POLITECNICO
DI TORINO

Data Science Lab

Python Programming

DataBase and Data Mining Group

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Summary

- **Python language**
  - Python data types
  - Controlling program flow
  - Functions
  - Lambda functions
  - List comprehensions
  - Classes
- **Structuring Python programs**

Python data types

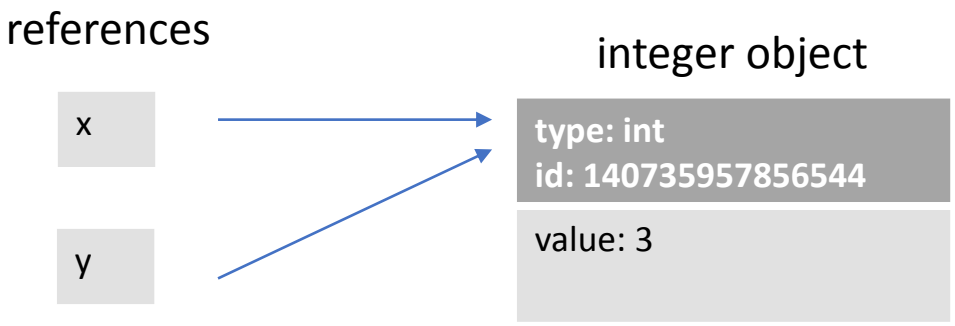
- Python is an **object oriented** language
- Every piece of data in the program is an **Object**
  - Objects have **properties** and **functionalities**
  - Even a simple **integer** number is a Python **object**

Example of an integer object

type: int id: 140735957856544
value: 3

Python data types

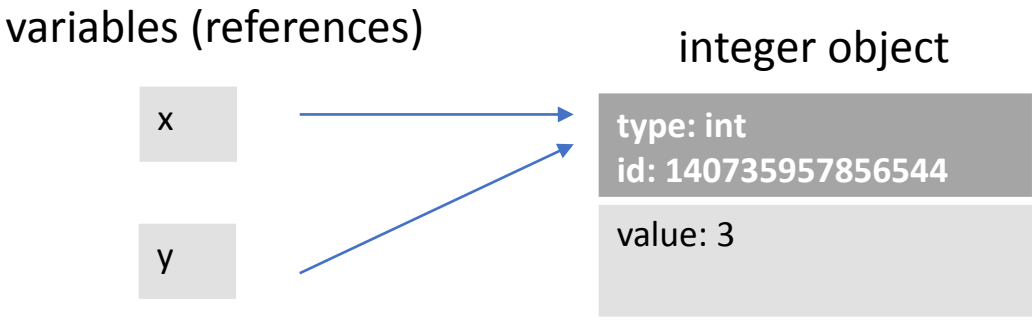
- **Reference** = **symbol** in a program that refers to a particular **object**
- A single Python object can have **multiple references (alias)**



Python data types

- In Python
  - **Variable** = **reference** to an object

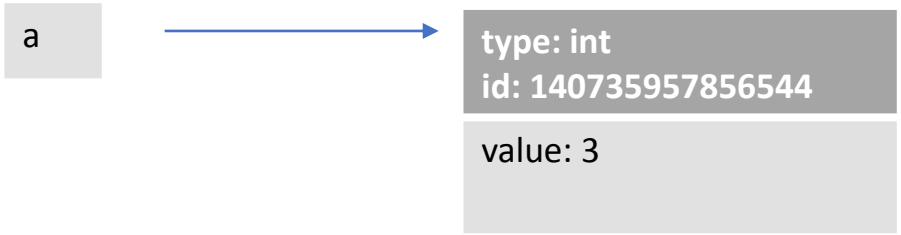
- When you **assign** an object to a variable it becomes a **reference** to that object



Python data types

- **Defining a variable**
  - **No need** to specify its data type
  - **Just assign** a value to a new variable name

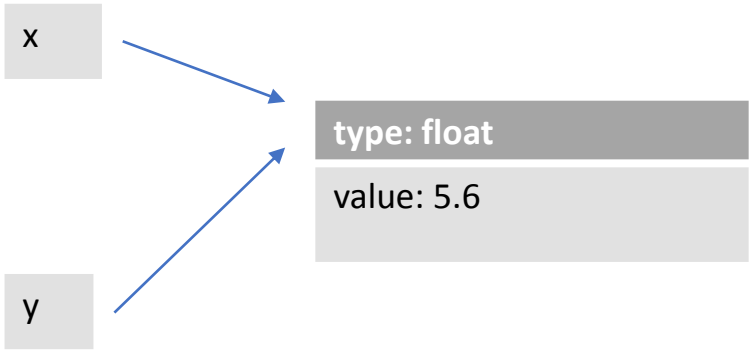
```
a = 3
```



Python data types

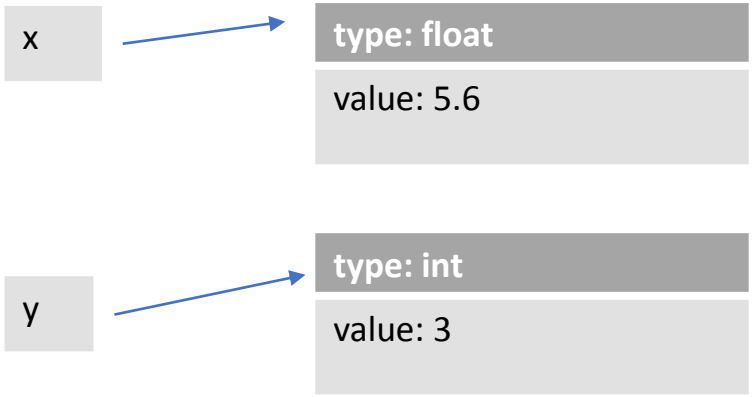
- Example

```
x = 5.6
y = x
```



  - If you assign y to a new value…

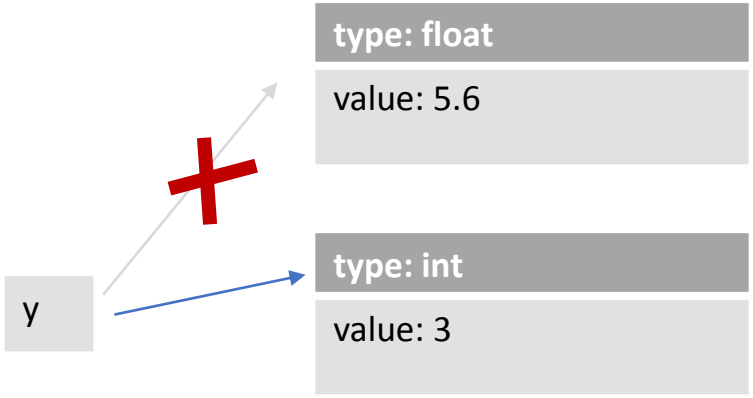
```
y = 3
```



Python data types

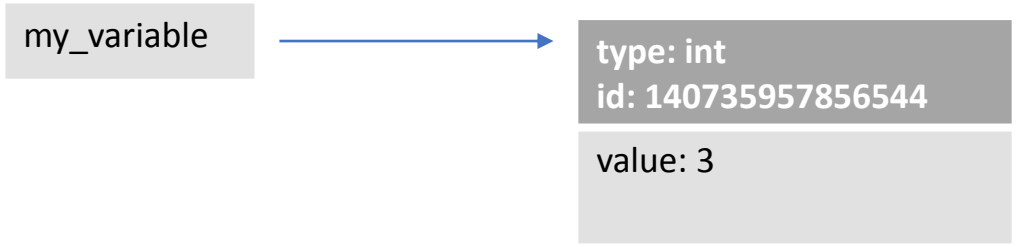
- From the previous example we learn that:
  - Basic data types, such as integer and float variables are **immutable**:
    - Assigning a new number will not change the value inside the object by rather create a new one

```
y = 5.6
y = 3
```



Python data types

- Verify this reasoning with id()
  - **id(my_variable)** returns the **identifier** of the object that the variable is referencing



Python data types

- **Jupyter example**
  - Type in your code

In [1]:
```
x = 1
y = x
print(id(x))
print(id(y))
```

  - Press CTRL+ENTER to run and obtain a result

Out[1]:
```
140735957856544
140735957856544
```

Python data types

- **Basic data types**
  - *int*, *float*, *bool*, *str*
  - *None*
  - All of these objects are **immutable**
- **Composite data types**
  - *tuple* (**immutable** list of objects)
  - *list*, *set*, *dict* (**mutable** collections of objects)

Python data types

- **int, float**
  - Available operations
    - `+`, `-`, `*`, `/`, `//` (integer division), `%` reminder, `**` (exponentiation)
    - Example

```
In [1]:  x = 9
         y = 5
         r1 = x // y          # r1 = 1
         r2 = x % y           # r2 = 4
         r3 = x / y           # r3 = 1.8
         r4 = x ** 2          # r4 = 81
```

    - Note that dividing 2 **integers** yields a **float**

Python data types

- **bool**
  - Can assume the values True, False
  - Boolean operators: **and, or, not**
    - Example

In [1]:

```
is_sunny = True
is_hot = False
is_rainy = not is_sunny                  # is_rainy = False
bad_weather = not (is_sunny or is_hot)   # bad_weather = False

temperature1 = 30
temperature2 = 35
growing = temperature2 > temperature1    # growing = True
```

Python data types

- **String**

In [1]:
```
string1 = "Python's nice"                # with double quotes
string2 = 'He said "yes"'                # with single quotes
print(string1)
print(string2)
```

Out[1]:
```
Python's nice
He said "yes"
```

- Definition with single or double quotes is equivalent

Python data types

- **Conversion** between types
  - Example

In [1]:

```
x = 9.8
y = 4
r1 = int(x)                    # r1 = 9
r2 = float(y)                  # r2 = 4.0
r3 = str(x)                    # r3 = '9.8'
r4 = float("6.7")              # r4 = 6.7
r5 = bool("True")              # r5 = True
r6 = bool(0)                   # r6 = False
```

Python data types

- **Strings: concatenation**
  - Use the **+** operator

In [1]:

```
string1 = 'Value of '
sensor_id = 'sensor 1.'
print(string1 + sensor_id)          # concatenation
val = 0.75
print('Value: ' + str(val))         # float to str
```

Out[1]:

```
Value of sensor 1.
Value: 0.75
```

Python data types

- **Working with strings**
  - **len:** get string length
  - **strip:** remove leading and trailing spaces (tabs or newlines)
  - **upper/lower**: convert uppercase/lowercase

In [1]:

```
s1 = ' My string '
length = len(s1)            # length = 11
s2 = s1.strip()             # s2 = 'My string'
s3 = s1.upper()             # s3 = ' MY STRING '
s4 = s1.lower()             # s4 = ' my string '
```

Python data types

- **Sub-strings**
  - **str[start:stop]**
    - The start index is **included**, while stop index is **excluded**
    - Index of characters starts **from 0**
  - **Shortcuts**
    - **Omit start** if you want to start from the beginning
    - **Omit stop** if you want to go until the end of the string

In [1]:

```
s1 = "Hello"
charact = s1[0]              # charact = 'H'
s2 = s1[0:3]                 # s2 = 'Hel'
s3 = s1[1:]                  # s3 = 'ello'
s4 = s1[:3]                  # s4 = 'Hell'
```

Python data types

- **Sub-strings**
  - **Negative indices:**
    - count characters **from the end**
    - **-1 = last character**

In [1]:

```
s1 = "MyFile.txt"


s2 = s1[:-1]                # s2 = 'MyFile.tx'
s3 = s1[:-2]                # s3 = 'MyFile.t'
s4 = s1[-3:]                # s4 = 'txt'
```

Python data types

- **Strings are immutable**

In [1]:

```
str1 = "example"
str1[0] = "E"                    # will cause an error
```

- Use instead:

In [1]:

```
str1 = "example"
str1 = 'E' + str1[1:]
```

Python data types

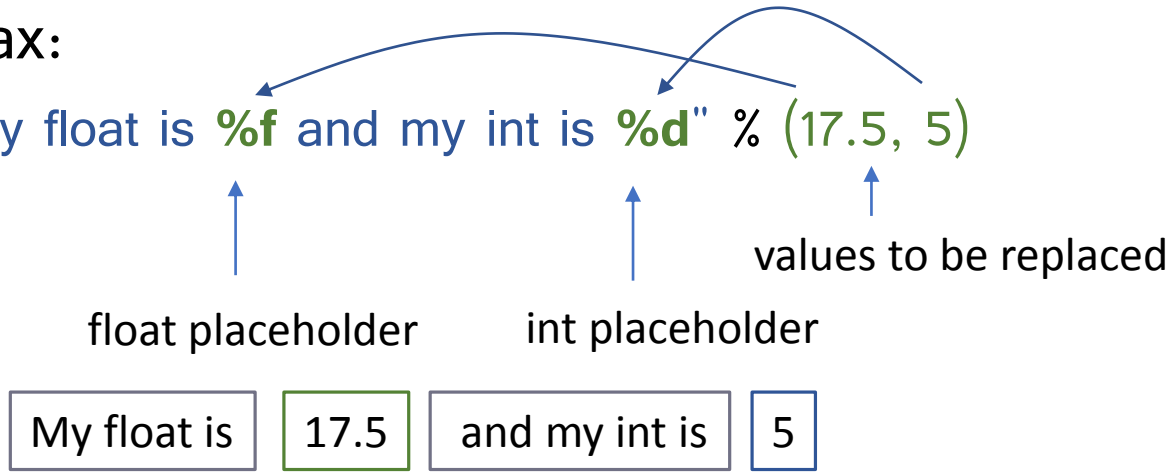
PoliTo DBMG

- **Formatting strings (from Python 3.6)**
  - Useful pattern to build a string from one or more variables
  - E.g. suppose you want to build the string:

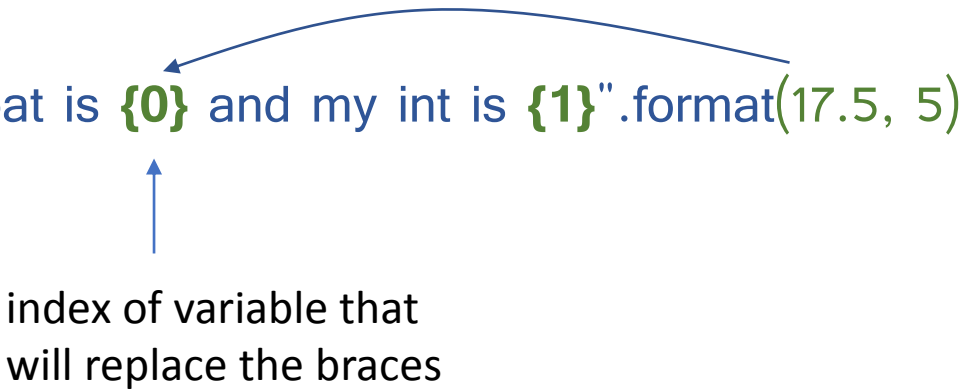
	var1		var2
My float is	17.5	and my int is	5

  - Syntax:
    - **f**"My float is **{var1}** and my int is **{var2}**"

- **Formatting strings (older versions)**
  - Syntax:
    - "My float is %f and my int is %d" % (17.5, 5)



    - "My float is {0} and my int is {1}".format(17.5, 5)



Python data types

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- **Example (>=Python 3.6)**

In [1]:

```
city = 'London'
temp = 19.23456
str1 = f"Temperature in {city} is {temp} degrees."
str2 = f"Temperature with 2 decimals: {temp:.2f}"
str3 = f"Temperature + 10: {temp+10}"
print(str1)
print(str2)
print(str3)
```

Out[1]:

```
Temperature in London is 19.23456 degrees.
Temperature with 2 decimals: 19.23
Temperature + 10: 29.23456
```

Python data types

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- **None type**
  - Specifies that a reference does not contain data

In [1]:

```
my_var = None

if my_var is None:
    print('My_var is empty')
```

  - Useful to:
    - Represent "missing data" in a list or a table
    - Initialize an empty variable that will be assigned later on
      - (e.g. when computing min/max)

Python data types

- **Tuple**
  - **Immutable** list of variables
  - Definition:

In [1]:

```
t1 = ('Turin', 'Italy')      # City and State
t2 = 'Paris', 'France'       # optional parentheses

t3 = ('Rome', 2, 25.6)       # can contain different types
t4 = ('London',)             # tuple with single element
```

Python data types

- **Tuple**
  - **Assigning** a tuple to a set of variables

In [1]:

```
t1 = (2, 4, 6)
a, b, c = t1

print(a)      # 2
print(b)      # 4
print(c)      # 6
```

Python data types

- **Swapping** elements with tuples

In [1]:

```
a = 1
b = 2
a, b = b, a
print(a)
print(b)
```

Out[1]:

```
2
1
```

- **Tuple**
  - Tuples can be **concatenated**

In [1]:

```
t1 = 'a', 'b'
t2 = 2, 4
t3 = t1 + t2
print(t3)
```

Out[1]:

```
('a', 'b', 2, 4)
```

Python data types

- **Tuple**
  - Accessing elements of a tuple
    - t [start:stop]

In [1]:

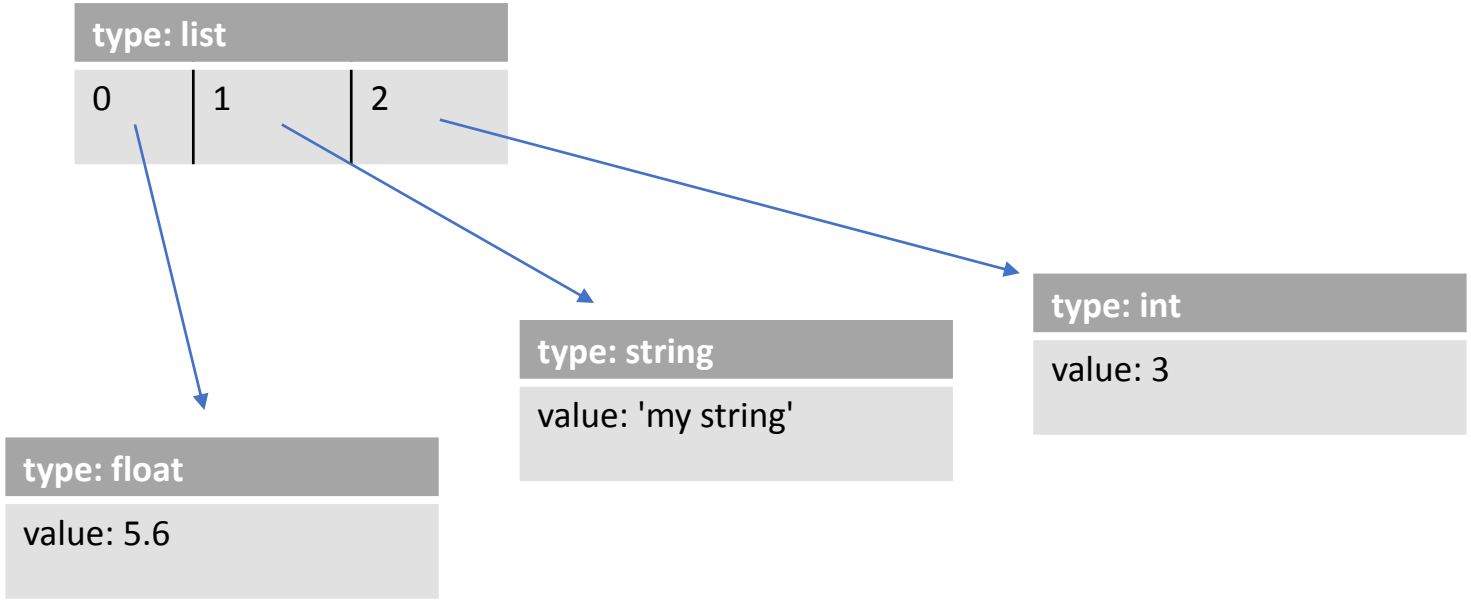
```
t1 = ('a', 'b', 'c', 'd')

val1 = t1[0]                # val1 = 'a'
t2 = t1[1:]                 # t2 = ('b', 'c', 'd')
t3 = t1[:-1]                # t3 = ('a', 'b', 'c')

t1[0] = 2                   # will cause an error
                            # (a tuple is immutable)
```

Python data types

- **List**
  - **Mutable** sequence of heterogeneous elements
  - Each element is a **reference** to a Python object



Python data types

- **List**
  - Definition

```
In [1]:  l1 = []                          # empty list
         l2 = [1, 'str', 5.6, None]       # can contain different types

         a, b, c, d = l2                  # can be assigned to variables
                                          # a=1, b='str', c=5.6, d=None
```

Python data types

- **List**
  - **Adding** elements and **concatenating** lists

In [1]:

```
l1 = [2, 4, 6]
l2 = [10, 12]
l1.append(8)                    # append an element to l1
l3 = l1 + l2                    # concatenate 2 lists
print(l1)
print(l3)
```

Out[1]:

```
[2, 4, 6, 8]
[2, 4, 6, 8, 10, 12]
```

Python data types

PoliTo DBMG

- **List**
  - **Other methods:**
    - list1.count(element):
      - Number of occurrences of element
    - list1.extend(l2):
      - Extend list1 with another list l2
    - list1.insert(index, element):
      - Insert element at position
    - list1.pop(index):
      - Remove element by position

Python data types

- **List**
  - **Accessing** elements:
    - Same syntax as tuples, but this time assigment is allowed

In [1]:

```
l1 = [0, 2, 4, 6]
val1 = l1[0]                    # val1 = 0
a, b = l1[1:-1]                 # a=2, b=4
l1[0] = 'a'
print(l1)
```

Out[1]:

```
['a', 2, 4, 6]
```

Python data types

- **List**
  - **Accessing** elements
    - Can specify the **step**
      - **step = 2** skips 1 element
      - **step = -1** reads the list in reverse order
      - **step = -2** reverse order, skip 1 element

```
In [1]: l1 = [0, 1, 2, 3, 4]
        l2 = l1[::2]            # l2 = [0, 2, 4]
        l3 = l1[::-1]           # l3 = [4, 3, 2, 1, 0]
        l4 = l1[::-2]           # l3 = [4, 2, 0]
```

Python data types

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- **List**
  - **Assigning** multiple elements

In [1]:
```
l1 = [0, 1, 2, 3, 4]
l1[1:4] = ['a', 'b', 'c']   # l1 = [0, 'a', 'b', 'c', 4]
```

  - **Removing** multiple elements

In [1]:
```
l1 = [0, 1, 2, 3, 4]
del l1[1:-1]       # l1 = [0, 4]
```

Python data types

- **List**
  - **Check** if element belongs to a list

```
In [1]: l1 = [0, 1, 2, 3, 4]
        myval = 2
        if myval in l1:
            print("found")          # printed because 2 is in list
```

  - **Iterate** over list elements

```
In [1]: l1 = [0, 1, 2, 3, 4]
        for el in l1:
            print(el)
```

Python data types

PoliTo DBMG

- **List**
  - **Sum, min, max** of elements

In [1]:
```
l1 = [0, 1, 2, 3, 4]
min_val = min(l1)           # min_val = 0
max_val = max(l1)           # max_val = 4
sum_val = sum(l1)           # sum_val = 10
```

  - **Sort** list elements

In [1]:
```
l1 = [3, 2, 5, 7]
l2 = sorted(l1)             # l2 = [2, 3, 5, 7]
```

Notebook Examples

- 1-Python Examples.ipynb
  - 1) Removing list duplicates

Python data types

- **Set**
  - **Unordered** collection of **unique** elements
  - Definition:

```
In [1]: s0 = set()                      # empty set
        s1 = {1, 2, 3}
        s2 = {3, 3, 'b', 'b'}           # s2 = {3, 'b'}
        s3 = set([3, 3, 1, 2])          # from list: s3 = {1,2,3}
```

Python data types

- **Set**
  - **Operators between two sets**
    - | (union), & (intersection), - (difference)

In [1]:

```
s1 = {1,2,3}
s2 = {3, 'b'}
s3 = s1 | s2                # union: s3 = {1, 2, 3, 'b'}
s4 = s1 & s2                # intersection: s4 = {3}
s5 = s1 - s2                # difference: s5 = {1, 2}
```

- **Set**
  - **Add/remove elements**

```
In [1]: s1 = {1,2,3}
        s1.add('4')                    # s1 = {1, 2, 3, '4'}
        s1.remove(3)                   # s1 = {1, 2, '4'}
```

Python data types

PoliTo DBMG

- **Set**
  - **Check** if element belongs to a set

```
In [1]: s1 = set([0, 1, 2, 3, 4])
        myval = 2
        if myval in s1:
            print("found")          # printed because 2 is in set
```

  - **Iterate** over set elements

```
In [1]: s1 = set([0, 1, 2, 3, 4])
        for el in s1:
            print(el)
```

Python data types

- **Set example: removing list duplicates**

In [1]:
```
input_list = [1, 5, 5, 4, 2, 8, 3, 3]
out_list = list(set(input_list))


print(out_list)
```

- **Note:** order of elements is not preserved

Out [1]:
```
[1, 2, 3, 4, 5, 8]
```

Python data types

- **Dictionary**
  - Collection of key-value pairs
  - Allows fast **access** of elements **by key**
    - Keys are **unique**
  - **Definition:**

```
In [1]: d1 = {'Name' : 'John', 'Age' : 25}
        d0 = {}                                  # empty dictionary
```

Python data types

- **Dictionary**
  - **Access** by key:

```
In [1]: d1 = {'key1' : 'val1', 5 : 6.7}
        val1 = d1['key1']           # val1 = 'val1'
        val2 = d1[5]                # val2 = 6.7
        val3 = d1['not_valid']      # Get an error if key does not exist
```

  - Reading **keys** and **values**:
    - Note: keys() and values() return **views on original data**

```
In [2]: d1 = {'key1' : 1, 'key2' : 2}
        keys = list(d1.keys())      # keys = ['key1', 'key2']
        values = list(d1.values())  # values = [1, 2]
```

Python data types

PoliTo DBMG

- **Dictionary**
  - Access by key with **default value**:

In [1]:
```
d1 = {'bottle' : 4, 'glass' : 3}

glass_val = d1.get('glass', 0)        # glass_val = 3
bread_val = d1.get('bread', 0)        # bread_val = 0
```

  - Instead of writing:

In [2]:
```
if 'bread' in d1.keys():
    bread_val = d1['bread']
else:
    bread_val = 0
```

Python data types

- **Dictionary**
  - **Adding/updating** values:

```
In [1]: d1 = {'key1' : 'val1', 5 : 6.7}
        d0['key1'] = 3              # Update existing value
        d0['newkey'] = 3            # Add a new key
```

  - **Deleting** a key:

```
In [2]: d2 = {'key1':1, 'key2':2}
        del d2['key1']              # d1 = {'key2':2}
```

Python data types

- **Dictionary**
  - **Iterating** keys and values
  - E.g. get the cumulative cost of items in a market basket

In [1]:

```
d1 = {'Cola' : 0.99, 'Apples' : 1.5, 'Salt' : 0.4}
cost = 0
for k, v in d1.items():
    cost += v
    print(f"{k}: {cost}")
```

Out [1]:

```
Cola: 0.99
Apples: 2.49
Salt: 2.89
```

Controlling program flow

- **if/elif/else**
  - Conditions expressed with >, <, >=, <=, ==, !=
    - Can include boolean operators (and, not, or)

In [1]:

```
if sensor_on and temperature == 10:
    print("Temperature is 10")
elif sensor_on and 10 < temperature < 20:
    in_range = True
    print("Temperature is between 10 and 20")
else:
    print("Temperature is out of range or sensor is off.")
```

indentation is mandatory

Controlling program flow

PoliTo DBMG

- **While loop**
  - Iterate while the specified condition is True

In [1]:

```
counter = 0
while counter <5:
    print (f"The value of counter is {counter}")
    counter += 2    # increment counter of 2
```

Out [1]:

```
The value of counter is 0
The value of counter is 2
The value of counter is 4
```

Controlling program flow

- **Iterating** for a fixed number of times
  - Use: range(start, stop)

In [1]:

```
for i in range(5, 8):
    txt = f"The value of i is {i}"
    print(txt)
```

Out [1]:

```
The value of i is 5
The value of i is 6
The value of i is 7
```

Controlling program flow

- **Enumerating** list objects
  - Use: enumerate(my_list)

In [1]:

```
my_list = ['a', 'b', 'c']
for i, element in enumerate(my_list):
    print(f"The value of my_list[{i}] is {element}")
```

Out [1]:

```
The value of my_list[0] is a
The value of my_list[1] is b
The value of my_list[2] is c
```

Controlling program flow

- **Iterating on multiple lists**
  - Use: zip(list1, list2, …)

In [1]:

```
my_list1 = ['a', 'b', 'c']
my_list2 = ['A', 'B', 'C']
for el1, el2 in zip(my_list1, my_list2):
    print(f"El1: {el1}, el2: {el2}")
```

Out [1]:

```
El1: a, el2: A
El1: b, el2: B
El1: c, el2: C
```

Notebook Examples

- 1-Python Examples.ipynb
  - 2) Euclidean distance between lists

Controlling program flow

PoliTo DBMG

- **Break/continue**
  - Alter the flow of a **for** or a **while** loop
  - Example

my_file.txt

```
car
skip
truck
end
van
```

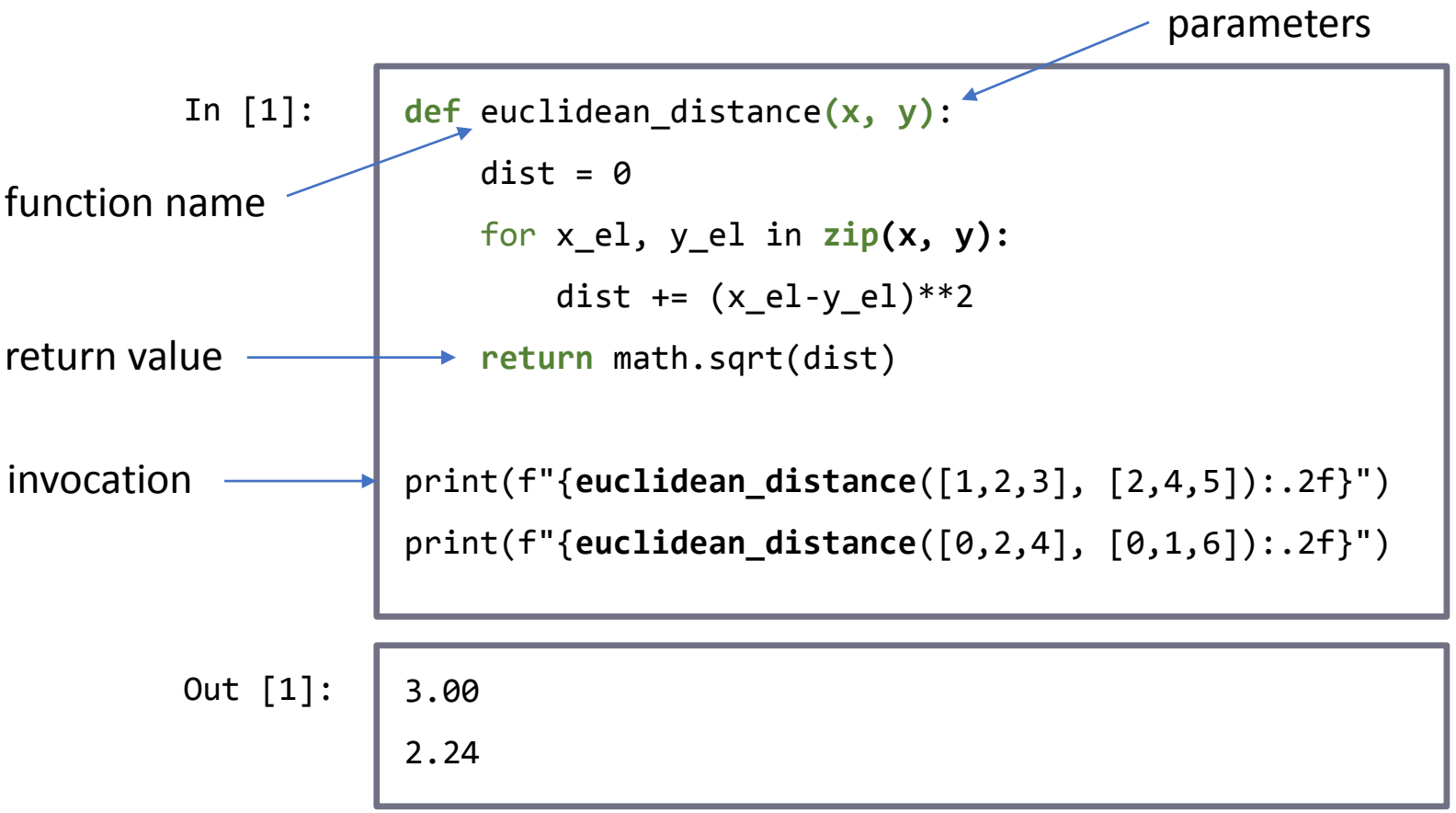
```
with open("./data/my_file.txt") as f:
    for line in f:          # read file line by line
        if line=='skip':
            continue        # go to next iteration
        elif line=='end':
            break           # interrupt loop
        print(line)
```

Out [1]:

```
car
truck
```

Functions

- **Essential** to organize code and avoid repetitions



Functions

- **Variable scope**
  - Rules to specify the **visibility** of variables
  - **Local scope**
    - Variables defined inside the function

```
In [1]: def my_func(x, y):
            z = 5          <-- not accessible from outside
            return x + y + z

        print(my_func(2, 4))
        print(z)           <-- error: z undefined
```

- **Variable scope**
  - **Global scope**
    - Variables defined outside the function

In [1]:

```
def my_func(x, y):
    return x + y + z

z = 5
my_func(2, 4)
```

z can be read inside the function

Out [1]:

```
11
```

- **Variable scope**
  - **Global scope vs local scope**

In [1]:

```
def my_func(x, y):
    z = 2          <-- define z in local scope
    return x + y + z   <-- use z from local scope

z = 5              <-- define z in global scope
print (my_func(2, 4))
print (z)          <-- z in global scope is not modified
```

Out [1]:

```
8
5
```

- **Variable scope**
  - Force the usage of variables in the global scope

In [1]:

```
def my_func(x, y):
    global z          <-- now z refers to global scope
    z = 2             <-- this assigment is performed to z in the global scope
    return x + y + z
z = 5
print (my_func(2, 4))
print (z)
```

Out [1]:

```
8
2
```

Functions

- Functions can **return tuples**

In [1]:

```
def add_sub(x, y):
    return x+y, x-y

sum, diff = add_sub(5, 3)
print(f"Sum is {sum}, difference is {diff}.")
```

Out [1]:

```
Sum is 8, difference is 2.
```

Functions

- Parameters with **default value**

In [1]:

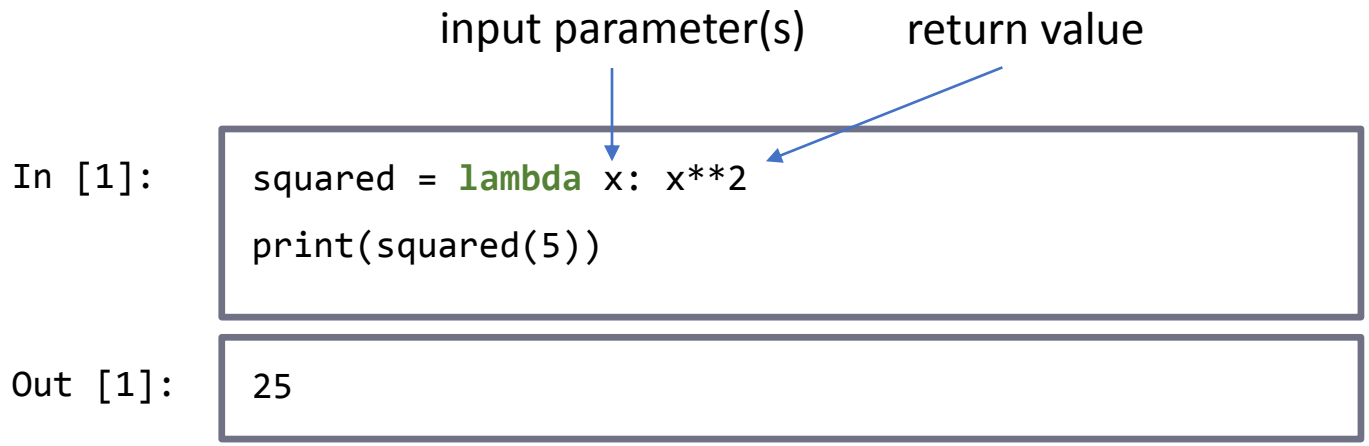
```
def func(a, b, c='defC', d='defD'):
    print(f"{a}, {b}, {c}, {d}")
func(1, 2)                    # use default for c, d
func(1, 2, 'a')               # use default for d, not for c
func(1, 2, d='b')             # passing keyword argument
func(b=2, a=1, d='b')         # keyword order does not matter
func(1, c='a')                # Error: b not specified
```

Out [1]:

```
1, 2, defC, defD
1, 2, a, defD
1, 2, defC, b
1, 2, defC, b
```

Lambda functions

- Functions that can be defined **inline** and **without a name**
- Example of lambda function definition:



Lambda functions

- **These patterns are useful shortcuts…**
  - Example: **filter** negative numbers from a list:

In [1]:

```
numbers = [1, -8, 5, -2, 5]
negative = []
for x in numbers:
    if x < 0:
        negative.append(x)
```

  - This code can be completely rewritten with lambda functions…

Lambda functions

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- **Filter and map patterns**
  - **Filter** the elements of a list based on a condition
  - **Map** each element of a list with a new value

In [1]:

```
numbers = [1, -8, 5, -2, 5]
negative = list(filter(lambda x: x<0, numbers))
squared = list(map(lambda x: x**2, negative))
print(negative)
print(squared)
```

Out [1]:

```
[-8, -2]
[64, 4]
```

Lambda functions

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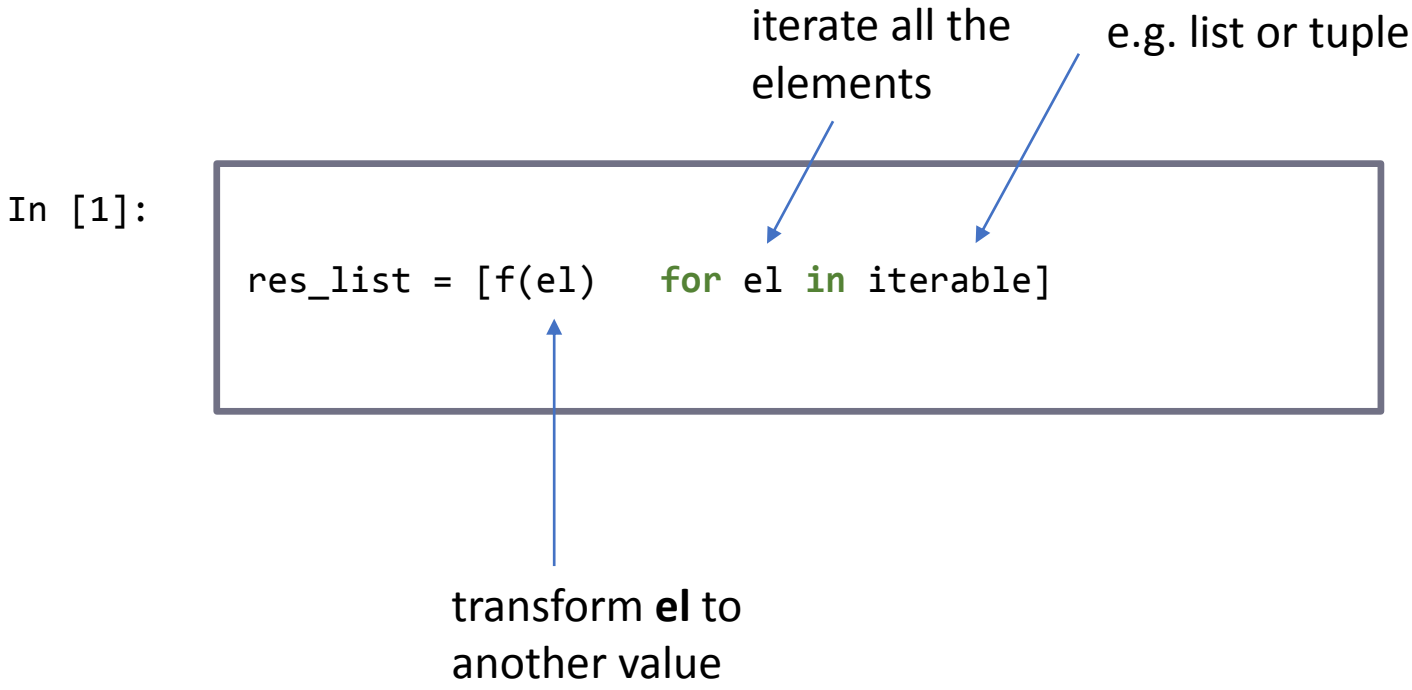
- **Lambda functions and conditions**
  - Example **conditional mapping**:

In [1]:
```
numbers = [1, 1, 2, -2, 1]
sign = list(map(lambda x: '+' if x>0 else '-', numbers))
print(sign)
```

Out [1]:
```
['+', '+', '+', '-', '+']
```

List comprehensions

- Allow creating **lists** from other **iterables**
  - Useful for implementing the **map pattern**
  - Syntax:



List comprehensions

- Example: convert to uppercase dictionary keys
  - (**map** pattern)

```
In [1]:
dict = {'a':10, 'b':20, 'c':30}

my_list = [str.upper() for str in dict.keys()]
print(my_list)
```

```
Out [1]:
['A', 'B', 'C']
```

List comprehensions

- Allow specifying **conditions** on elements
  - Example: **square positive** numbers in a list
    - **Filter** + **map** patterns

```
In [1]: my_list1 = [-1, 4, -2, 6, 3]

        my_list2 = [el**2 for el in my_list1 if el>0]
        print(my_list2)
```

```
Out [1]: [16, 36, 9]
```

List comprehensions

- Example: euclidean distance

```
def euclidean_distance(x, y):
    dist = 0
    for x_el, y_el in zip(x, y):
        dist += (x_el-y_el)**2
    return math.sqrt(dist)
```

```
def euclidean_distance(x, y):
    dist = sum([(x_el-y_el)**2 for x_el, y_el in zip(x, y)])
    return math.sqrt(dist)
```

(Dictionary) comprehensions

- Similarly to lists, allow building dictionaries

In [1]:

```
keys = ['a','b','c']
values = [-1, 4, -2]

my_dict = {k:v for k, v in zip(keys, values)}
print(my_dict)
```

Out [1]:

```
{'a': -1, 'b': 4, 'c': -2}
```

List comprehensions

- List comprehensions and lambda functions can shorten your code, but …
  - Pay attention to **readability**!!
  - **Comments** are welcome!!

Classes

- A class is a model that specifies a collection of
  - attributes (= variables)
  - methods (that interact with attributes)
  - a constructor (called to initialize an object)
- An object is an **instance** of a specific class

- Example:
  - class: Triangle (all the triangles have 3 edges)
  - object: a specific instance of Triangle

Classes

- Simple class example:

In [1]:

```
class Triangle:
    num_edges = 3

triangle1 = Triangle()
print(triangle1.num_edges)
```

class name

attribute definition

class instantiation

access to attribute

Out [1]:

```
3
```

- In this example all the object instances of Triangle have the same attribute value for num_edges: 3

Classes

- Constructor and initialization:

```
In [1]: class Triangle:
            num_edges = 3
            def __init__(self, a, b, c):
                self.a = a
                self.b = b
                self.c = c

        triangle1 = Triangle(2, 4, 3)
        triangle2 = Triangle(2, 5, 2)
```

self is always the first parameter

constructor parameters

self is a reference to the current object

initialize attributes

invoke constructor and instantiate a new Triangle

Classes

- Methods
  - Equivalent to Python functions, but defined inside a class
  - The first argument is always **self** (reference to current object)
    - **self** allows accessing the object attributes
  - Example:

```
class MyClass:
    def my_method(self, param1, param2):
        ...
        self.attr1 = param1
        ...
```

- Example with methods

In [1]:

```
class Triangle:
    def __init__(self, a, b, c):
        self.a, self.b, self.c = a, b, c
    def get_perimeter(self):
        return self.a + self.b + self.c

triangle1 = Triangle(2,4,3)
triangle1.get_perimeter()
```

method

use **self** for referring to attributes

method invocation (**self** is passed to the method automatically)

Out [1]:

```
9
```

Classes

- **Private** attributes
  - Methods or attributes that are **available only inside the object**
  - They are **not accessible** from outside
  - Necessary when you need to define elements that are useful for the class object but must not be seen/modified from outside

- **Private** attributes

In [1]:

```
class Triangle:
    def __init__(self, a, b, c):
        self.a, self.b, self.c = a, b, c
        self.__perimeter = a + b + c
    def get_perimeter(self):
        return self.__perimeter

triangle1 = Triangle(2,4,3)
print(triangle1.get_perimeter())
print(triangle1.__perimeter)
```

2 leading underscores make variables private

Error! Cannot access private attributes

Out [1]:

```
9
```

Notebook Examples

- 1-Python Examples.ipynb
  - 3) Classes and lambda functions: rule-based classifier

Exception handling

- To track errors during program execution

In [1]:

```
try:
    res = my_dict['key1']
    res += 1
except:
    print("Exception during execution")
```

In [2]:

```
try:
    res = a/b
except ZeroDivisionError:
    print("Denominator cannot be 0.")
```

can specify exception type →

Exception handling

- The **finally** block is executed in any case after try and except
  - It tipically contains cleanup operations
  - Example: reading a file

In [1]:

```
try:
    f = open('./my_txt','r')     # open a file
    ...                          # work with file
except:
    print("Exception while reading file")
finally:
    f.close()
```

Exception handling

- The try/except/finally program in the previous slide can also be written as follows:

In [1]:
```
try:
    with open('./my_txt', 'r') as f:
        for line in f:
            ... # do something with line
except:
    print("Exception while reading file")
```

- If there is an **exception** while reading the file, the with statement ends
- In any case, when the with statement ends the file is automatically closed (similarly to the finally statement)

Notebook Examples

- 1-Python Examples.ipynb
  - 4) Classes and exception handling: reading csv files

Structuring Python programs

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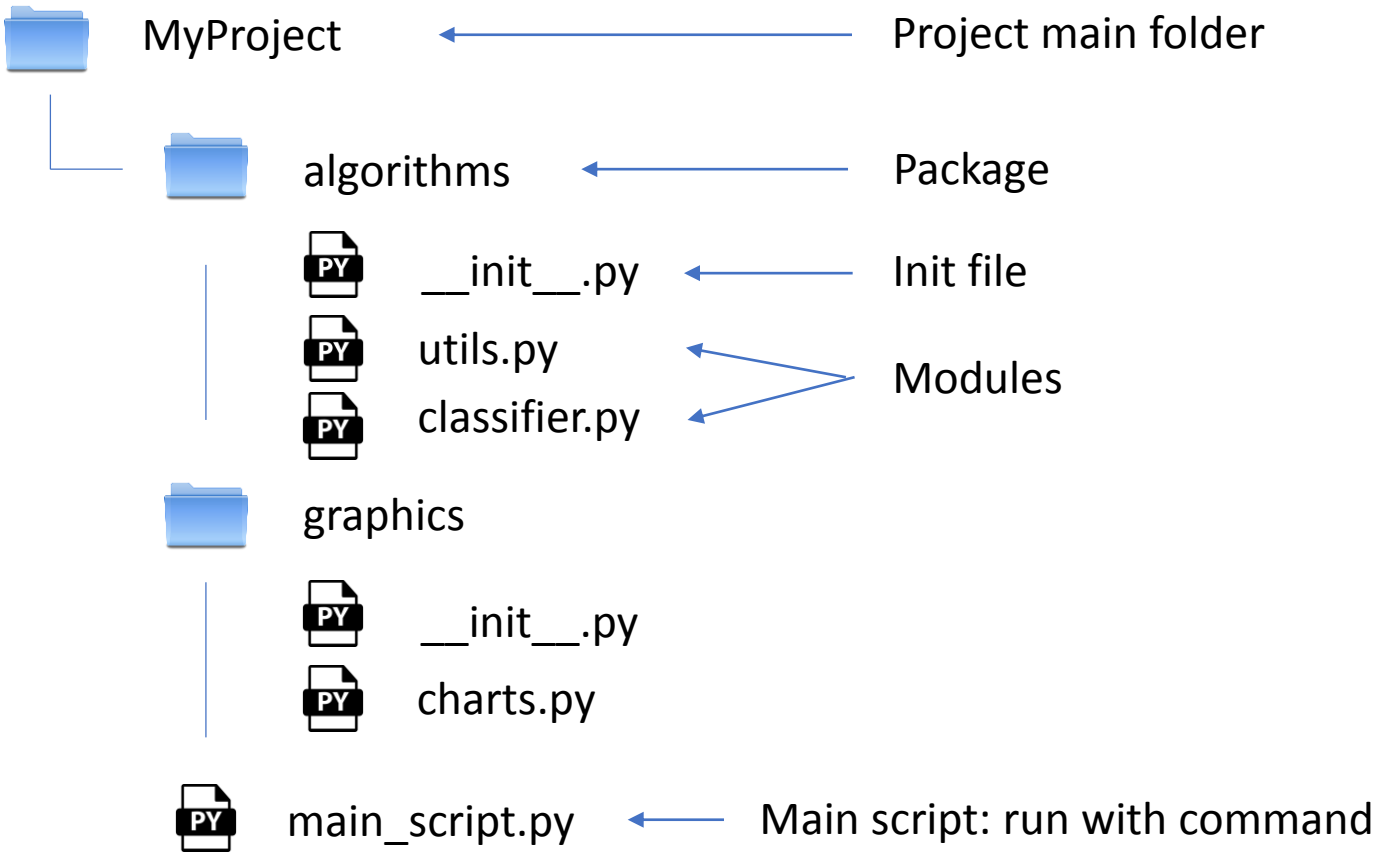
- The code of a Python project is organized in **packages** and **modules**
- **Package**:
  - Represented with a directory in the file system
  - Collects a set of Python modules
  - A folder must contain a **__init__.py** file to be considered a Python package
- **Module**
  - Represented with a Python file (.py)
  - Contain **attributes**, **functions** and **class** definitions

- **Example: project structure**



- **Example: content of Python module**

graphics

__init__.py

charts.py

charts.py

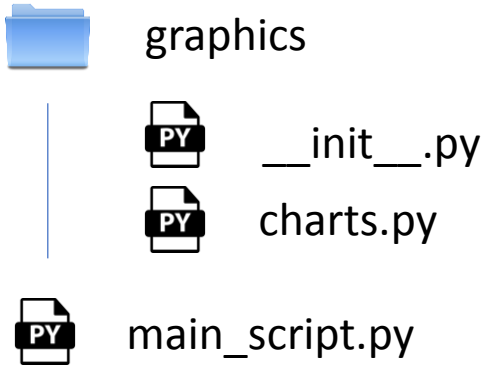
```
import matplotlib.pyplot as plt
import os

def plot_result():
    ...
    plt.plot(...)
    ...

plot_path = "../Data/plots"
if not os.path.exists(plot_path):
    os.makedirs(plot_path)
```

Function definition

Attribute

Initialization operations

- **Importing a module**
  - To use attributes, functions and classes defined in a module, it must be imported with the **import** command

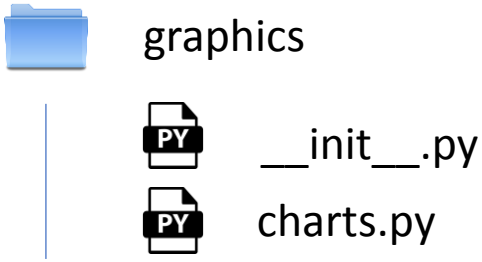


main_script.py

```
import graphics.charts
```

Structuring Python programs

- **Operations executed when importing a module (e.g. graphics.charts)**
  - Execute **__init__.py** file in the package
    - This file can be empty or contain some initialization instructions for the package
  - Execute the content of the module (**charts.py**)
    - This will load its attributes/functions/classes and run its initialization code (if any)



- **Operations executed when importing a module (e.g. graphics.charts)**

```
import graphics.charts
```

charts.py

```
...
def plot_result():
    ...
plot_path = "../Data/plots"
if not os.path.exists(plot_path):
    os.makedirs(plot_path)
```

1) Load a function

2) Load an attribute

3) Initialize directories

Structuring Python programs

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- **Importing a module**
  - After import, any attribute, function or class can be used from the module

main_script.py

```
import graphics.charts
graphics.charts.plot_result()        # Function
print(graphics.charts.plot_path)     # Attribute
```

- **Importing the content of a module**
  - Avoids to write the name of the module when using attributes or functions

main_script.py

```
from graphics.charts import *
plot_result()      # Function
print(plot_path)   # Attribute
```

Structuring Python programs

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- **Other ways of importing modules**
  - Renaming a module

```
import graphics.charts as ch
ch.plot_result()
```

  - Importing a single function/attribute

```
from graphics.charts import plot_result
plot_result()
```

Structuring Python programs

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- **The main script file(s)**
  - Typically contains a **main function**
  - Can also contain functions and classes as any other **module**
  - **2 use cases**
    - Run "python main_script.py" from terminal
      - Execute the main function
    - Import some content (e.g. a function) of the main script
      - "from main_script import my_func"

Structuring Python programs

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- **The main script file(s)**
  - Use case 1: "python main_script.py"
  - Python defines a variable called **__name__**
  - The if statement is satisfied an main() is called

main_script.py

```
def main():
    print("This is the main function")

if __name__ == '__main__':
    main()
```

- **The main script file(s)**
  - Use case 2: import content to another file
    - main_script.py is executed by the **import**, but main() is not called since __name__ does not contain '__main__'

main_script.py

```
def my_function():
    ... do something ...


...


if __name__ == '__main__':
    main()
```

main_script2.py

```
import main_script
main_script.my_function()
```