



PYTHON FOR COMPUTATIONAL PROBLEM SOLVING

Closures

Prof. Sindhu R Pai

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Department of Computer Science and Engineering

A closure is a nested function which has access to a free variable from an enclosing function that has finished its execution.

Three characteristics of a Python closure are:

- It is a nested function
- It has access to a free variable in outer scope
- It is returned from the enclosing function

A free variable - a variable that is not bound in the local scope.

Closures with immutable variables such as numbers and strings - use the nonlocal keyword.

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Functions - Closure



1. Example:

```
def outer(msg): # This is the outer enclosing function
    def inner(): # This is the nested function
        print(msg)
    return inner # returns the nested function
```

Now let's try calling this function.

```
different = outer("This is an example of closure")
different () #refers to inner()
```

Output:

This is an example of closure

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Functions - Closure



2. Example:

```
def f1(): #outer function
    def f2(): #inner function
        print ("Hello")
        print ("world")
    print('f2=',id(f2))
    return f2
c=f1() #refers to f2()
c()
print('c=',id(c)) #id of f2() and c() are same
```

Output:

```
f2= 2908823806840
Hello
world
c= 2908823806840
```

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Functions - Closure



3. Example:

```
def division(y): #outer function
    def divide(x): #inner function
        return x/y
    return divide
```

```
d1=division(2) #refers to divide
d2=division(3) #refers to divide
```

```
print(d1(20))
print(d2(96))
```

Output:

```
10.0
32.0
```

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4. Example:

```
def f1(): #outer function
    def f2(): #inner function
        print ("Hello")
        print ("world")
    return f2
c=f1() #refers to f2()
del f1
c() #still works
```

Output:

```
Hello
world
```

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5. Example:

```
def outer(msg):  
    text = msg      #text is having the scope of outer function  
    def inner():  
        print(text) #using non-local variable text  
    return inner    #return inner function
```

```
func = outer('Hello')  
func()
```

Output:
Hello

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6. Example:

```
def outerfunc(x):  
    def innerfunc():  
        print(x)  
    return innerfunc
```

Output:

```
7  
7
```

```
myfunc=outerfunc(7)  
myfunc() #refers to innerfunc()  
del outerfunc  
myfunc() #still refers to innerfunc() retaining the value of enclosing scope of x
```

We are assigning the function `outerfunc()` to the variable `myfunc`. Even if we delete `outerfunc()` from the memory, the function `outerfunc()` can be called, using the referred variable `myfunc`.

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7. Example:

```
def f1(): #outer function
    x=0
    def f2(): #inner function
        nonlocal x # x - that belongs to scope of outer function is made non-local
        x=x+1
        return x
    return f2

func = f1()
retval = func()
print ("x=", retval)
retval = func()
print ("x=", retval)
```

Output:

x= 1

x= 2

Function Closure vs. Nested function

- Not all nested functions are closures.
- For a nested function to be a closure, the following conditions need to be satisfied:
 1. The inner function has access to the non-local variables or local variables of the outer function.
 2. The outer function must return the inner function.

Function Closure vs. Nested function

Example: Nested Function but not Closure (When `msg` is passed to `inner()`, `msg` ends up belonging to `inner()` function's local scope. So, the 1st condition is not satisfied)

```
def outer(msg):           # This is the outer enclosing function
    def inner(m=msg):     # This is the nested function
        print(m,"World")
    return inner           # returns the nested function
```

```
different = outer(msg="Hello")
different()                #refers to inner()
```

Output
Hello World

Function Closure: Summary

- A function object that remembers values in enclosing scopes even when the variable goes out of scope.
- Python closures help avoiding the usage of global values and provide some form of data hiding. They are used in Python decorators.



THANK YOU

Department of Computer Science and Engineering

Dr. Shylaja S S, Director, CDSAML & CCBD, PESU

Prof. Sindhu R Pai – sindhurpai@pes.edu

Prof. Sowmya Shree P