Out[84]: <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 [85]: # 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 [86]: *# 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 [87]: `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 [88]: `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 [89]: 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 [90]: def display(name):
        print('\r', name, end='')
```

```

        return display(name)

display('Udhay')
UdhayUdhayUdhay

```

```

-----

RecursionError                                Traceback (most recent call last)

<ipython-input-90-27cc4d29d856> in <module>
      3     return display(name)
      4
----> 5 display('Udhay')

<ipython-input-90-27cc4d29d856> 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-90-27cc4d29d856> 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 [91]: import sys
         print(sys.getrecursionlimit())

```

3000

```

In [92]: sys.setrecursionlimit(250)
         print(sys.getrecursionlimit())

```

250

```

In [93]: 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
Hi! I am in Loop
This is Loop 13
Hi! I am in Loop
This is Loop 14
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This is Loop 15
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This is Loop 16
Hi! I am in Loop
This is Loop 17
Hi! I am in Loop

```



This is Loop 18  
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This is Loop 201
Hi! I am in Loop
This is Loop 202
Hi! I am in Loop
This is Loop 203
```

-----

RecursionError

Traceback (most recent call last)

```
<ipython-input-93-0bcdb2fc752b> in <module>
    10     return loop(noOfRecursions)
    11
---> 12 loop(noOfRecursions)
```



```

<ipython-input-93-0bcdb2fc752b> in loop(noOfRecursions)
      8     noOfRecursions+=1
      9     print('This is Loop %d'%noOfRecursions)
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<ipython-input-93-0bcdb2fc752b> in loop(noOfRecursions)
      8     noOfRecursions+=1
      9     print('This is Loop %d'%noOfRecursions)
----> 10     return loop(noOfRecursions)
      11
      12 loop(noOfRecursions)

<ipython-input-93-0bcdb2fc752b> 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 [94]: 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-94-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 [108]: def double(num):
          return num * 2

```

```
double(23)
```

```
Out[108]: 46
```

```

In [109]: p = lambda x: x*2

```

```
type(p)
```

```
Out[109]: function
```

```

In [110]: p

```

```
Out[110]: <function __main__.<lambda>(x)>
```

```

In [111]: p(23)

```

```
Out[111]: 46
```

```

In [112]: def calculation(x, y, z):
          return 2* x **3 + 3.4 * x - 34

```

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

```
Out[112]: 1454.6
```

```

In [113]: lambda x,y,z:2* x **3 + 3.4 * x - 34

```

```
Out[113]: <function __main__.<lambda>(x, y, z)>
```

```

In [114]: (lambda x,y,z:2* x **3 + 3.4 * x - 34)(9, 23, 2)

```

```
Out[114]: 1454.6
```

```

In [115]: result = lambda x,y,z:2* x **3 + 3.4 * x - 34
          result(9, 23, 2)

```

```
Out[115]: 1454.6
```

```

In [116]: (lambda name: f'My name is {name}')( 'udhay')

```

```
Out[116]: 'My name is udhay'
```

## Higher Order Functions

```
In [117]: range(9)
```

```
Out[117]: range(0, 9)
```

```
In [118]: list(range(9))
```

```
Out[118]: [0, 1, 2, 3, 4, 5, 6, 7, 8]
```

```
In [119]: range(9)[::]
```

```
Out[119]: range(0, 9)
```

```
In [120]: map(double, range(9))
```

```
Out[120]: <map at 0x58b7d68>
```

```
In [121]: list(map(double, range(9)))
```

```
Out[121]: [0, 2, 4, 6, 8, 10, 12, 14, 16]
```

```
In [122]: list(map(p, range(9)))
```

```
Out[122]: [0, 2, 4, 6, 8, 10, 12, 14, 16]
```

```
In [123]: list(map(lambda X:X*2, range(9)))
```

```
Out[123]: [0, 2, 4, 6, 8, 10, 12, 14, 16]
```

```
In [124]: list(map(lambda name: f'My name is {name}', ('savitha', 'Rakesh', 'krishna', 'RReddy')))
```

```
Out[124]: ['My name is savitha',  
           'My name is Rakesh',  
           'My name is krishna',  
           'My name is RReddy']
```

```
In [125]: def even_test(num):  
           return num%2 == 0
```

```
In [126]: list(map(even_test, range(9)))
```

```
Out[126]: [True, False, True, False, True, False, True, False, True]
```

```
In [127]: list(map(lambda m:m%2==0, range(9)))
```

```
Out[127]: [True, False, True, False, True, False, True, False, True]
```

```
In [128]: list(filter(even_test, range(9)))
```

```
Out[128]: [0, 2, 4, 6, 8]
```

```

In [129]: list(filter(lambda m:m%2==0, range(9)))
Out[129]: [0, 2, 4, 6, 8]

In [130]: list(filter(lambda m:m%2!=0, range(9)))
Out[130]: [1, 3, 5, 7]

In [131]: list(filter(lambda m:m%2!=0, {12, 34, 34, 45, 56, 77, 554}))
Out[131]: [77, 45]

In [150]: list(map(float, range(9)))
Out[150]: [0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0]

In [151]: list(map(str, range(9)))
Out[151]: ['0', '1', '2', '3', '4', '5', '6', '7', '8']

In [158]: hash('0')
Out[158]: -8419196215612726409

In [162]: print(list(map(hash, ['0', '1', '2', '3'])))
[-8419196215612726409, 1005445016849638610, -6807328765686990196, -4220812698924798439]

In [159]: hash(0)
Out[159]: 0

In [160]: list(map(hash, [0, 1, 2, 3]))
Out[160]: [0, 1, 2, 3]

```

### What is the difference between map and itertools.reduce?

```

In [139]: from functools import reduce

In [140]: reduce(lambda p,q: p + q, range(6))
Out[140]: 15

In [141]: list(map(lambda p,q: p +q, range(6), range(6)))
Out[141]: [0, 2, 4, 6, 8, 10]

In [142]: mystrings = ('I', 'am', 'confident', 'about', 'myself')

In [143]: print(' '.join(mystrings))

```

I am confident about myself

```
In [144]: reduce(lambda ch1, ch2: ch1+ ' '+ ch2, mystrings)
```

```
Out[144]: 'I am confident about myself'
```

```
In [145]: # 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 [146]: import operator
print(reduce(operator.add,[ 1 , 3, 5, 6, 2 ] ))
print(reduce(operator.mul,[ 1 , 3, 5, 6, 2 ] ))
```

17

180

```
In [147]: print(reduce(operator.add,mystrings))
```

Iamconfidentaboutmyself

```
In [149]: reduce(lambda x,y : x+y, [ 1 , 3, 5, 6, 2])
```

```
Out[149]: 17
```

```
In [148]: 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 [152]: zip([1], [3])
```

```
Out[152]: <zip at 0x58ad988>
```

```

In [153]: list(zip([1], [3]))
Out[153]: [(1, 3)]

In [154]: list(zip('aaa', 'bcd'))
Out[154]: [('a', 'b'), ('a', 'c'), ('a', 'd')]

In [155]: list(zip('aaa', 'bc'))
Out[155]: [('a', 'b'), ('a', 'c')]

In [156]: list(itertools.zip_longest('aaa', 'bc'))
Out[156]: [('a', 'b'), ('a', 'c'), ('a', None)]

In [157]: list(itertools.zip_longest('aaa', 'bc', fillvalue='-'))
Out[157]: [('a', 'b'), ('a', 'c'), ('a', '-')]

In [166]: list(map(lambda x,y:(x,y), 'aaa', 'bcd'))
Out[166]: [('a', 'b'), ('a', 'c'), ('a', 'd')]

In [167]: list(map(lambda x,y:(x,y), 'aaa', 'bc'))
Out[167]: [('a', 'b'), ('a', 'c')]

In [168]: 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 [169]: # 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 [170]: def outer():
           print('In outer function')
           nnum = 786

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

           inner()
```

```
In [171]: outer()
```

```
In outer function
```

```
In Inner function 786
```

```
In [172]: inner()
```

```
-----

NameError                                Traceback (most recent call last)

<ipython-input-172-7f0b98f222e6> in <module>
----> 1 inner()

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

```
In [173]: print(nnum)
```

```
-----

NameError                                Traceback (most recent call last)

<ipython-input-173-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 [180]: 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 [186]: def outer():
           print('In outer function')
           nnum = 786

           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 0x0000000005C5D0A8: int object at 0x0000000005F36...
inner.__closure__[0].cell_contents:786
['__add__', '__class__', '__contains__', '__delattr__', '__dir__', '__doc__', '__eq__', '__form...
In Inner function 786
result <class 'NoneType'> None
```

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

```
In [193]: 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 0x0000000005C5D0A8: int object at 0x0000000005F36
inner.__closure__[0].cell_contents:786
inner.__code__.co_freevars:('nnum',)
inner.__code__.co_cellvars:()
In Inner function 786
result <class 'NoneType'> None

```

```

In [195]: 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 [196]: def closure2(msg):
    def printer():
        print(msg)
    return printer

```

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

Foo!

```
In [197]: def not_closure2(msg):
          def printer(msg=msg):
              print(msg)
          return printer

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

Foo!

```
In [199]: 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 [200]: def outer():
          d = {'y': 0}

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

outer = outer()
outer()
```

Out[200]: 1

```
In [201]: def foo():
          a = [1, ]

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

```

        return a[0]
    return bar

foo = foo()
foo()

```

Out[201]: 2

## 0.1 Decorators

### Without decorators

```

In [202]: 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 [203]: 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 [204]: 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 [205]: @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 [206]: @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 [207]: 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 [208]: @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 [209]: @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 [210]: 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 [212]: print('\n===USING DECORATORS')
```

```
def print_statements(func):
    def inner(*args, **kwargs):
        print('function -start ')
        # print 'In print_statements 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 [217]: 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) \
              .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 0.096 sec, returning None, arguments (1000,) and {}

In [218]: `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 :(