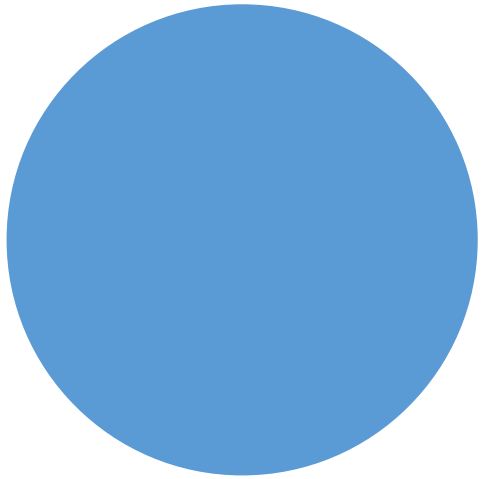
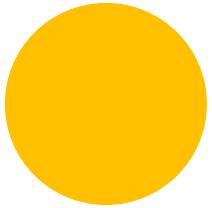



Programming 1

Introduction in programming

Course 4

What we talked about?

- Loops
  - How to repeate a sequence of code
- Data Structers
  - List
  - Tuples
  - Sets
  - Dictionarys

What we will talk about?

- Functions
  - Function definition
  - Functions call
- Variables
  - Local variables
  - Global variables

Let us consider the following example

A Flashlight

Decomposition

Two perspectives

- How is functioning?
  - What components contains?
  - How this components interact?
- How can be used?
  - What to know in order to use it?
  - How to start/stop?

Abstractisation

Decomposition

- **Idea**
  - Multiple components work together in order to obtain a result (ex. A functional flashlight)

- Between the components exits clear interaction (ex. light is on after the switcher close the circuit with the battery)

- This concept is also available when we write

Abstractisation

- **Idea**
  - it is not necessary to know how a flashlight is functioning in order to use it
- A flashlight is a "black box", we do not know how is functioning
- We know the "interface" of the flashlight: how to turn on/off
- How is this "black box" functioning when we push the turn on button?


Apply this principles
when you programming!

Add STRUCTURE Using DECOMPOSITION

- In programming, divide code into modules
  - are self-contained
  - used to break up code
  - intended to be reusable
  - keep code organized
  - keep code coherent

- This lecture, achieve decomposition with functions

- Next classes, achieve decomposition with classes , modules in Python and packages

Hide DETAILS Using ABSTRACTIZATION

- In case of the flashlight example it is enough to have a minimal user manual in order to use, it is not necessary to have the scheme of the flashlight

- In programming, think of a piece of code as a black box
  - cannot see details
  - do not need to see details
  - do not want to see details
  - hide tedious coding details

- Achieve abstraction with function specifications or docstrings

Functions

- Rewrite pace of reusable code named functions
- Functions are not executed by a program when they are not called or invoked
- A function have the following characteristics
  - has a name
  - has parameters (0 or more)
  - has a docstring (optional but recommended)
  - has a body
  - returns something

How to write and call a function?

Key word

Name

Parameters Or Arguments

Docstring

```
def is_even (i):
    """
    Input: i, a `int` value
    Return True if i is even or False if it is odd
    """
    print ("In is_even function")
    return i%2 == 0

is_even (3)
```

Function Body

Later, call the function and assign values to arguments

Function Body

```
def is_even (i):
    """
    Input: i, a `int` value
    Return True if i is even or False if it is odd
    """
    print (" In is_even function ")
    return i%2 == 0
```

Statement

Key word

Expression that is evaluated And Return type

Specifications/Docstring

- Are a contract between implementer of the function and user
  - Assumptions
    - conditions that must be met by users of function. Typically constraints on parameters, such as type, and sometimes acceptable ranges of values
  - Guarantees
    - Conditions that must be met by function, provided that it has been called in way that satisfies assumptions

Variable – Visibility domain

- Formal parameter gets bound to the value of actual parameter when function is called
- New scope/frame/environment created when enter a function
- Scope is mapping of names to objects

```
def f(x):
    x = x + 1
    print ("in f(x): x =", x)
    return x

x = 3
z = f(x)
```

Formal Parameter

Actual Parameter

Function definition

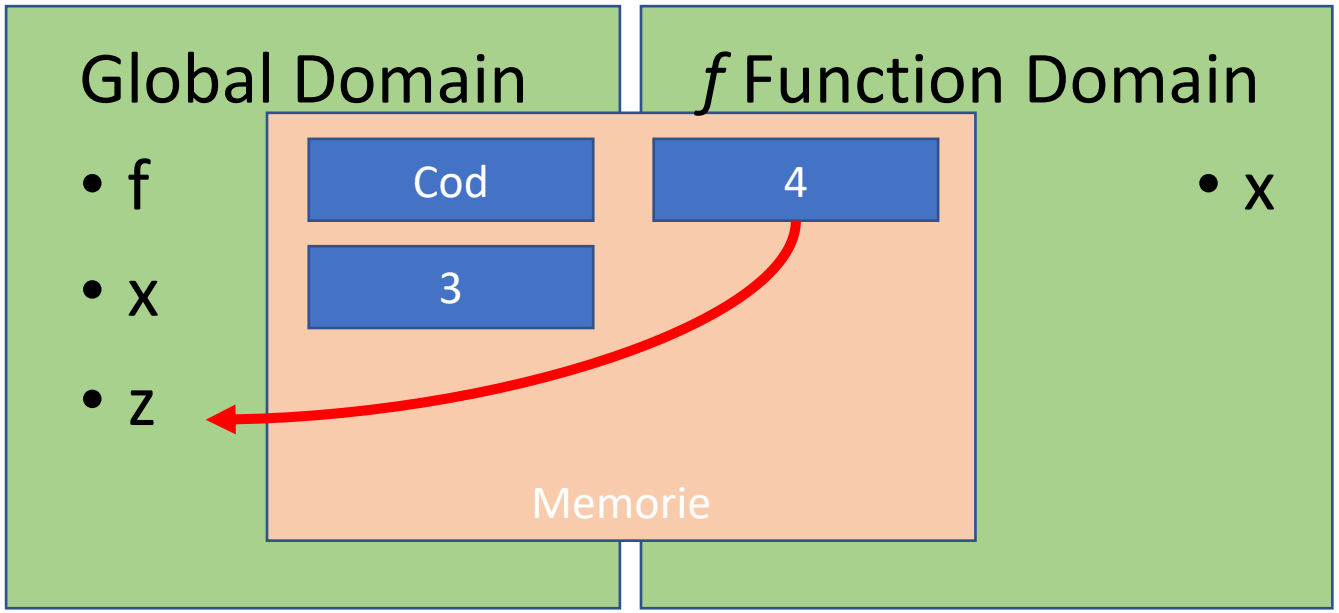
Main Program:

- Initialize variable *x*
- Call function *f*
- Assign the result returned by the function to variable *z*

Variable – Visibility Domain

```
def f(x):
    x = x + 1
    print ("in f(x): x =", x)
    return x

x = 3
z = f(x)
```



What happens if the fuction does not return any value?

- Python returns the value *None*, if no return given
- Represents the absence of a value
- *None* is a special constant in the language
- *None* is used like *NULL*, *void*, or *nil* in other languages

Function as Functions Arguments

- Arguments can have any type, including functions

```
def a():
    print ("In function a")
def b(y):
    print ("In function b")
    return y
def c():
    print ("In function c")
    return z()

print (a())
print (5+b(2))
print (c(a))
```

[Optional] Default Values for arguments

- Remember *range()* function?

- How can we use it?
  - range(10)
  - range(1,10)
  - range(1, 10, 2)

- How this function is defined?

[Optional] Default Values for arguments

- Default values for a function's arguments
- These arguments are optional when the function is called

```
def my_simple_range(start, stop, step=1):
    l=[]
    el = start
    while el < stop:
        l.append(el)
        el = el + step
    return l

print(my_simple_range(1,10))
print(my_simple_range(1,10,1))
```

[Optional] Lambda notations

- Python's lambda creates anonymous functions

```
f = lambda z: z * 42
f(7)

g = (lambda x,y: x+y)(2,3)
print(g)
```

- Only one expression in the lambda body; its value is always returned
- Python supports functional programming idioms: map, filter, closures, continuations, etc.

[Optional] Lambda notation – map, reduce, filter

```
def add1(x): return x+1
def odd(x): return x%2 == 1
def add(x,y): return x + y

print(list(map(add1, [1,2,3,4])))
print(list(map(add,[1,2,3,4],[100,200,300,400])))
print(list(filter(odd, [1,2,3,4])))
import functools
functools.reduce(add, [1,2,3,4])
```

OUTPUT

```
[2, 3, 4, 5]
[101, 202, 303, 404]
[1, 3]
10
```

Visibility domain

- All computer languages have scope rules
- Scope rules specify which variables can be seen
- Python: These rules can be summarized as LEGB:
  1. Local
  2. Enclosing
  3. Global
  4. Built-in
- The search order matters: first search Lo- cal, then Enclosing, Global, and Built-in

TOKE ONLY ABOUT:

- LOCAL
- GLOBAL

Local Scope

- Always search Local Scope first

- Local Scope refers to names assigned in any way within a function, that are not declared as global

Global Scope

- Global scope is searched after Local[, and Enclosed]
- Global scope is simplest to understand
- A name declared at Global scope, is not enclosed in a function

```
x = 100
print(x)
```

Declaring Variables / Variables Scope

- A variable name must be defined before it is used

```
print(x)
x = 100
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
 <ipython-input-15-5065468fbb19> in <module>()
----> 1 print(x)
      2 x = 100

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

Local Again

- Local Scope: names assigned in a function
- Local is searched first

```
x = 99
y = 17
def fun(x):
    y=100
    print (x, y)
fun(77)
print (x, y)
```

Result?
77 100
99 17

Local Again

- Local Scope: names assigned in a function
- Local is searched first

Result?
77 100
99 17

```
x = 99
y = 17
def fun(x):
    y=100
    print (x, y)
fun(77)
print (x, y)
```

x Variable values
---
99 <- global declaration
77 <- function call (function parameter hides global *x* name)
99 <- global declaration

y Variable values
---
17 <- global declaration
100 <- function body declaration
17 <- global declaration

Keyword global

- A global variable can be declared in a function using the keyword global
- Caution: function has to be called in order to define the variable, otherwise the variable is never defined

```
def fun():
    global x
    x=100

fun()
print (x)
```