

More on Functions

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Functions of Functions

- Functions are full-fledged objects in Python
 - This means you can pass functions as parameters
 - Example: Calculate the average of the values of a function at $-n, -n+1, -n+2, \dots, -2, -1, 0, 1, 2, \dots, n-2, n-1, n$
 - The function needs to be a function of one integer variable
 - Example:
 - $n = 2$, function is squaring
 - Return value is $((-2)^2 + (-1)^2 + 0^2 + 1^2 + 2^2)/5 = 2$

Functions of Functions

- We first define the averaging function with two arguments
 - The number n
 - The function over which we average, called `func`

```
def averaging(n, func):
```

Functions of Functions

- Inside the function, we create an accumulator and a loop index, running from $-n$ to n .

```
def averaging(n, func):  
    accu = 0  
    for i in range(-n, n+1):
```

Functions of Functions

- Inside the loop, we modify the accumulator `accu` by adding the value of the function at the loop variable.

```
def averaging(n, func):  
    accu = 0  
    for i in range(-n, n+1):  
        accu += func(i)
```

Functions of Functions

- There are $2n+1$ points at which we evaluate the function.
- We then return the average as the accumulator over the number of points

```
def averaging(n, func):  
    accu = 0  
    for i in range(-n, n+1):  
        accu += func(i)  
    return accu / (2*n+1)
```

Functions of Functions

- In order to try this out, we need to use a function
- We can just define one in order to try out our averaging function

```
def square(number):  
    return number*number  
  
def averaging(n, func):  
    accu = 0  
    for i in range(-n, n+1):  
        accu += func(i)  
    return accu/(2*n+1)  
  
print(averaging(2, square))
```

Local and Global Variables

- A Python function is an independent part of a program
 - It has its own set of variables
 - Called local variables
 - It can also access variables of the environment in which the function is called.
 - These are global variables
 - The space where variables live is called their scope
 - We will revisit this issue in the future

Examples

```
a=3
b=2
def foo(x):
    return a+x
def bar(x):
    b=1
    return b+x

print(foo(3), bar(3))
```

- a and b are two global variables
- In function foo:
 - a is global, its value remains 3
- In function bar:
 - b is local, since it is redefined to be 1

Preview of Scoping: The global keyword

- In the previous example, we generated a local variable b by just assigning a value to it.
- There are now two variables with name b
- In `bar`, the global variable is hidden
- If we want to assign to the global variable, then we can use the keyword `global` to make b refer to the global variable. An assignment then does not create a new local variable, but rather changes the value of the old one.

Example

```
a = 1  
b = 2
```

```
def foo():  
    global a  
    a = 2  
    b = 3  
    print("In foo:" , "a=", a, " b=", b)
```

```
print("Outside foo: " , "a=", a, " b=", b)  
foo()  
print("Outside foo: " , "a=", a, " b=", b)
```

```
##Outside foo:  a= 1  b= 2  
##In foo:  a= 2  b= 3  
##Outside foo:  a= 2  b= 2
```

- In foo:
 - A local variable *b*
 - A global variable *a*
 - The value of *a* changes by executing *foo()*

Scoping

- Scoping is definitely an advanced topic
 - The take-home is:
 - **Don't ever, ever use global variables**
 - **Unless you really need to.**
- Under most circumstances, you should pass variables as arguments.
 - **Python Philosophy: Rules are followed by convention, there is no enforcement**
 - Because sometimes you need to make exceptions