

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"
    
```

zero binary octal hexa
 Multiline string: `"""X\tY\tZ\n1\t2\t3"""`
 escaped new line `'\n'` escaped tab `'\t'`
 escaped ' `'\''`
 hexadecimal octal
☞ 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",)
 - str bytes** (ordered sequences of chars / bytes)
- key containers**, no a priori order, fast key access, each key is unique
 - dictionary** dict {"key": "value"} dict (a=3, b=4, k="v")
 - (key/value associations) {1: "one", 3: "three", 2: "two", 3.14: "pi"}
 - collection** set {"key1", "key2"} {1, 9, 3, 0} **set** ()
 - ☞ keys=hashable values (base types, immutables...)* **frozenset** immutable set empty

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 *can specify integer number base in 2nd parameter*
- int** (15.56) → 15 *truncate decimal part*
- float** ("-11.24e8") → -112400000.0
- round** (15.56, 1) → 15.6 *rounding to 1 decimal (0 decimal → integer number)*
- 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 (cf. formatting on the back)*
- chr** (64) → '@' **ord** ('@') → 64 *code ↔ char*
- 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

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

x=1.2+8+sin(y)
a=b=c=0 *assignment to same value*
y, z, r=9.2, -7.6, 0 *multiple assignments*
a, b=b, a *values swap*
a, *b=seq } *unpacking of sequence in*
***a, b=seq** } *item and list*
x+=3 *increment ↔ x=x+3*
x-=2 *decrement ↔ x=x-2*
x=None *« undefined » constant value*
del x *remove name 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]

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

Items count **len(lst) → 5**
 Individual access to **items** via **lst [index]**
lst [0] → 10 ⇒ first one **lst [1] → 20**
lst [-1] → 50 ⇒ last one **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] → [50, 40, 30, 20, 10]** **lst [1:3] → [20, 30]** **lst [:3] → [10, 20, 30]**
lst [1:-1] → [20, 30, 40] **lst [:-2] → [50, 30, 10]** **lst [-3:-1] → [30, 40]** **lst [3:] → [40, 50]**
lst [::2] → [10, 30, 50] **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
    
```

☞ indentation !
 ☞ 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
    
```

→ direct access to names, renaming with **as**

```

import monmod
    
```

→ access via **monmod.nom1** ...

☞ 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"
    
```

☞ with a var **x**:
if bool(x) == True : ↔ **if x :**
if bool(x) == False : ↔ **if not x :**

Maths

☞ floating numbers... approximated values

Operators: + - * / // % **

Priority (...)
 × ÷ ↑ ↑ a^b
 integer ÷ ÷ remainder

@ → matrix × *python 3.5 + 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

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 :
 → normal processing block
except Exception as e :
 → error processing block

☞ 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:
$$S = \sum_{i=1}^{i=100} i^2$$

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

s = input("Instructions: ")

Input

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

writing

- f.write("coucou")**
- f.writelines(list of lines)**
- f.close()** dont forget to close the file after use!
- f.flush()** write cache
- f.truncate([size])** resize

reading

- f.read([n])** → next chars if n not specified, read up to end!
- f.readlines([n])** → list of next lines
- f.readline()** → next line
- f.seek(position, origin)**

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

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.index(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)
```

Selection:

```

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

Examples:

```

"{: +2.3f}".format(45.72793) → '+45.728'
"{1: >10s}".format(8, "toto") → 'toto'
"{x!r}".format(x="I'm") → "'I\'m'"
    
```

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