

### Base Types

integer, float, boolean, string, bytes

```
int 783 0 -192 0b010 0o642 0xF3
float 9.23 0.0 -1.7e-6
bool True False
str "One\nTwo"
bytes b"toto\xfe\775"
```

Non modifiable values (immutables)

### Container Types

ordered sequences, fast index access, repeatable values

```
list [1,5,9] ["x",11,8.9] ["mot"]
tuple (1,5,9) 11,"y",7.4 ("mot",)
```

key containers, no a priori order, fast key access, each key is unique

```
dict {"key": "value"} dict(a=3,b=4,k="v")
set {"key1", "key2"} {1,9,3,0}
frozenset immutable set
```

### Identifiers

for variables, functions, modules, classes... names

a...zA...Z\_ followed by a...zA...Z\_0...9

- diacritics allowed but should be avoided
- language keywords forbidden
- lower/UPPER case discrimination

⊗ a toto x7 y\_max BigOne  
⊗ 8y and for

### Conversions

type (expression)

```
int("15") → 15
int("3f",16) → 63
int(15.56) → 15
float("-11.24e8") → -112400000.0
round(15.56,1) → 15.6
bool(x) False for null x, empty container x, None or False x; True for other x
str(x) → "..." representation string of x for display
chr(64) → '@' ord('@') → 64
repr(x) → "..." literal representation string of x
bytes([72,9,64]) → b'H\t@'
list("abc") → ['a','b','c']
dict([(3,"three"),(1,"one")]) → {1:'one',3:'three'}
set(["one","two"]) → {'one','two'}
```

separator str and sequence of str → assembled str  
':'.join(['toto','12','pswd']) → 'toto:12:pswd'

str splitted on whitespaces → list of str  
"words with spaces".split() → ['words','with','spaces']

str splitted on separator str → list of str  
"1,4,8,2".split(",") → ['1','4','8','2']

sequence of one type → list of another type (via list comprehension)  
[int(x) for x in ('1','29','-3')] → [1,29,-3]

### Variables assignment

= assignment ⇔ binding of a name with a value

- evaluation of right side expression value
- assignment in order with left side names

```
x=1.2+8+sin(y)
a=b=c=0
y,z,r=9.2,-7.6,0
a,b=b,a
a,*b=seq
*a,b=seq
x+=3
x-=2
x=None
del x
```

### Sequence Containers Indexing

for lists, tuples, strings, bytes...

negative index	-5	-4	-3	-2	-1
positive index	0	1	2	3	4

```
lst=[10,20,30,40,50]
```

Items count: len(lst) → 5

Individual access to items via lst [index]

```
lst[0] → 10 (first one)
lst[-1] → 50 (last one)
lst[1] → 20
lst[-2] → 40
```

On mutable sequences (list), remove with del lst[3] and modify with assignment lst[4]=25

Access to sub-sequences via lst [start slice: end slice: step]

```
lst[: -1] → [10,20,30,40]
lst[1: -1] → [20,30,40]
lst[: : 2] → [10,30,50]
lst[1: 3] → [20,30]
lst[-3: -1] → [30,40]
lst[: : ] → [10,20,30,40,50] shallow copy of sequence
```

Missing slice indication → from start / up to end.

On mutable sequences (list), remove with del lst[3:5] and modify with assignment lst[1:4]=[15,25]

### Boolean Logic

Comparisons : < > <= >= == != (boolean results)

a and b logical and both simultaneously

a or b logical or one or other or both

⊗ pitfall : and and or return value of a or of b (under shortcut evaluation).  
⇒ ensure that a and b are booleans.

not a logical not

True False } True and False constants

### Statements Blocks

```
parent statement:
┌ statement block 1...
│ ...
└ statement block 2...
  │ ...
  └ next statement after block 1
```

⊗ configure editor to insert 4 spaces in place of an indentation tab.

### Modules/Names Imports

module truc ⇒ file truc.py

```
from monmod import nom1,nom2 as fct
import monmod
```

⊗ modules and packages searched in python path (cf sys.path)

### Conditional Statement

statement block executed only if a condition is true

```
if logical condition:
    statements block
```

Can go with several elif, elif... and only one final else. Only the block of first true condition is executed.

```
if age <= 18:
    state = "Kid"
elif age > 65:
    state = "Retired"
else:
    state = "Active"
```

### Maths

floating numbers... approximated values

Operators: + - \* / // % \*\*

Priority (...)

@ → matrix × python3.5+numpy

```
(1+5.3)*2 → 12.6
abs(-3.2) → 3.2
round(3.57,1) → 3.6
pow(4,3) → 64.0
```

usual order of operations

### Maths

angles in radians

```
from math import sin, pi...
sin(pi/4) → 0.707...
cos(2*pi/3) → -0.4999...
sqrt(81) → 9.0
log(e**2) → 2.0
ceil(12.5) → 13
floor(12.5) → 12
```

modules math, statistics, random, decimal, fractions, numpy, etc. (cf. doc)

### Exceptions on Errors

Signaling an error: raise ExcClass(...)


Errors processing: try: ... except Exception as e:

⊗ finally block for final processing in all cases.

### Conditional Loop Statement

statements block executed as long as condition is true

**while** *logical condition*:  
→ statements block



**Loop Control**

- break** immediate exit
- continue** next iteration
- else** block for normal loop exit.

Algo: 
$$S = \sum_{i=1}^{100} i^2$$

*beware of infinite loops!*

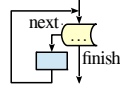
```
s = 0
i = 1
while i <= 100:
    s = s + i**2
    i = i + 1
print("sum:", s)
```

initializations before the loop  
condition with a least one variable value (here i)  
make condition variable change!

### Iterative Loop Statement

statements block executed for each item of a container or iterator

**for** *var in sequence*:  
→ statements block



Go over sequence's values

```
s = "Some text"
cnt = 0
for c in s:
    if c == "e":
        cnt = cnt + 1
print("found", cnt, "e")
```

initializations before the loop  
loop variable, assignment managed by for statement  
Algo: count number of e in the string.

### Display

```
print("v=", 3, "cm :", x, ", ", y+4)
```

items to display: literal values, variables, expressions

**print** options:

- sep=" "** items separator, default space
- end="\n"** end of print, default new line
- file=sys.stdout** print to file, default standard output

**Input**

```
s = input("Instructions: ")
```

**input** always returns a string, convert it to required type (cf. boxed Conversions on the other side).

loop on dict/set ⇔ loop on keys sequences  
use slices to loop on a subset of a sequence

Go over sequence's index

- modify item at index
- access items around index (before / after)

```
lst = [11, 18, 9, 12, 23, 4, 17]
lost = []
for idx in range(len(lst)):
    val = lst[idx]
    if val > 15:
        lost.append(val)
        lst[idx] = 15
print("modif:", lst, "-lost:", lost)
```

Algo: limit values greater than 15, memorizing of lost values.

Go simultaneously over sequence's index and values:

```
for idx, val in enumerate(lst):
```

### Generic Operations on Containers

**len(c)** → items count  
**min(c)** **max(c)** **sum(c)**  
**sorted(c)** → list sorted copy  
**val in c** → boolean, membership operator **in** (absence **not in**)  
**enumerate(c)** → iterator on (index, value)  
**zip(c1, c2...)** → iterator on tuples containing  $c_i$  items at same index  
**all(c)** → True if all c items evaluated to true, else False  
**any(c)** → True if at least one item of c evaluated true, else False

*Note: For dictionaries and sets, these operations use keys.*

Specific to ordered sequences containers (lists, tuples, strings, bytes...)

- reversed(c)** → inversed iterator
- c\*5** → duplicate
- c+c2** → concatenate
- c.index(val)** → position
- c.count(val)** → events count

**import copy**  
**copy.copy(c)** → shallow copy of container  
**copy.deepcopy(c)** → deep copy of container

### Integer Sequences

**range([start,] end [,step])**  
start default 0, end not included in sequence, step signed, default 1

```
range(5) → 0 1 2 3 4
range(2, 12, 3) → 2 5 8 11
range(3, 8) → 3 4 5 6 7
range(20, 5, -5) → 20 15 10
range(len(seq)) → sequence of index of values in seq
```

range provides an immutable sequence of int constructed as needed

### Operations on Lists

modify original list

- lst.append(val)** add item at end
- lst.extend(seq)** add sequence of items at end
- lst.insert(idx, val)** insert item at index
- lst.remove(val)** remove first item with value val
- lst.pop([idx])** → value remove & return item at index idx (default last)
- lst.sort()** **lst.reverse()** sort / reverse list in place

### Function Definition

function name (identifier)  
named parameters

```
def fct(x, y, z):
    """documentation"""
    # statements block, res computation, etc.
    return res
```

parameters and all variables of this block exist only in the block and during the function call (think of a "black box")

Advanced: **def fct(x, y, z, \*args, a=3, b=5, \*\*kwargs):**  
\*args variable positional arguments (→ tuple), default values.  
\*\*kwargs variable named arguments (→ dict)

### Operations on Dictionaries

```
d[key]=value
d[key] → value
d.update(d2)
d.keys()
d.values()
d.items()
d.pop(key, default)
d.popitem()
d.get(key, default)
d.setdefault(key, default)
```

**d.clear()**  
**del d[key]**  
update/add associations  
→ iterable views on keys/values/associations  
→ value  
→ (key, value)  
→ value  
→ value

### Operations on Sets

Operators:

- | → union (vertical bar char)
- & → intersection
- ^ → difference/symmetric diff.
- < <= > >= → inclusion relations

Operators also exist as methods.

```
s.update(s2)
s.copy()
s.add(key)
s.remove(key)
s.discard(key)
s.clear()
s.pop()
```

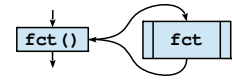
### Function Call

```
r = fct(3, i+2, 2*i)
```

storage/use of returned value  
one argument per parameter

this is the use of function name with parentheses which does the call

Advanced: \*sequence \*\*dict



### Files

storing data on disk, and reading it back

```
f = open("file.txt", "w", encoding="utf8")
```

file variable  
name of file on disk (+path...)  
opening mode  
encoding of chars for text files: utf8, ascii, latin1, ...

**writing**

```
f.write("coucou")
f.writelines(list of lines)
```

**reading**

```
f.read([n])
f.readlines([n])
f.readline()
```

read empty string if end of file  
→ next chars if n not specified, read up to end!  
→ list of next lines  
→ next line

text mode t by default (read/write str), possible binary mode b (read/write bytes). Convert from/to required type!

**f.close()** dont forget to close the file after use!

**f.flush()** write cache  
**f.truncate([size])** resize reading/writing progress sequentially in the file, modifiable with:  
**f.tell()** → position  
**f.seek(position, origin)**

Very common: opening with a guarded block (automatic closing) and reading loop on lines of a text file:

```
with open(...) as f:
    for line in f:
        # processing of line
```

### Operations on Strings

```
s.startswith(prefix[, start[, end]])
s.endswith(suffix[, start[, end]])
s.strip([chars])
s.count(sub[, start[, end]])
s.partition(sep)
s.index(sub[, start[, end]])
s.find(sub[, start[, end]])
s.is...()
s.upper()
s.lower()
s.title()
s.swapcase()
s.casefold()
s.capitalize()
s.center([width, fill])
s.ljust([width, fill])
s.rjust([width, fill])
s.zfill([width])
s.encode(encoding)
s.split([sep])
s.join(seq)
```

**Formatting**

formatting directives  
values to format

```
"modele{ } { }".format(x, y, r)
```

Examples:

```
{:+.2f}.format(45.72793) → '+45.728'
{1:>10s}.format(8, "toto") → 'toto'
{x!r}.format(x="I'm") → 'I\'m'
```

**Selection:**

```
2
nom
0.nom
4[key]
0[2]
```

**Formatting:**

```
fill char alignment sign mini width . precision-maxwidth type
```

<> ^ = + - space 0 at start for filling with 0  
integer: b binary, c char, d decimal (default), o octal, x or X hexa...  
float: e or E exponential, f or F fixed point, g or G appropriate (default), string: s ... % percent

**Conversion:** s (readable text) or r (literal representation)

good habit : don't modify loop variable