python™

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Introduction

- Python project : python.org
- Language created by Guido van Rossum
  - 1989 : 1st version (0.9)
  - 1994 : version 1.0
  - 2000 : version 2.0
  - **2001** : version 2.1 (Python Software Foundation)
  - **2008** : version 3.0 (non compatible 2.x)
  - 2024 : 3.13 et 2.7 (eol 1/1/2020)

Assets of the language

- Multi platforms
- Interpretated : `python [[-i] monscript.py]`
- Simple Syntax
- 3 paradigms of programming
  - Functional `map(sqrt, [1, 4, 9])`
  - Imperative
    ```
    while delta < epsilon:
        delta = computeAgain()
    ```
  - Object
    ```
    valeurs = [3, 5, 7]
    pos = valeurs.index(7)
    ```
- Rich Integrated Library + External ones (PyPI)
- Big Community

Programmation Web

Flask
web development,
one drop at a time

django The web framework for perfectionists with deadlines.

FastAPI

Calcul Scientifique, Data Science

- SciPy.org
  - NumPy : numpy.org
  - SciPy
  - Matplotlib : matplotlib.org
  - Sympy : sympy.org
  - Pandas : pandas.pydata.org

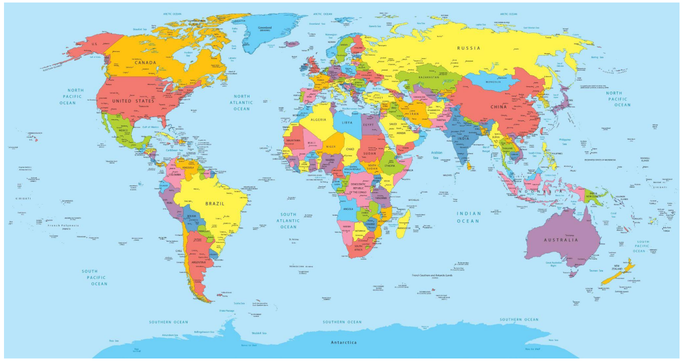
  - IPython : ipython.org
  - Notebook
- Travis Oliphant, Eric Jones, and Pearu Peterson

IA

- https://www.tensorflow.org/
- https://pytorch.org/
- https://scikit-learn.org
- https://keras.io/
- https://github.com/Microsoft/cntk
- https://github.com/Theano/Theano
- https://www.automl.org/
- https://shap.readthedocs.io/
- https://github.com/BobLd/YOLOv4MLNet

GIS

- Data : GeoPandas, GeoAlchemy, Xarray, Shapely, GeoPy, Geos, Fiona, GDAL, Rasterio, OGR, RSGISlib, PySAL, TorchGeo, Rasterstats, WhiteboxTools, scikit-mobility, EarthPy, Geocoder, PyCRS, RasterVision, osmnx, Overpy, geospatial-learn, GeoMesa, RasterFrames, laspy, PDAL, h3-py, Rtree,
- Spatial : PySAR, SarPy, snappy, PyRAT
- Cartes/Visualisation : ipyleaflet, geoplot, cartopy, folium, GeoViews, geoplot, Pydeck, PyVista, Open3D, geemap, reportlab
- Web : GeoDjango
- Liaison logiciels : ArcGIS, qgis



Resources

- Documentation :
  - docs.python.org/3/
    - Tutorial
    - Library Reference
    - Langage Reference
    - Python Module Index
  - Help from interpreter : dir, help, ?
- Python Package Index : PyPI
  - pypi.python.org/pypi
  - 500k projects
  - outil pip, conda
- Real Python tutorials: https://realpython.com/

Environnements Distributions

- Python idle
- IPython : projet SciPy
- IDE: PyCharm / VS Code / Spyder
- Jupyter Notebook
- Jupyter Lab

- Distribution Anaconda

Syntaxe du Langage

- Variable
- Base Types
- Block
- Condition
- Loop
- Comprehension
- With

Types de données de base

bool	True, False	None, 0, 0., [], (,), {}, …
int	3, -3, 0b1001, 0o675, 0x3F 1_000_000_000	int32/int64 (python 2) infini (python3)
long	9223372036854775808, 4L	la suite des int (python 2)
float	4., 1.5, -7.6E-123 float('nan'), float('inf')	IEEE 754 simple/double
complex	3+4j	
str	'Toto', "Titi"	
datetime.time, datetime.date, datetime.datetime	date(2017,11,20)	
decimal.Decimal	Decimal('1')/Decimal('3')	virgule fixe
fractions.Fraction	Fraction('1/3')	
NoneType	None	

Opérations

- Booleans : or, and, not
- Comparisons : ==, !=, <, <=, >=, is, is not, in, not in

  a is None

  3 in [1, 2, 3]
- Numbers : +, -, *, /, //, %, **
- Matrix : @
- Bitwise : |, &, ^, ~, <<, >>
- Acces (index, key, slice) : [ ]

  s[0], s[-1]

  s[3:12]

  s[3:12:2]

Operators and functions

- Logical :
  - or, and, not
  - <, <=, >, >=, ==, !=, is, is not
- Mathematical :

  +, -, *, /, //, %, **, +=, -+, *=, /=, %=

  functions Built-In : float, int, long, abs, cmp, min, max, sum

  module math (floor, sqrt, cos, pi, e, …)
- Strings :

  +

  functions Built-In : len, str, repr, cmp

  methods : join, upper, lower, index, …

  slices

Structures de contrôle

- if elif else
  - pas de case (jusqu'à 3.9)
- for in
  - « foreach » over all iterable object
  - for i « old school » : range, enumerate
- while
  - no do while
- comprehension : list, dict, generator
- with
  - open/close resource
- match case (python 3.10): https://peps.python.org/pep-0636/

Functions

- Definition
  - def f(x):

    ```
        return x +1
    ```
  - lambda x: x+1
  - 2^{e} order : map, iter, all, any, filter
- Argument
  - position or keyword
  - var argos: tuple (*) / dict (**)
- Return value / None
- Scope of variables
- Built-in functions

Objets Standards

- Strings
- Lists
- Dictionnaries
- Tuples
- Generators

Sequences et Dictionnaries

- Listes : list

  [1,2,3], [3],[], [[1,2,3], [4,5,6]]
- Tuples : tuple

  1,2,3, (1,2,3), (1,), ()
- Sets : set

  {1,2}
- Dictionnaries : dict

  {'Pau':64, 'Toulouse':31}
- Operators : + et []   (acces or slice)

Iterable/Iterator/Generator

- Un itérateur permet de parcourir une donnée complexe
  - Built-In fonction `next()`
- Un objet itérable renvoie un itérateur sur lui-même
  - Built-In fonction `iter()`
- Permet un parcours avec une boucle, une comprehension list

```
spam = ['eggs1', 'eggs2', 'eggs3']
for item in spam:
  print item
```

- Un générateur fournit des valeurs à la demande
  - Faible coût mémoire
  - Un générateur est itérable
  - Implémentation avec `yield` et `yield from` (*)
  - Exemple : `range(10)`

(*) python 3 uniquement

Package/Module

- Déclaration et structure
  - module = fichier python (.py)
  - package = répertoire avec un fichier __init__.py
- Convention de nommage
- Opérations sur les modules

Programmation Orientée Objets

- Concepts de la POO
- Membres d’instances et de classes
- Méthodes spéciales
- Encapsulation

Librairies Communes

- Système / processus : sys
- Système de fichiers : os.path, pathlib, glob
- Expressions régulières : re
- Base de données : PEP249

Gestion des Fichiers

- Ouverture/fermeture de fichiers
- Lecture/Ecriture
- Informations sur les fichiers
- Gestion des répertoires

Environnement IPython

IP[y]:

- http://ipython.org
- Shell python
- Interactivité ++
- Aide
- Complétion automatique

Environnement Jupyter

- Environnement Web
    - notebook
    - lab
- Conserver code et résultats
- Graphiques
- Article scientifique

NumPy

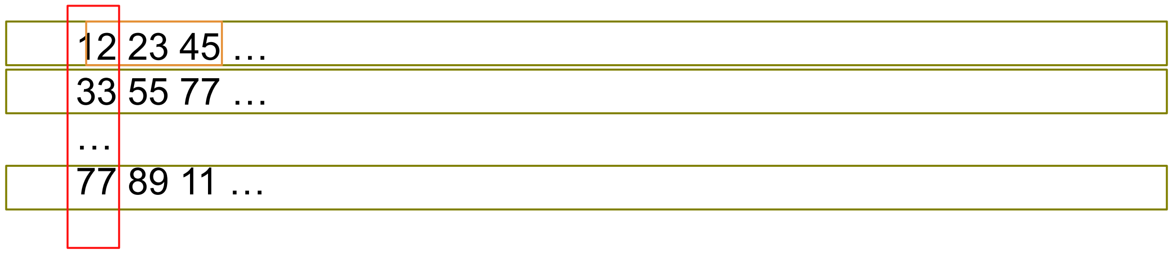
- http://www.numpy.org/
- Types NumPy :
- N-dimensionnal array + matrix
  - Broadcasting
- Algèbre Linéaire
- FFT
- Finances
- Input/Output
- Polynomes
- Tris
- Statistiques

Types Numpy

- https://docs.scipy.org/doc/numpy-1.13.0/user/basics.types.html
- Taille + Signe
- Exemple : int8, uint32
- Entiers
- Flottants
- Complexes

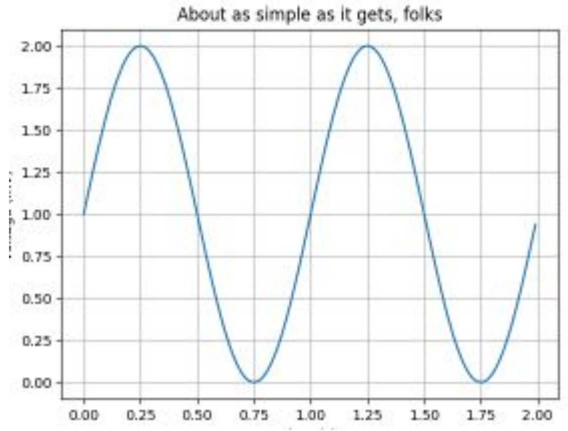
Matrices : C ou Fortran contiguous

Exemple: mode C, phénomène cache

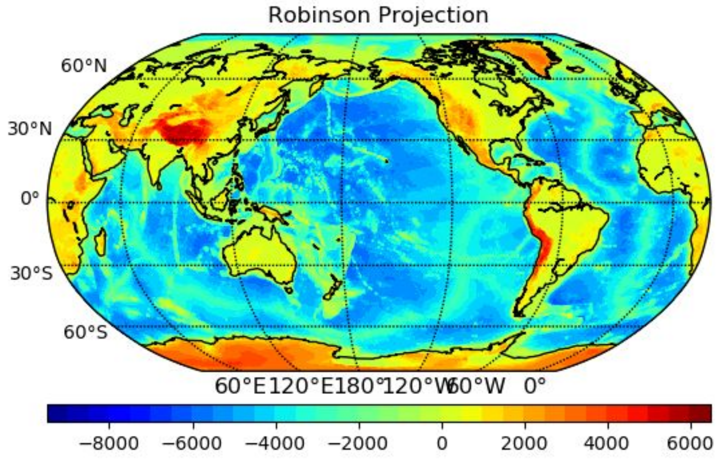


Matplotlib & Basemap

- https://matplotlib.org/
- matplotlib.pyplot



- mpl_toolkits.basemap



Matplotlib & co

- https://plotly.com/
- https://docs.bokeh.org/en/latest/
- https://panel.holoviz.org/
- https://seaborn.pydata.org/
- https://dash.gallery/Portal/
-

Pandas

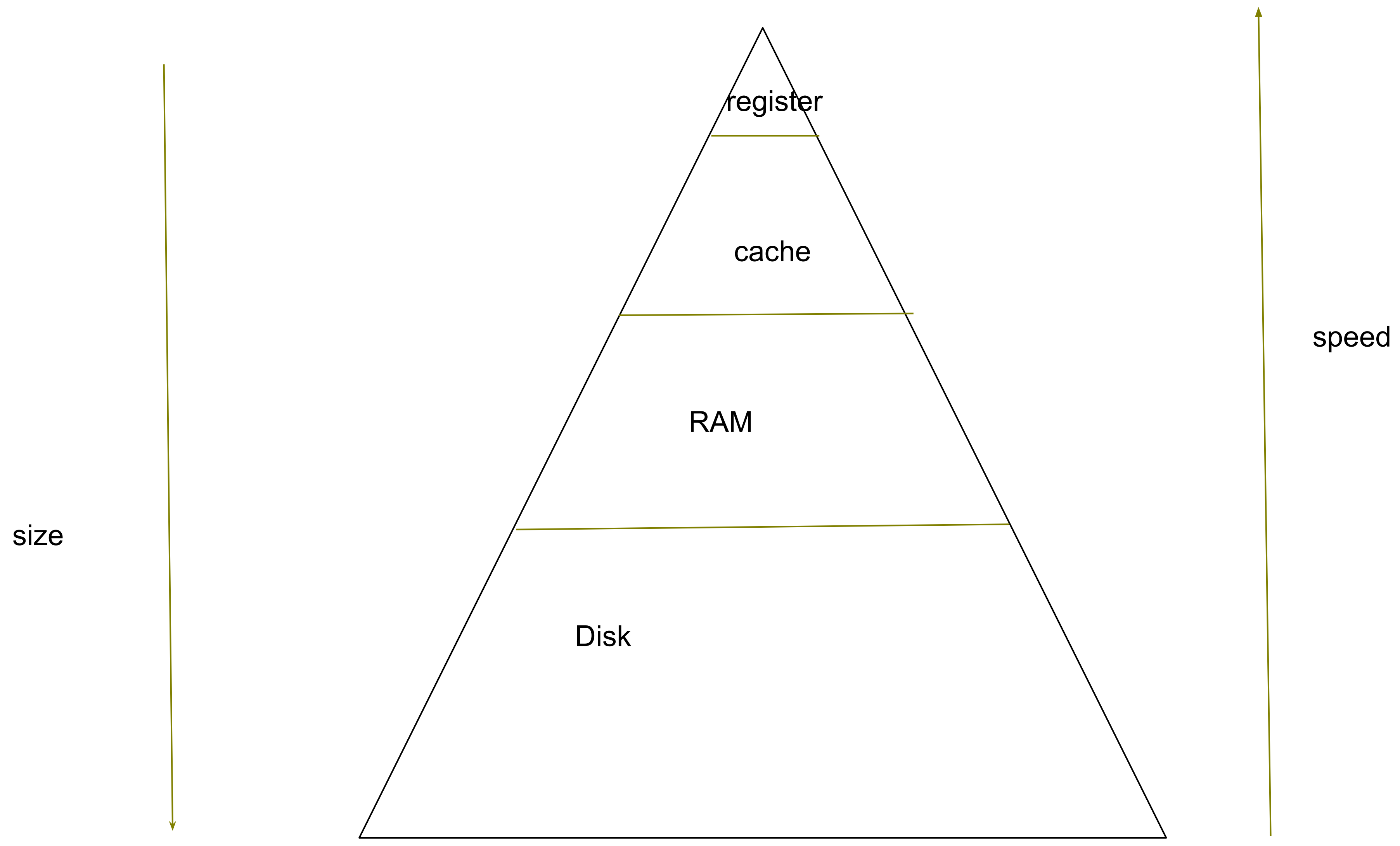
- https://pandas.pydata.org/
- Entrés/sorties multi-format
- Nettoyage, conversion
- Transformation
- Passerelles vers numpy et matplotlib

Encodage

- ascii : 128 caractères (1 bit de contrôle)
- 1 caractère = 1 octet (char du langage C)
  - latin-1 (ISO8859-1) : europe occidentale
  - latin-5 (ISO8859-5) : cyrillique
  - …
- 1 caractère = 1 octet avec l'€ (europe occid.)
  - latin-15 (ISO8859-15)
  - CP1252/ANSI : Microsoft
- Unicode : 3 encodages
  - UTF-8
  - UTF-16
  - UTF-32

Décorateur

- https://realpython.com/primer-on-python-decorators/
- Quoi décorer
  - fonction
  - classe
- Principe : wrapper ce qu'on décore
- Exemples:
  - @total_ordering
  - @dataclass
  - @property
  - @lru_cache


register
cache
RAM
Disk
size
speed

Virtual Environments

- venv (included in python)
- virtualenv
- conda (anaconda, miniconda)
- poetry

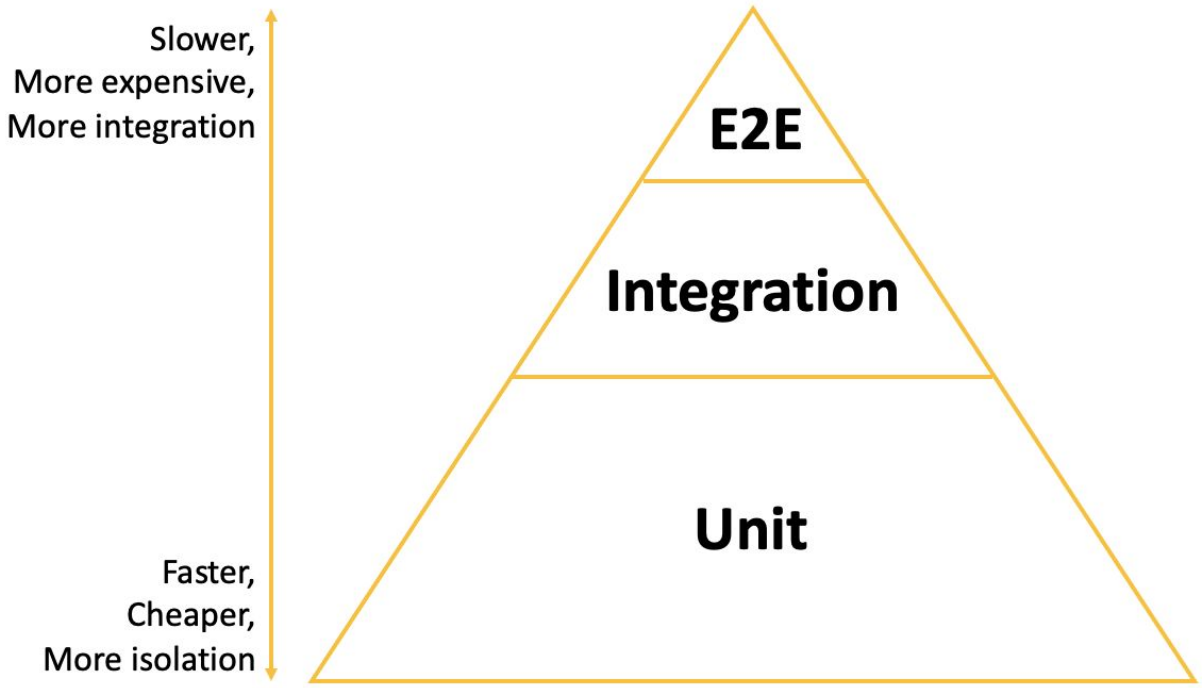
Build

https://packaging.python.org/en/latest/overview/

- A lot of possibilities
- Formats
  - tar, zip, git (python only)
  - wheel (for pip)
  - binary
- Quid project
  - mixte: python/C++
  - python => C/C++
  - JIT with numba (https://numba.pydata.org/)
- Dependencies: requirements.txt
- Organisation
  - setup.py (old) + setuptools
  - pyproject.toml (modern)
    - PEP 517/518, 621(https://peps.python.org/pep-0000/)
    - Tuto : https://packaging.python.org/en/latest/tutorials/packaging-projects/

Tests en Python

- python: unittest
- tiers:
  - pytest
  - nose
  - …



Pytest

- pytest.org
  - pip install pytest pytest-mock
- Run
  - Scan all project
    - pytest
  - Run one test file:
    - pytest test_magic_square.py
  - Run one package test:
    - pytest test_somepackage
  - Run all tests with name containing pattern
    - pytest -k is_magic_square_all_present

Test links

- https://realpython.com/tutorials/testing/
- https://realpython.com/pytest-python-testing/
-

Files

- builtin function open
- librairies
  - pathlib (object mode)
  - os.path (text mode)
  - a lot more
    - csv
    - json
    - xml.etree
      - lxml (https://lxml.de/)
    - BeautifulSoup (html/xml)
      - https://www.crummy.com/software/BeautifulSoup/
    - pandas: https://pandas.pydata.org/

ORM

- Object Relational Mapper
  - class Movie <-> table movies
  - attribute title <-> column title
  - associations
  - object Movie <-> row in table movies
- Queries
  - insert/update/delete: object
  - select with object vocabulary => objects Movie
- Python:
  - ORMs: SqlAlchemy, Django ORM
  - Pandas: use sqlalchemy

IHM / GUI

- for tcl/tk: tkinter (inside python)
- for Qt:
  - Qt for Python aka PySide2 (official)
  - PyQt

Type checking

- https://realpython.com/python-type-checking/
- Hints introduced by python 3.6
    - type annotation
    - module typing, numpy.typing
- Advantages:
    - documentation
    - code auto completion
- checker: linter, mypy, …

Concurrent Programming

1. Multi Processing
   a. multiprocessing, shared_memory
2. Multi Threading
   a. threading (attention si trop de threads)
3. Executor/pool (thread or process)
4. Asynchronous programming
   a. async keyword (python 3.6)
      i. Ex: fastapi framework
   b. module asyncio
   c. module celery (with flask/django)

Online Resources

Python for Data Analysis, 3E

https://wesmckinney.com/book/

Nouveautés Python

- 3.6:
  - formatted strings
  - hints
    - x: int = 3
  - async
- 3.10
  - match … case
- 3.12
  - improve generics hints, f-strings
  - @override