# Introduction to Python 3

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# Shh

- Python is . . .

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- slow.

# Python is slow

- A tight loop like below runs 10 to 100 (or more) times slower than C or java.

```
1  total = 0
2  for i in range(1000):
3      for j in range(1000):
4          total += i              # how many times this statement runs?
5
6  print total
7  # 499950000000
```

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```

- Although you can re-write the above and make it run almost, but not quite, as fast.

```
1  print sum([1000 * i for i in xrange(1000)])
2  # 499950000000
```

# Why is Python slow

- Interpreted, not compiled.
- Almost no automatic optimization.
- High-level, versatile programming constructs tend to be larger, more complicated, and slower.
- A simple piece of code may have a huge performance implication. e.g. `range(1000)` creates and returns a 1000-element list every time it is called.

# Why Python is *not* slow

- Faster programming constructs (e.g., `xrange()` vs. `range()`, comprehension vs. `for` loop)
- Modules written in C (e.g., cPickle vs. pickle)
- NumPy and SciPy for scientific computation.
- Python/C API (`http://docs.python.org/2/c-api`)
- Cython (`http://cython.org`) takes Python code and generates efficient C code.
- PyPy Just-In-Time (JIT) compiler. (`http://pypy.org`)

# Implementations

- The reference implemention (in C) is called CPython, which Guido van Rossum authored, starting in 1989

- Guido is also known as Benevolent Dictator For Life (BDFL. See `http://tinyurl.com/5pg99q`)

# Implementations (cont.)

- There are other implementations as well.
- IronPython (.NET CLR `http://ironpython.net`)
- Jython (Java VM `http://www.jython.org/`)
- pyjs (JavaScript `http://pyjs.org/`)
- Skulpt (web browser `http://www.skulpt.org`)
- CodeSkulptor (web browser `http://www.codeskulptor.org`)

# Python 2 or 3?

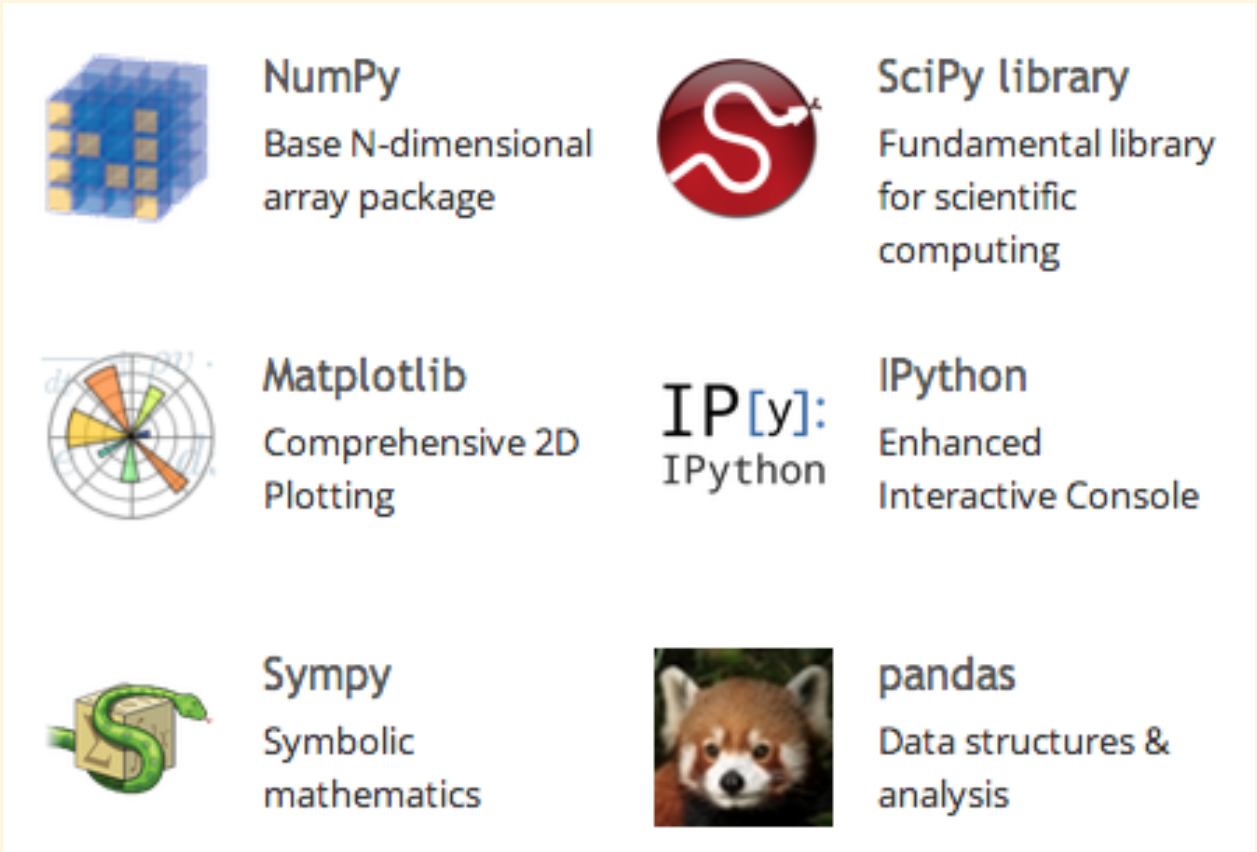
- Python 3.0 (2008) broke backward compatibility.
  - Can’t use 2 modules in 3 and vice versa.
- "2 is legacy, 3 is the present and future." (`http://tinyurl.com/omgx9tk`)
  - 3.4 is expected in early 2014.
  - 2.0 was released in 2000.
  - 2.7 (2010) will be the last 2.x branch.
- Many of 3’s major futures have been backported to 2.6 and 2.7, but not all.
- Other implementations in general still lack support for Python 3.

# Editors and IDE's

- EMACS comes with python.el (24.2 and up) and python-mode.el (newer). See (`http://tinyurl.com/y67za8d`)
- VIM configuration links at `http://tinyurl.com/apx3avc`
- IDLE (`http://tinyurl.com/c7j2k3x`)
- (Semi-) commercial editors, e.g., Komodo, PyCharm, Sublime, ...
- IPython (`http://ipython.org`) and IPython notebook.
- And many others. See `http://tinyurl.com/leqyjw7`.

# IPython and IPython Notebook

- A comprehensive environemnt for interactive and exploratory computing.
- A “new killer app” back in 2011. 1.0 released in 2013.
- One of the six core packages of SciPy stack.



# PyPI and pip

- Python Package Index (PyPI) is the repository of software for Python at `http://pypi.python.org/pypi`.
- As of a day in Jan 2014, it has about 38,800 packages.
- Python Indexing Project (pip) (`http://www.pip-installer.org`) is the standard tool for *installing* packages (or modules) from PyPI.
- Some examples of using pip. At the shell prompt:

```
1 $ pip
2 $ pip list
3 $ pip install SomePackage
4 $ pip install --user SomePackage
5 $ pip install --upgrade SomePackage
6 $ pip uninstall
```

- Once a package is successfully installed, then you can import the module within your script.

# Installing SciPy Stack

- It *is* possible to install all the packages one by one (and all the dependencies). It *could* turn out to be tricky.
- An alternative is to download and install free or commercial distributions. Some names are: Anaconda, Enthought Canopy, Python(x,y), WinPython, ...
- See `http://www.scipy.org/install.html`.
- Check out Wakari.IO (`https://www.wakari.io`) for playing with SciPy stack on the cloud, without local installation.

# Quiz

- Choose the best one that fits each description:
  1. Standard module supporting object (de-)serialization, which is written in C.
  2. Compiler that turns Python source into efficient C code.
  3. Software tool for installing / managing packages.
  4. Benevolent Dictator For Life.
  5. Provides a rich architecture for interactive (scientific) computing. Version 1.0 was released in 2013.

comprehension cPickle CPython Cython Guido van Rossum IPython Niklaus Wirth Pickle pip Sublime xrange() Yukihiro Matsumoto

# NumPy

- Provides the `ndarray` object.
- `ndarray` implements an efficient homogeneous multidimensional array.
- Element-wise and vectorized matrix operations are provided.
- Lots of modules use / built on NumPy.
- Documentation at `http://docs.scipy.org/doc`.

# SciPy

- Collection of mathematical algorithms and utility functions built on NumPy.
- Organized into subpackages: cluster, constants, fftpack, integrate, interpolate, io, linalg (linear algebra), ndimage (N-dimentional image processing), odr (orthogonal distance regression), optimize, signal (signal processing), sparse (sparce matrices), spatial, special (functions), stats, weave (C/C++ integration)
- Documentation at `http://docs.scipy.org/doc`.

# Matplotlib

- Provides comprehensive 2D and simple 3D plotting.
- Simple plot, Subplots (multiple axes), Histograms, Path, Simple 3D plot (surface, wireframe, scatter, bar), Streamlines (of a vector field), Ellipses, Bar charts, Pie charts, Filled (curves and polygons), Financial charts, Polar plots, . . . , including TeX expressions support (internal or external) and Sketch plots (XKCD style)
- Screenshots are (with source code) at `http://matplotlib.org/users/screenshots.html`.
- Documentation at `http://matplotlib.org/contents.html`.

# pandas

- “Python Data Analysis Library” (Release 0.12 as of 2013).
- Series, DataFrame , and Panel objects
- reading/writing data to and from: CSV, text file, Excel, SQL db, and fast HDF5 (scientific data file formats and libraries developed at NCSA), JSON, HTML Table, STATA.
- Labeling columns, iteration, Hierarchical Indexing, Transformation, Selection, Missing Data, Merge, Grouping (or split-apply-combine), Reshaping (or pivoting), Time Series, I/O tools, R interface (via rpy2).
- Documentation at `http://pandas.pydata.org`.
- Wes McKinney, “10-minute tour of pandas” (`http://vimeo.com/59324550`) or workshop (`http://www.youtube.com/watch?v=MxRMXhjXZos`)

# Demonstration

- Using IPython

# Learning Resources

- Websites:
  - Main website `http://www.python.org` and SciPy site `http://scipy.org`.
  - Official Python Tutorial `http://docs.python.org/2/tutorial/index.html`.
  - Google's Python Class (2 day class materials including video and exercises) `https://developers.google.com/edu/python`.

# Learning Resources

- Three advanced level tutorial videos:
  - technical (old)
    `http://www.youtube.com/watch?v=E_kZDvwofHY`.
  - idioms (new)
    `http://www.youtube.com/watch?v=OSGv2VnC0go`.
  - functional style
    `http://www.youtube.com/watch?v=Ta1bAMOMFOI`.
  - 2000+ videos at `http://pyvideo.org`.

# Learning Resources

- Books:
  - Mark Lutz (2013) *Learning Python* 5th ed (1,400 plus pages).
  - “6 Free E-Books” mentioned on `http://tinyurl.com/m2y9rad`.
  - Matthew Russell (2013) “Mining the Social Web” 2nd edition is out. Example code files (in IPython Notebook file .ipynb format) are at `http://tinyurl.com/n3txeu5`.

# Learning Resources

- Any cool computer language has:
  - Zen (read and memorize!) `http://www.python.org/dev/peps/pep-0020/`
  - Koans (unit testing) `http://tinyurl.com/7n6yfvn`
  - Challenges (old) `http://www.pythonchallenge.com/`
- Need more challenges?
  - Try the Project Euler `http://projecteuler.net`

# Learning Resources

- MOOC's using Python extensively:
  - "Introduction to Computer Science and Programming Using Python" (edX, `http://tinyurl.com/o3pbmc3`)
  - "Introduction to Interactive Programming in Python" (Coursera, `http://tinyurl.com/c95qh2q`)
  - "Coding the Matrix: Linear Algebra through Computer Science Applications" (Coursera, `http://tinyurl.com/awkbdho`)

# Learning Resources

- Twitter:
  - "teaching python 140 character at a time": `http://twitter.com/raymondh`
- Gallery
  - IPython Notebook gallery (including social data) `http://tinyurl.com/c5tj9xh`