Utrecht Bioinformatics Center

Jupyter and Variables

Day 1 – Introduction to Python

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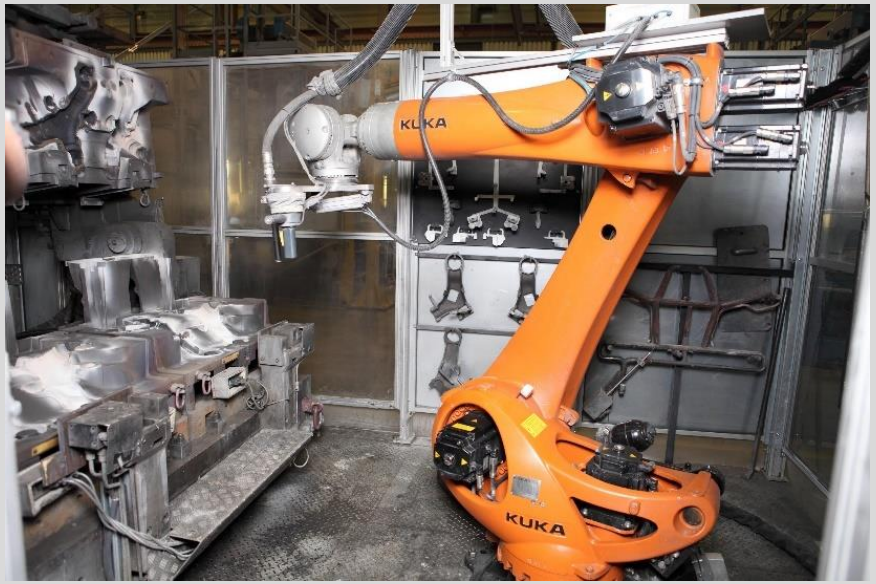
What is programming?

- Programming → act of giving **<u>very clear instructions</u>** to a computer
- Programming languages: Perl, Python, JAVA, C++, R, BASIC, etc.
- The programmer RULES

Python



Functions and Scripts

Running a program

Python

- Why choose to learn Python as a programming language?

- Robust
- Flexible
- Relatively easy to learn and use
- Free
- Fast

- Documentation:
- Official Python 3 docs: https://docs.python.org/3/
- **Google**

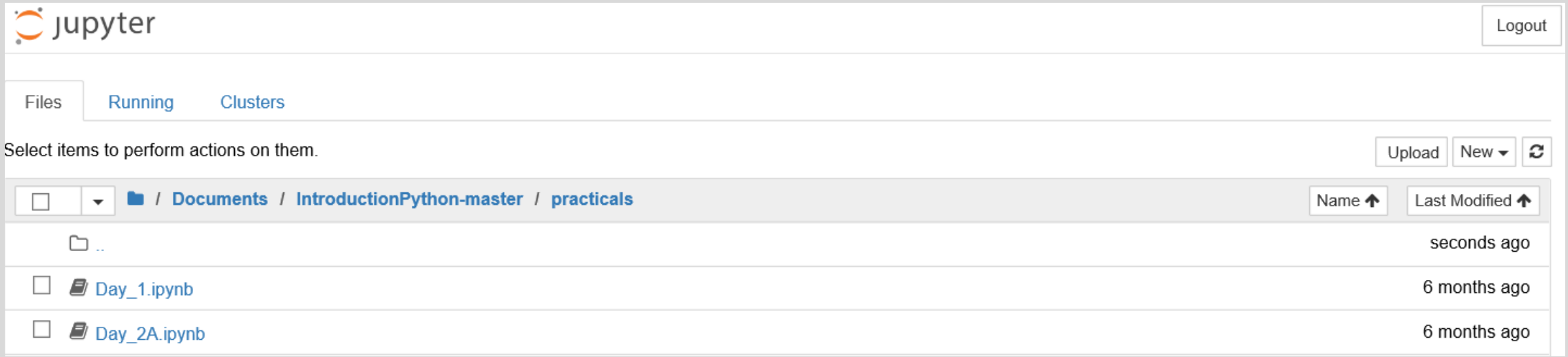
- Online books and tutorials! (yes, even youtube…)

Jupyter Notebook

- Jupyter is a script editor and much more (see https://jupyter.org/)

- Start Jupyter, thru Start or Anaconda navigator, this also starts Python. A page opens in your browser where you can navigate to the exercises (the .ipynb files)

- Open the file Day_1.ipynb



Jupyter Notebook

Open the file Day_1.ipynb

Restart

Save .ipynb file

Add new cell

jupyter Day_1-2_Variables-and-loops Last Checkpoint: a few seconds ago (unsaved changes)

Logout

File Edit View Insert Cell Kernel Widgets Help

Trusted

Python 2

Run Code

Variables

- Lets make a variable:
- Execute the code by pressing ctrl + enter
  - Name: first_name
  - Value: john

Comments

In [2]:
```
# Write here your code
first_name = "john"
print first_name
```

```
john
```

Code cell

Exercise:

- Print your surname using a new variable.
- Can you print both your first and surname?

Comments

Running a script

- Example, what can python do?
  - Open First_example_what_can_python_do.ipynb
  - Run (ctrl+enter) the first cell (twice if needed)
  - Let’s see what happened

Python 3 Cheat Sheet

Latest version on : https://perso.limsi.fr/pointal/python:memento

Base Types

integer, float, boolean, string, bytes

```
int 783  0 -192  0b010 0o642 0xF3
                 zero binary octal hexa
float 9.23 0.0  -1.7e-6
                ×10^-6
bool True False
str "One\nTwo"   Multiline string:
    escaped new line  """X\tY\tZ
    'I\'m'            1\t2\t3"""
    escaped '         escaped tab
bytes b"toto\xfe\775"
      hexadecimal octal
```

immutable

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",)  ()
```

Non modifiable values (immutables) expression with only comas → tuple

```
str b"toto"   (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:"π"}
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

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   and *= /= %= …
x-=2   decrement ⇔ x=x-2
x=None  « undefined » constant value
del x   remove name x
```

Conversions

```
int("15") → 15          type(expression)
int("3f",16) → 63       can specify integer number base in 2nd parameter
int(15.56) → 15         truncate decimal part
float("-11.24e8") → -1124000000.0
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]
```

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

index from 0
(here from 0 to 4)

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…
    ⋮
parent statement:
    statement block2…
    ⋮
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)

Maths

floating numbers… approximated values angles in radians

Operators: + - * / // % **
Priority (…) × ÷ ↑ ↑ a^b integer ÷ ÷ remainder

@ → 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
```

```
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)

usual order of operations

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.

with a var x:
if bool(x)==True: ⇔ if x:
if bool(x)==False: ⇔ if not x:

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

Exceptions on Errors

Signaling an error:
raise *ExcClass(…)*

Errors processing:

```
try:
    normal procesising block
except Exception as e:
    error processing block
```

normal raise X() processing → error processing raise processing → error processing

finally block for final processing in all cases.

Using a cheat-sheet is not cheating!

Conditional Loop Statement

*statements block executed **as long as** condition is true*

```
while logical condition:
    statements block
```

beware of infinite loops!

```
s = 0
i = 1   } initializations before the loop
        condition with a least one variable value (here i)
while i <= 100:
    s = s + i**2
    i = i + 1
print("sum:",s)
```

make condition variable change !

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

Loop Control

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

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"   } initializations before the loop
cnt = 0
    loop variable, assignment managed by for statement
for c in s:
    if c == "e":
        cnt = cnt + 1
print("found",cnt,"'e'")
```

Algo: count number of e in the string.

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.

good habit : don't modify loop variable

Go simultaneously over sequence's **index** and **values**:
for idx,val in enumerate(lst):

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).

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
```

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 liste *in place*

Operations on Dictionaries

d[*key*]=*value* d.clear()
d[*key*]→ *value* del d[*key*]
d.update(*d2*) } update/add associations
d.keys()
d.values() } →iterable views on keys/values/associations
d.items()
d.pop(*key*[,*default*])→ *value*
d.popitem()→ (*key*,*value*)
d.get(*key*[,*default*])→ *value*
d.setdefault(*key*[,*default*])→*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()

Files

storing data on disk, and reading it back

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

file **variable** for operations **name** of file on disk (+path…) opening **mode**: 'r' read, 'w' write, 'a' append, …'+' 'x' 'b' 't' **encoding** of chars for *text files*: utf8 ascii latin1 …

cf. modules os, os.path and pathlib

writing
f.write("coucou")
f.writelines(*list of lines*)

reading
read empty string if end of file
f.read([*n*]) → next chars (if *n* not specified, read up to end !)
f.readline([*n*]) → **list** of next lines
f.readline() → 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
```

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"   } initializations before the loop
cnt = 0
    loop variable, assignment managed by for statement
for c in s:
    if c == "e":
        cnt = cnt + 1
print("found",cnt,"'e'")
```

Algo: count number of e in the string.

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.

good habit : don't modify loop variable

Go simultaneously over sequence's **index** and **values**:
for idx,val in enumerate(lst):

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

Function Definition

function name (identifier) named parameters

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

result value of the call, if no computed result to return: return None

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)*

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*

Operations on Strings

s.startswith(*prefix*[,*start*[,*end*]])
s.endswith(*suffix*[,*start*[,*end*]]) s.strip([*chars*])
s.count(*sub*[,*start*[,*end*]]) s.partition(*sep*)→ (*before*,*sep*,*after*)
s.index(*sub*[,*start*[,*end*]]) s.find(*sub*[,*start*[,*end*]])
s.is…() *tests on chars categories (ex. s.isalpha())*
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

formating directives values to format

"modele{} {} {}".format(x,y,r)→ str

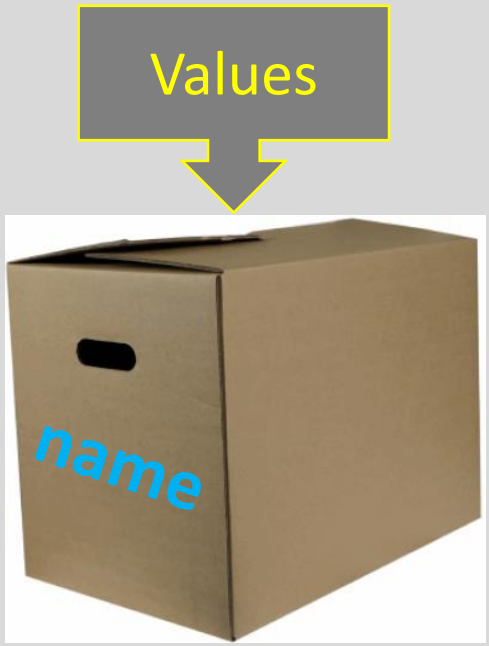
"{*selection* : *formatting* ! *conversion*}"

- **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)

Variables



- Variables are used to store information or data.
  - *Like a box where you can put stuff in.*

- **Variables have a name and a value.**
  - variable_name = value
  - Whatever = “whatever”

- **Some rules/conventions for naming variables:**
  - Variable names can contains alphabetic characters (a-Z),numbers (0-9) and underscores (_).
  - The first character cannot be a number.
  - Variable names are case-sensitive.

- Please give variables a sensible name and use “_” to separate words.
  - First_name
  - dna_sequence

Variables - Types

- **Strings**
  - “This is a string”
- **Numbers**
  - Integers → 1, 5, 200, etc.
  - Floats → 1.2, 5.25, 200.1, etc.
- **Booleans**
  - True or False

Strings - Methods

- All types have build in methods to manipulate them.

- For example:

  my_string.upper() - returns the string in uppercase

```
first_name = ”john“
print (first_name.upper())

JOHN
```

```
Apple = “john”
print (Apple.upper())

JOHN
```

Strings - Methods

- *string*.lower() - returns the string in lowercase
- *string*.upper() - returns the string in uppercase
- *string*.capitalize() - returns the string capitalized
- *string*.count("x") - counts the number of occurrences of x in string
- *string*.find("x") - returns the position of the first occurrence of character x
- *string*.replace("a", "b") - replaces all occurrences of a with b in the string
- *string*.split(“x”) - Splits the string at each case of character x
- And more: https://docs.python.org/3/library/stdtypes.html#text-sequence-type-str

Strings - Methods

- Cheat-sheet page 2

Operations on Strings

```
s.startswith(prefix[,start[,end]])
s.endswith(suffix[,start[,end]])   s.strip([chars])
s.count(sub[,start[,end]])   s.partition(sep) → (before,sep,after)
s.index(sub[,start[,end]])   s.find(sub[,start[,end]])
s.is…()  tests on chars categories (ex. s.isalpha())
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)
```

Strings - Methods

+ Concatenate a string

```
"ABC" + "DEF" = "ABCDEF"
```

***** Repetition of a string

```
"ABC" * 2 = "ABCABC”
```

[n] Slice, returns n^{th} value (Python counts from 0)

```
"ABCDEF"[3] = "D”
```

[x:y] Range slice, returns the xth to y^{th} value

```
"ABCDEF"[2:4] = "CD”
```

Not an operator but very useful: **len()** Gives the length of a string

```
len("ABCDEF") = 6
```

Index and Slicing

- Python uses an index to select specific elements.

Index	0	1	2	3	4	5
String “ABCDEF”	A	B	C	D	E	F

- "ABCDEF"[start:to:step]

```
"ABCDEF"[3] = "D”

"ABCDEF"[2:4] = "CD”

"ABCDEF"[1:6:2] = “BDF”
```

- Practice!

Index and Slicing

- Cheat-sheet page 1

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`

☞ **index from 0**
(here from 0 to 4)

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]`

Strings – Special Characters & Comments

- Tabs: \t
- Newlines: \n
- Quotes: \”
- Backslash: \\

```
print (“Tab\tTab\nSecond Line\nPrint out a \”backslash\” : \\”)
        Tab    Tab
        Second Line
        Print out a “backslash” : \
```

Comments start with: #

- Useful for: Exlaining code, disable parts of the script

Numbers

- Two types of numbers
  Integers: 1, 5, etc.
  Floats: 1.5, 5.2, etc.

5 → integer
5.0 → float

- Simple math using numbers (x = 5.0 and y = 2.0) :

Addition:	+	x + y = 7.0	
Subtraction:	-	x – y = 3.0	
Division:	/	x / y = 2.5	
Multiplication:	*	x*y = 10.0	
Power:	**	x**y = 25.0	
Modulo (remainder):	%	x%y = 1.0	(2+2=4; 5-4 = 1)

- Python uses the standard order of operations
  5 * (2 +1) = 15
  5 * 2 + 1 = 11

Numbers

- Math cheat-sheet page 1

☝ *floating numbers… approximated values*

Operators: `+ - * / // % **`

Priority `(…)` × ÷ ↑ integer ÷ ↑ ÷ remainder a^b

`@` → 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)*

Converting between types

str(variable)	converts variable to a string
int(variable)	converts variable to a integer
float(variable)	converts variable to a float

- Examples

```
print ("2" + "2“)                                22
print (int("2") + int("2"))                      4
print (str(2) + str(2))                          22
print (int("this does not work, why?")) …
print (float(5) / float(2))                      2.5
print (int(5.0) / int(2.0))                      2
```

Converting between types

- Cheat-sheet page 1

Conversions

`type(expression)`

```
int("15") → 15
int("3f",16) → 63
int(15.56) → 15
float("-11.24e8") → -1124000000.0
round(15.56,1)→15.6
```

can specify integer number base in 2nd parameter

truncate decimal part

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]
```

Booleans – True of False

- Booleans are the outcome when you compare or test variables
- Often used in control flow

- Examples

x = 2	x = “yes”
x < 3	x == “no”
True	False

- Operators for comparison
  - < less than
  - <= less than or equal to
  - > greater than
  - >= greater than or equal to
  - == equal
  - != not equal

- Cheat-sheet page 1

Boolean Logic

Comparisons : `<` `>` `<=` `>=` `==` `!=`
(boolean results) ≤ ≥ = ≠

`a and b` logical and *both simulta--neously*

`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

Booleans – Multiple tests

- Three simple words to make more complex comparisons:

And:

True and True → True
True and False → False
False and False → False

Or:

True or True → True
True or False → True
False or False → False

Not:

not True → False
not False → True

Examples:

```
5 > 3 and 5 > 1
True
5 < 3 or 5 > 1
True
not 5 > 3
False
not 5 > 3 or 5 > 1
False
not (5 > 3 or 5 > 1)
False
```

Exercises

- Writing a script is **solving** a problem **step by step**
- Try to understand what is happening
- Try for yourself, experiment and **play around** a bit
- When code does not work:
  - Try to understand the error message
  - Check line by line
  - Check parts in a new cell
  - Try a different approach
  - Ask a neighbor
  - Ask the teachers
- We can show and discuss some of the <u>assignment type</u> exercises on screen

Loops

Day 1 – Introduction to Python

Control Flow - if / else / elif

- With if, else and elif control the execution of parts of a program.

```
if (condition):
<tab> do something
```

- Example:

```
x = 5
if (x < 0):
      print ("x is negative”)
elif (x > 0):
      print ("x is positive”)
else:
      print ("x is 0“)

x is positive
```

Loops!

- Can repeat code

- Two types of loops:

  While

  Repeats code while a statement is true

  When you want to repeat an **unknown** number of times.

  For

  Runs a piece of code a fixed number of times

  When you want to repeat an **known** number of times.

Loops - while

while <condition>:
<tab> do something

Example:

```
number = float(input("Please provide a number: "))
    while number < 20:
        print (number)
        number += 1
    Please provide a number: 15
        15.0
        16.0
        17.0
        18.0
        19.0
```

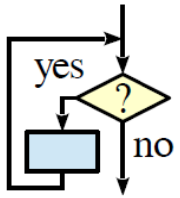
Condition never becomes false →

Loops - while

Conditional Loop Statement

statements block executed ***as long as*** *condition is true*

```
while logical condition :
    statements block
```




```
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 !

beware of infinite loops!

Algo:

$$s = \sum_{i=1}^{i=100} i^2$$

Loop Control

break *immediate exit*

continue *next iteration*

else *block for* ***normal*** *loop exit.*

statemen

item of c

Loops - for

for <variable> in <string>:

<tab> do something

Example:

```
for each_day in my_life:
        Wakeup()
        Do_something()
        Sleep()
        if each_day == day_i_was_born:
                Eat_Cake()
```

Example:

```
string = “my string”
for char in string:
        print (char)
```

```
m
y

s
t
r
i
n
g
```

Example:

```
patat = “frt”
for peer in patat:
        if (peer == “r”):
                print (peer + “ie”)
        else:
                print (peer)
```

```
f
rie
t
```

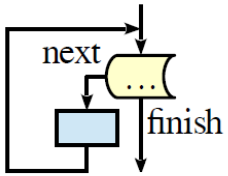
Loops - for

statements block executed ***for each*** *item of a container or iterator*

Iterative Loop Statement

ontrol
ate exit
ration
nal

```
for var in sequence:
    statements block
```



Go over sequence's **values**

```
s = "Some text"
cnt = 0
```

initializations ***before*** *the loop*

loop variable, ***assignment managed by for statement***

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

Algo: count number of e *in the string.*

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.

☞ good habit : don't modify loop variable

Go simultaneously over sequence's **index** and **values**:

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

Exercises

Extra Exercises

- www.practicepython.org

- And more!

All Exercises

- 1: Character Input 🌶
- 2: Odd Or Even 🌶
- 3: List Less Than Ten 🌶🌶
- 4: Divisors 🌶🌶
- 5: List Overlap 🌶🌶
- 6: String Lists 🌶🌶
- 7: List Comprehensions 🌶🌶
- 8: Rock Paper Scissors 🌶🌶🌶
- 9: Guessing Game One 🌶🌶🌶
- 10: List Overlap Comprehensions 🌶🌶
- 11: Check Primality Functions 🌶🌶🌶
- 12: List Ends 🌶
- 13: Fibonacci 🌶🌶
- 14: List Remove Duplicates 🌶🌶
- 15: Reverse Word Order 🌶🌶🌶
- 16: Password Generator 🌶🌶🌶🌶
- 17: Decode A Web Page 🌶🌶🌶🌶
- 18: Cows And Bulls 🌶🌶🌶
- 19: Decode A Web Page Two 🌶🌶🌶🌶
- 20: Element Search 🌶
- 21: Write To A File 🌶

All Solutions

- 1: Character Input Solutions
- 2: Odd Or Even Solutions
- 3: List Less Than Ten Solutions
- 4: Divisors Solutions
- 5: List Overlap Solutions
- 6: String Lists Solutions
- 7: List Comprehensions Solutions
- 8: Rock Paper Scissors Solutions
- 9: Guessing Game One Solutions
- 10: List Overlap Comprehensions Solutions
- 11: Check Primality Functions Solutions
- 12: List Ends Solutions
- 13: Fibonacci Solutions
- 14: List Remove Duplicates Solutions
- 15: Reverse Word Order Solutions
- 16: Password Generator Solutions
- 17: Decode A Web Page Solutions
- 18: Cows And Bulls Solutions
- 19: Decode A Web Page Two Solutions
- 20: Element Search Solutions
- 21: Write To A File Solutions

That was it for today

If “you need some help”:

“you can ask us some questions” while “we are still around”

elif “you want to practice some more”:

print “no problem”

else:

“save file, close jupyter” and “we see you tomorrow”