

LECTURE 3

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WHAT IS DISCUSSED IN THE LAST CLASS

- Object and Expression
 - Built-in types, constants, functions
 - Built-in operators
 - Operator order
 - Floating point errors
 - Short-cut evaluation
 - Type-checking

TODAY, WE WILL LEARN ABOUT

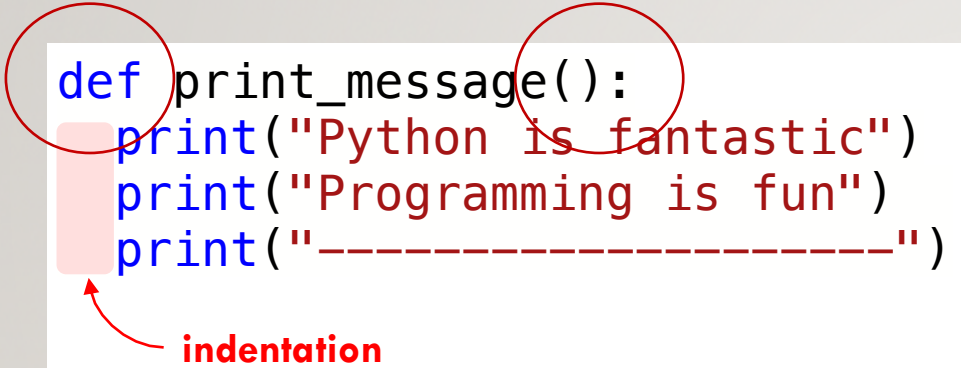
- Functions in python
 - Function definition/call, return
 - Local variables
 - Global variables
 - Parameters and arguments
 - Function as an object

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FUNCTION

- A **function definition** specifies the name of a new function and the sequence of statements that are executed when the function is called



```
def print_message():  
    print("Python is fantastic")  
    print("Programming is fun")  
    print("-----")
```

```
def repeat_message():  
    print_message()  
    print_message()
```

```
repeat_message()
```

VOCABULARY

- **def** is used to define a function
- **func** is the function name
- **y, z** are called parameters

- Call function
- 1,2 are called arguments

- **Global** variable

```
main.py  saved
1 x = 10
2 def func(y, z):
3     val = 1
4     res = x + y + z + val
5     return res
6 print(func(1, 2))
7 print(val)
```

```
14
Traceback (most recent call last):
  File "main.py", line 7, in <module>
    print(val)
NameError: name 'val' is not defined
>
```

- **return** is used to pass the result to the point where the function is called

- **Local** variable

- Expression (a part of statement) vs. Statement

RETURN STATEMENT

```
def isPositive(x):  
    return (x > 0)  
  
print(isPositive(5))  
print(isPositive(0))  
  
def isNegative(x):  
    print("Hello!")  
    return (x < 0)  
    print("Goodbye!")  
  
print(isNegative(5))  
  
def f(x):  
    result = x + 42  
  
print(f(5))
```

PRACTICE

- What would be the result?

```
def cubed(x):  
    print(x**3)  
  
cubed(2)  
print(cubed(3))  
print(2*cubed(5))
```


PARAMETER AND RETURN TYPE

```
def hypotenuse(a, b):  
    return ((a**2) + (b**2))**0.5  
  
print(hypotenuse(3, 4))  
print("-----")  
  
def xor(b1, b2):  
    return ((b1 and (not b2)) or (b2 and (not b1)))  
  
print(xor(True, True))  
print(xor(True, False))  
print(xor(False, True))  
print(xor(False, False))  
print("-----")  
  
def isPositive(n):  
    return (n > 0)  
  
print(isPositive(10))  
print(isPositive(-1.234))
```

5.0

False

True

True

False

True

False

> |

FUNCTION COMPOSITION

```
def f(w):  
    return 10*w  
  
def g(x, y):  
    return f(3*x) + y  
  
def h(z):  
    return f(g(z, f(z+1)))  
  
print(h(1))
```



—> h(1)
—> f(z+1) returns 20
—> g(1, 20)
—> f(3) returns 30
—> return 50
—> f(50) returns 500
print(500)

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LOCAL VARIABLES

- A function to evaluate the quadratic function $ax^2 + bx + c$:

```
def quadratic(a,b,c,x):  
    quad_term = a*x**2  
    lin_term  = b*x  
    return quad_term + lin_term + c  
  
print(quadratic(1,2,3,4))
```

- The variables **quad_term** and **lin_term** exist only during the execution of the function quadratic. They are called **local variable**
- A **function's parameters** are also local variable. The only difference is that when the function is called, they are initialized from the function argument

LOCAL VARIABLES

```
a = "Letter a"

def f(a):
    print("A =", a)

def g():
    a = 7
    f(a + 1)
    print("A =", a)

print("A =", a)
f(3.14)
print("A =", a)
g()
print("A =", a)
```

```
A = Letter a
A = 3.14
A = Letter a
A = 8
A = 7
A = Letter a
>
```

* Notes

- The values of a inside function f() and g() are different from "Letter a"
- They are valid until the function is terminated

WHY LOCAL VARIABLES?

- To use the function quadratic, you only want to remember this

```
def quadratic(a,b,c,x):  
    #implemented somehow
```

- Some variables are used only in a certain part of the program and we don't need to keep track of them
- **Modularization** means that software consists of parts that are developed and tested separately. To use a part, you don't need to understand how it is implemented

PRACTICE

- What would be the results of these example codes? Why?

```
def swap(a, b):  
    a, b = b, a  
  
x, y = 123, 456  
swap(x, y)  
print(x, y)
```

```
def f(x):  
    print("In f, x =", x)  
    x += 7  
    return round(x / 3)  
  
def g(x):  
    x *= 10  
    return 2 * f(x)  
  
def h(x):  
    x += 3  
    return f(x+4) + g(x)  
  
print(h(f(1)))
```

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GLOBAL VARIABLES

- Variables **defined outside of a function** are called global variables
- Generally, it is **not recommended to use global variables**. However, you need to understand how it works

```
g = 100

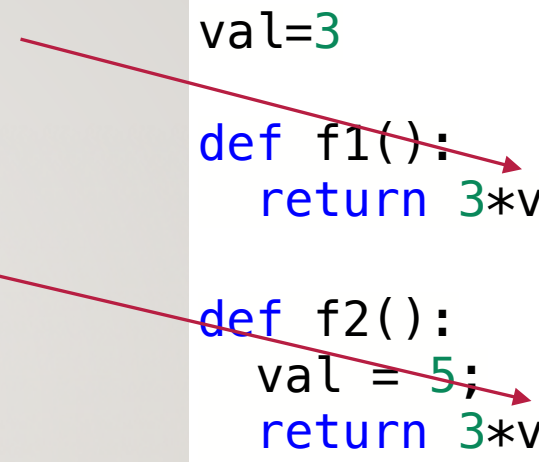
def f(x):
    return x + g

print(f(5))
print(f(6))
print(g)
```

LOCAL AND GLOBAL

- If a variable is **only used** inside a function, it is **global**
- If a variable is **assigned** in a function, it is **local**

```
val=3  
  
def f1():  
    return 3*val + 5  
  
def f2():  
    val = 5;  
    return 3*val + 5
```

A diagram illustrating variable scope resolution. Two red arrows originate from the text in the list. The first arrow starts from the word 'global' in the first bullet point and points to the 'val' variable in the first line of the code block. The second arrow starts from the word 'local' in the second bullet point and points to the 'val' variable in the fourth line of the code block, which is inside the function f2().

GLOBAL VARIABLES

- If To modify a global variable within a function, you must use the keyword **global** before the variable

```
g = 100

def f(x):
    global g
    g += 1
    return x + g

print(f(5))
print(f(6))
print(g)
```

PRACTICE

- What would be the result?

```
a = 17
def test():
    print(a)
    a = 13
    print(a)

test()
```


PRACTICE

- What would be the result?

```
a = 17
def test():
    print(a)
    a = 13
    print(a)

test()
```

Error!!

```
Traceback (most recent call last):
  File "main.py", line 7, in <module>
    test()
  File "main.py", line 3, in test
    print(a)
UnboundLocalError: local variable 'a' referenced before assignment
>
```

- * note : **a** is a **local variable** in the test function because of the assignment, but has no value inside when the first print statement is executed

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DEFAULT PARAMETER

- Sometimes, a function has a parameter that has a default value

```
def f(x, y=10):  
    return x + y  
  
print(f(5))  
print(f(5,1))
```

- **Default parameters have to locate after normal parameters**

```
def f(x=10, y):  
    return x + y
```

```
File "main.py", line 1  
    def f(x=10, y):  
        ^  
SyntaxError: non-default argument follows default argument  
> |
```

DEFAULT PARAMETER

- What would be printed out? 5? 6?

```
val = 5
```

```
def f(x = val):  
    print(x)
```

```
val = 6  
f()
```

DEFAULT PARAMETER

- What would be printed out? 5? 6?

```
val = 5

def f(x = val):
    print(x)

val = 6
f()
```

- **The default values are evaluated at the point of function definition**

NAMED PARAMETER

- We can include the name of the parameter in the function call to make the code clearer the order of argument does not matter

```
def avg(first, second=10, third=100):  
    return (first+second+third)/3  
  
print(avg(1, third=10))  
print(avg(first=1, third=10))  
print(avg(third=10, first=1))
```

```
7.0  
7.0  
7.0  
▶
```

- What if the following statement is executed?

```
print(avg(third=3, 1))
```

```
File "main.py", line 7  
    print(avg(third=3, 1))  
                      ^  
SyntaxError: positional argument follows keyword argument  
▶
```


VARIABLE-LENGTH ARGUMENTS

- Python allows to pass a variable number of arguments to a function
- An asterisk (*) is placed before the variable name that will hold the values of multiple arguments (non-keyword)

```
def myFun(*argv):  
    res = ""  
    for arg in argv:  
        res += arg  
    print(res)
```

```
myFun('Hello')  
myFun('Hello', 'Welcome')  
myFun('Hello', 'Welcome', 'to', 'Python', 'Programming', 'Class')
```

```
Hello  
HelloWelcome  
HelloWelcometoPythonProgrammingClass  
➤
```

- The details of the above code will be covered in the later class

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FUNCTIONS ARE OBJECTS

- A function is also an object

```
import math

def f(x):
    return math.sin(x/3 + math.pi/4)

print(f)
print(type(f))
```

```
<function f at 0x7fbcc239a1f0>
<class 'function'>
> []
```

FUNCTIONS ARE OBJECTS

- You can use a function as an argument

```
def shout(text):  
    return text.upper()  
  
def whisper(text):  
    return text.lower()  
  
def greet(func):  
    # storing the function in a variable  
    greeting = func("Hello, I am created by a function passed by argument.")  
    print(greeting)  
  
greet(shout)  
greet(whisper)
```

```
HI, I AM CREATED BY A FUNCTION PASSED AS AN ARGUMENT.  
hi, i am created by a function passed as an argument.  
> 
```

FUNCTIONS RETURNING A FUNCTION OBJECT

- Let's define the function that returns a quadratic function f defined by

$$f(x) = ax^2 + bx + c$$

```
def quadratic(a,b,c):  
    def f(x):  
        quad_term = a*x**2  
        lin_term = b*x  
        return quad_term + lin_term + c  
    return f  
  
print(quadratic(1,0,1)(2))
```

QUESTION?
