FP - Some useful notes

Week 04

Aula prática nº 4 – Funções

Functions

- Natural from maths
- Represent a sequence of actions
  - Using a name
  - With explicit parameters i.e. what you need
  - With explicit result i.e. values after return

function

This function has no name. It returns a function object which is assigned to the identifier `double`. We can now call it as a normal function. The statement

```
double = lambda x: x * 2
```

is nearly the same as

```
def double(x):
    return x * 2
```

https://www.tutorialspoint.com/python/python_functions.htm
https://www.datacamp.com/community/tutorials/functions-python-tutorial

The math inspiration


```
def f(x):
    return math.sin(x)
```

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

```
def f(x):
    return x**2
```

```
def f(x):
    return math.sqrt(x)
```

```
def f(x):
    return 1/x
```

The math inspiration

2. Escreva uma função para calcular o polinómio $p(x)=x^2+2x+3$ e use-a num programa para calcular e mostrar os valores de $p(0)$, $p(1)$, $p(2)$ e $p(p(1))$. Confira os resultados.

```
def p(x):
    return x**2 + 2*x + 3
```

```
def pol(a,b,c,x):
    return a*(x**2) + b*x + c
```

Do you agree?

```
P(1) < = >  pol(1,2,3,1)
```

The math inspiration

2. Escreva uma função para calcular o polinómio $p(x)=x^2+2x+3$ e use-a num programa para calcular e mostrar os valores de $p(0)$, $p(1)$, $p(2)$ e $p(p(1))$. Confira os resultados.

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```

```
def pol(a,b,c,x):
    return a*(x**2) + b*x + c
```

Do you agree?

```
p(p(1)) < = >  pol(1,2,3,pol(1,2,3,1))
```

Factorial (n!)

$U_0 = 1$ se n=0

$U_{n+1} = n * U_n$ se n>0

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

3! < = > factorial(3)

A way to “encapsulate” fixed content…

```
def dc1():
  message="""
  As armas e os barões assinalados,
Que da ocidental praia Lusitana,
Por mares nunca de antes navegados,
Passaram ainda além da Taprobana,
Em perigos e guerras esforçados,
Mais do que prometia a força humana,
E entre gente remota edificaram
Novo Reino, que tanto sublimaram;
"""
  return message
```

```
def c1():
  message="""
  As armas e os barões assinalados,
Que da ocidental praia Lusitana,
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E entre gente remota edificaram
Novo Reino, que tanto sublimaram;
"""
  print( message )
  return
```

Do you agree?

< = >

```
for i in range(5) :
    print( rc1() )
```

```
for i in range(5):
    c1()
```

… and call it using a simple name

```
def dc1():
  message="""
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"""
  print( message )
  return
```

Do you agree?

```
for i in range(5) :
   print( dc1())
```

< = >

```
for i in range(5) :
   c1()
```

Functions as chuncks of related code…

```
def divRem(a, b):
    return a//b, a%b
```

```
def printNtimes(msg, n):
    if n > 0:
        print(msg)
        printNtimes(msg, n-1)
```

```
def fullname(first, last):
    first = first.title()    # title makes
    last = last.title()
    return first + " " + last
```

Referred using a smaller name with parameters

```
def divRem(a, b):
    return a//b, a%b

q, r = divRem(13, 4)
print(q, r)
```

```
def printNtimes(msg, n):
    if n > 0:
        print(msg)
        printNtimes(msg, n-1)
```

```
def fullname(first, last):
    first = first.title()    # title makes
    last = last.title()
    return first + " " + last

print( fullname("maria", "costa") )
print( fullname("fernando", "pessoa") )
```

Lambda

lambda

```
lambda arguments: expression
```

- This function can have any number of arguments but only one expression, which is evaluated and returned.
- One is free to use lambda functions wherever function objects are required.
- You need to keep in your knowledge that lambda functions are syntactically restricted to a single expression.
- It has various uses in particular fields of programming besides other types of expressions in functions.

```
# Python code to illustrate cube of a number
# showing difference between def() and lambda().
def cube(y):
    return y*y*y;

g = lambda x: x*x*x
print(g(7))

print(cube(5))
```

```
(lambda x: x * x)(3)
```

https://www.w3schools.com/python/python_lambda.asp
https://realpython.com/python-lambda/
https://www.geeksforgeeks.org/python-lambda-anonymous-functions-filter-map-reduce/

lambda

Syntax

As you saw in the previous sections, a lambda form presents syntactic distinctions from a normal function. In particular, a lambda function has the following characteristics:

- It can only contain expressions and can't include statements in its body.
- It is written as a single line of execution.
- It does not support type annotations.
- It can be immediately invoked (IIFE).

```
intervalo1 = lambda a, b : (b,a) if a>b else  (a,b)
```

```
intervalo1 = lambda a, b : if a>b : (b,a) else: (a,b)
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https://realpython.com/python-lambda/

lambda

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```

```
intervalo1 = lambda a, b : if a>b : (b,a) else: (a,b)
```

https://realpython.com/python-lambda/

Just test

```
my_list = [1, 5, 4, 6, 8, 11, 3, 12]

new_list = list(filter(lambda x: (x%2 == 0) , my_list))

# Output: [4, 6, 8, 12]
print(new_list)
```

```
def myfunc(n):
  return lambda a : a * n

mydoubler = myfunc(2)
mytripler = myfunc(3)

print(mydoubler(11))
print(mytripler(11))
```

```
my_list = [1, 5, 4, 6, 8, 11, 3, 12]

new_list = list(map(lambda x: x * 2 , my_list))

# Output: [2, 10, 8, 12, 16, 22, 6, 24]
print(new_list)
```

https://www.programiz.com/python-programming/anonymous-function
https://www.w3schools.com/python/python_lambda.asp

Curiosities: default values

```
#!/usr/bin/python3

# Function definition is here
def printinfo( name, age = 35 ):
   "This prints a passed info into this function"
   print ("Name: ", name)
   print ("Age ", age)
   return

# Now you can call printinfo function
printinfo( age = 50, name = "miki" )
printinfo( name = "miki" )
```

When the above code is executed, it produces the following result –

```
Name:  miki
Age  50
Name:  miki
Age  35
```

https://www.tutorialspoint.com/python3/python_functions.htm

Curiosities: using parameters names

```
#!/usr/bin/python3

# Function definition is here
def printinfo( name, age ):
   "This prints a passed info into this function"
   print ("Name: ", name)
   print ("Age ", age)
   return

# Now you can call printinfo function
printinfo( age = 50, name = "miki" )
```

When the above code is executed, it produces the following result –

```
Name:  miki
Age  50
```

https://www.tutorialspoint.com/python3/python_functions.htm

Functions and parameters

Function parameters

Pass by value

unmutable

- *safe from change*, i.e. the contents of objects cannot be changed within a method
- Just copies them… - pass by value

- Basic values
- Int, float

Pass by reference

mutable

- objects of which contents can be changed within a method
- Uses reference – send a reference to the data

- "complex" structures
- List, dictionaries…

https://medium.com/@tyastropheus/tricky-python-ii-parameter-passing-for-mutable-immutable-objects-10e968cbda35
https://www.robasworld.com/pythonpassby/

Immutable objects can't be changed.

Mutable objects can be changed.

Type	Immutable?
`int`	Yes
`float`	Yes
`bool`	Yes
`complex`	Yes
`tuple`	Yes
`frozenset`	Yes
`str`	Yes
`list`	No
`set`	No
`dict`	No

https://realpython.com/pointers-in-python/

Function parameters

Pass by value

unmutable

```
>>> def increment(n):
...     n += 1
...     return n
>>> a = 3
>>> a = increment(a)
# the return value of increment() is captured!
>>> print(a)
a = 4
# a now refers to the new object created by the function
```

Pass by reference

mutable

```
>>> def increment(n):
...     n.append([4])
>>> L = [1, 2, 3]
>>> increment(L)
>>> print(L)
L = [1, 2, 3, 4]    # a changed!
```

https://medium.com/@tyastropheus/tricky-python-ii-parameter-passing-for-mutable-immutable-objects-10e968cbda35

Pass by value

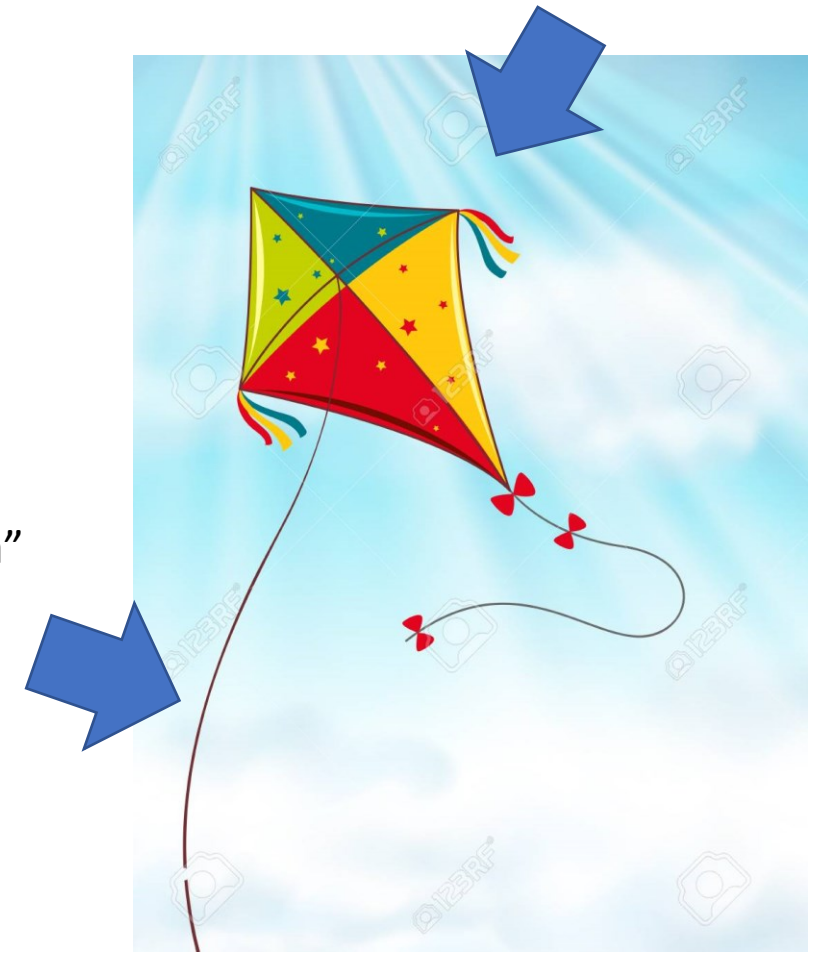
the copier
i.e. Creates the copy

The original
i.e. “data”

The copy to use
- No change on original

Pass by reference

The kite
i.e. “data”



The reference
i.e. allows to reach the “data”

Try this code in pythontutor

```
def changeme( mylist ):
    mylist.append([1,2,3,4])
    print("values inside the function", mylist)
    return

mylist=[10,20,30]
changeme( mylist)
print("values outside the function", mylist)
```

http://www.pythontutor.com/visualize.html

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Python 3.6
(known limitations)

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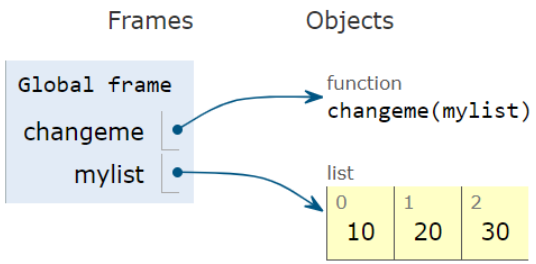
Edit this code

line that just executed
next line to execute

Print output (drag lower right corner to resize)



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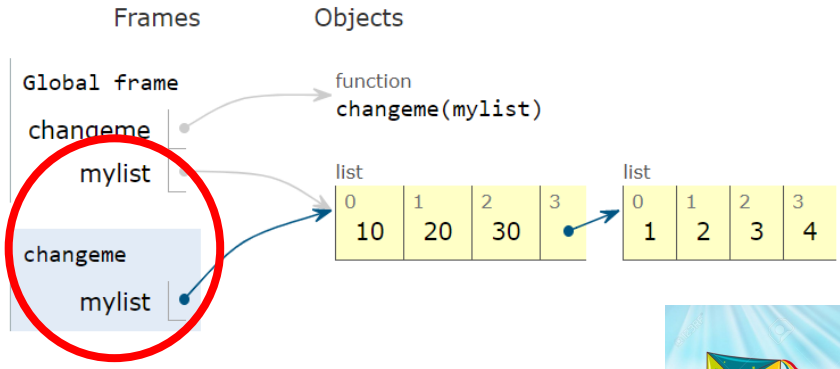

Same reference (line to the same “kite”)
They are the same…

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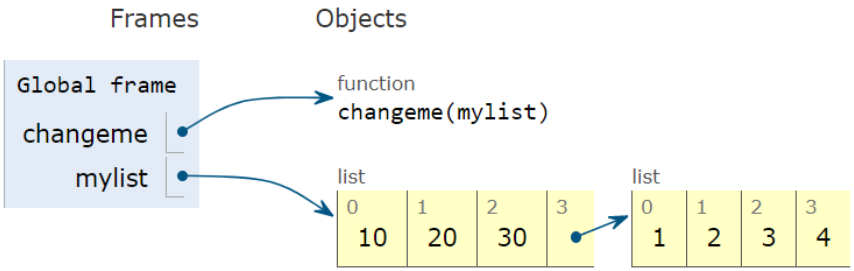

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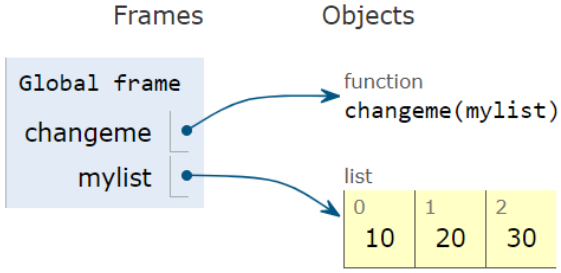

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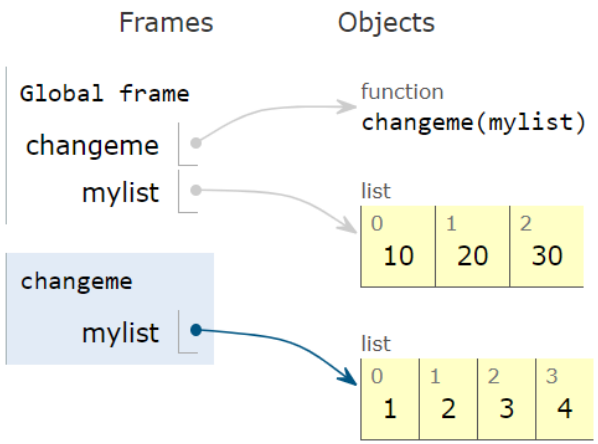

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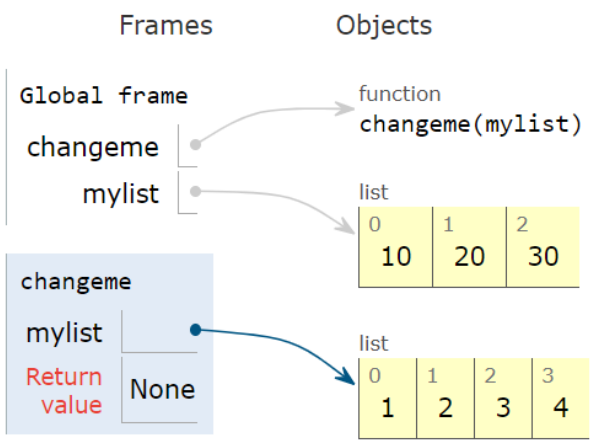

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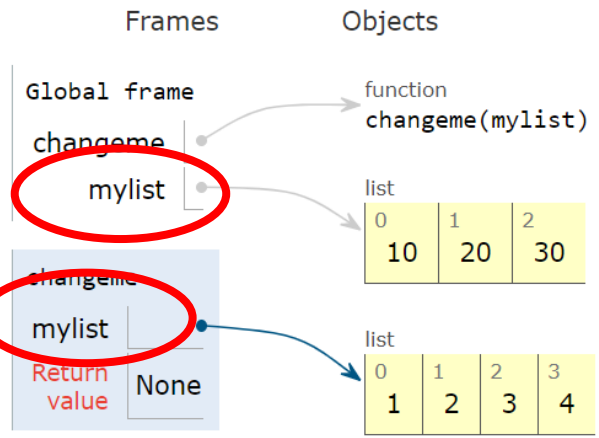

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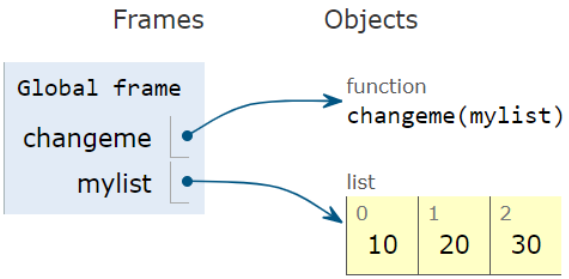

Pass by reference

All parameters (arguments) in the Python language are passed by reference. It means if you change what a parameter refers to within a function, the change also reflects back in the calling function. For example −


```
#!/usr/bin/python

# Function definition is here
def changeme( mylist ):
   "This changes a passed list into this function"
   mylist = [1,2,3,4]; # This would assig new reference in mylist
   print "Values inside the function: ", mylist
   return

# Now you can call changeme function
mylist = [10,20,30];
changeme( mylist );
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```
Values inside the function:  [1, 2, 3, 4]
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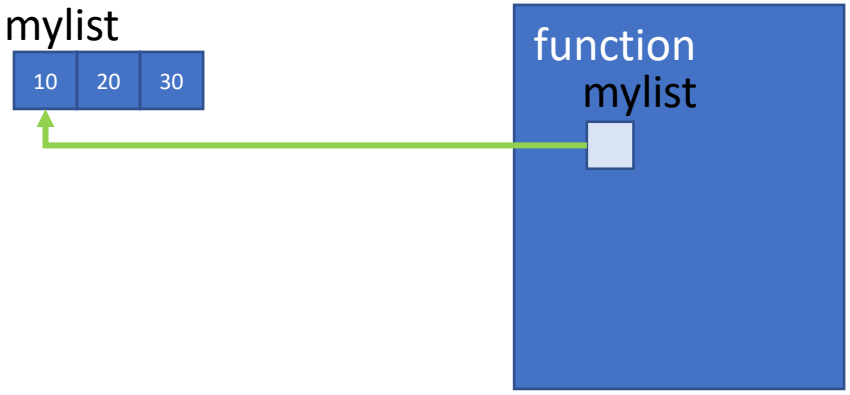


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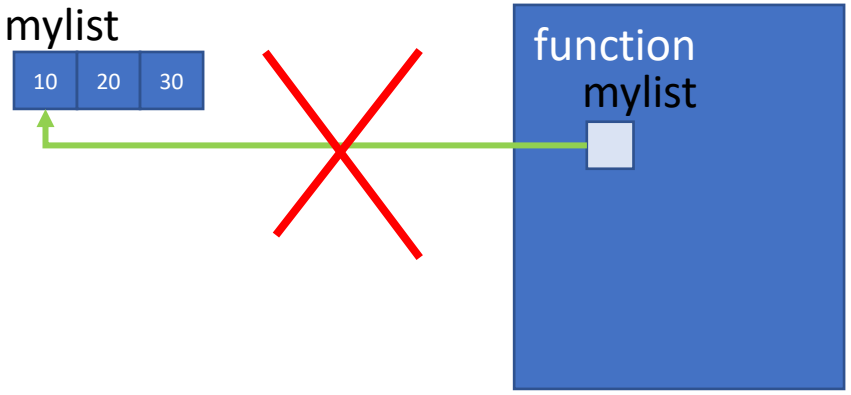

Loose reference…
i.e. override the reference
Loose the original data

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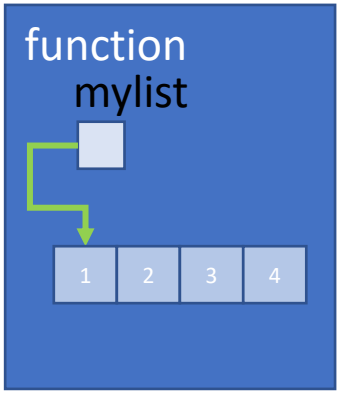

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The End