

Basic python

Ryan Leung (PhD in astrophysics)
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You can get this ppt and related files at:

https://github.com/ryan-leung/2016-JAN_python_workshop/

Learning Outcomes

- Know how to get a working python for your operating system.
- Use python in ipython notebook.
- Define different data structures.
- Make a loop with for and while.
- Defining functions.
- Reading files and plotting graphs.
- And practising with examples.

Introduction

Python and programing

What is python



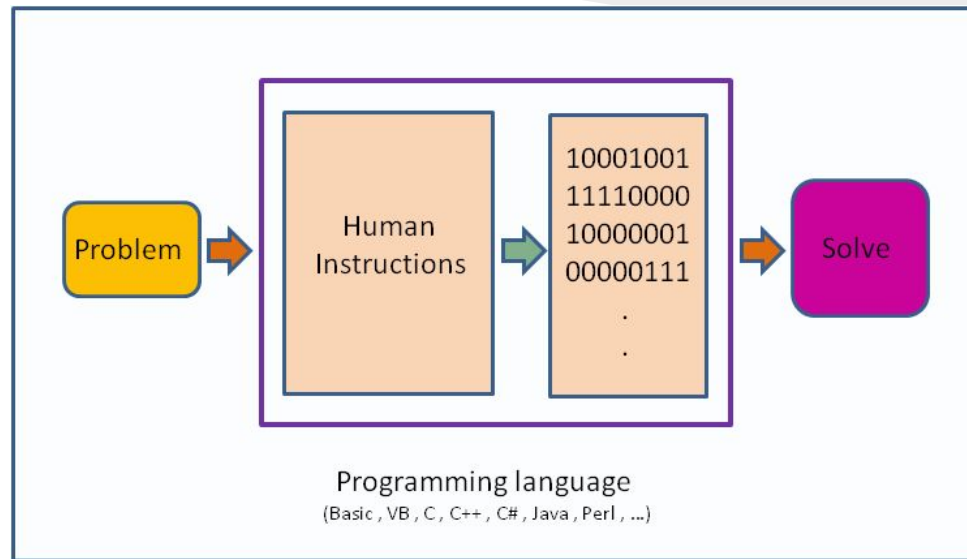
General-purpose, high-level programming language.

Object-oriented, interpreted, interactive.

Easy write, easy read.

Dynamic variables & memory management.

Programming basic



- Sequences of instruction that tell the computer to solve your problem.
- Like cooking, a program is a receipt.
- You prepare raw food, seasoning, etc.
- If you follow the receipt, you will get a good food (sort of).

Writing program

- Think what you are going to do
- Define some initial constant as “variables”
- Operate on those variables ==> final products.

But problems usually comes out, and that's call “bugs”.

Why python?



Coding and debugging is a tough task
Spend less time on it and get your work done!
Lots of packages written by others for speed deployment.

Interpreter vs compiler

- Python uses interpreter.
 - Parse command line by line.
 - Write script --> Interpreter (Run line by line) --> Run the result.
-
- Compiler reads in the whole code and generate an intermediate object file.
 - Write program --> Compiler (Translate to machine language) --> Run the result.

Installing

How to install python and get it works?

Python distribution

Anaconda / Miniconda

<https://store.continuum.io/cshop/anaconda/>

<http://conda.pydata.org/miniconda.html>

Official Site

<https://www.python.org/downloads/>

Portable Python

<http://portablepython.com/>

If you run Linux, some Linux distributions have python pre-installed or get it from repository:

Fedora: `sudo dnf install numpy scipy python-matplotlib python-ipython`

Ubuntu: `sudo apt-get install ipython-notebook python-matplotlib`

Macports

If you have macports on your mac, you can follow this instruction in [macports_installation.md](#)

Get Anaconda for Windows

Anaconda for Windows

PYTHON 2.7	PYTHON 3.5
<div>Windows 64-bit Graphical Installer</div> <div>337M</div>	<div>Windows 64-bit Graphical Installer</div> <div>392M</div>
<div>Windows 32-bit Graphical Installer</div> <div>321M</div>	<div>Windows 32-bit Graphical Installer</div> <div>316M</div>
Behind a firewall? Use these zipped Windows installers .	

Windows Anaconda Installation

1. Download the installer.
2. Double-click the .exe file to install Anaconda and follow the instructions on the screen.
3. Optional: [Verify data integrity with MD5](#).

Get Anaconda for Mac

Anaconda for OS X

PYTHON 2.7	PYTHON 3.5
<div>Mac OS X 64-bit Graphical Installer</div> <div>27411 (OS X 10.7 or higher)</div>	<div>Mac OS X 64-bit Graphical Installer</div> <div>25711 (OS X 10.7 or higher)</div>
<div>Mac OS X 64-bit Command-Line installer</div> <div>23911 (OS X 10.5 or higher)</div>	<div>Mac OS X 64-bit Command-Line installer</div> <div>23311 (OS X 10.5 or higher)</div>

OS X Anaconda Installation

1. Download the installer.
2. Double click the .pkg file and follow the instructions on the screen.
3. **Command-Line Installs:**

After downloading the installer, in the shell execute for Python 2.7:

```
bash Anaconda2-2.4.1-MacOSX-x86_64.sh
```

Or for Python 3.5:

```
bash Anaconda3-2.4.1-MacOSX-x86_64.sh
```

NOTE: You should type "bash", regardless of whether or not you are actually using the bash shell.

4. Optional: [Verify data integrity with MD5](#).

Get Anaconda for Linux

Anaconda for Linux

PYTHON 2.7	PYTHON 3.5
<div>Linux 64-bit</div> <div>23311</div>	<div>Linux 64-bit</div> <div>23511</div>
<div>Linux 32-bit</div> <div>27911</div>	<div>Linux 32-bit</div> <div>27711</div>

Linux Anaconda Installation

1. Download the installer.
2. After downloading the installer, in your terminal window execute for Python 2.7:

```
bash Anaconda2-2.4.1-Linux-x86_64.sh
```

Or for Python 3.5:

```
bash Anaconda3-2.4.1-Linux-x86_64.sh
```

NOTE: Type "bash" regardless of whether or not you are actually using the bash shell.

3. Optional: [Verify data integrity with MD5](#).



GO

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Python Releases for Windows

- [Latest Python 2 Release - Python 2.7.11](#)
- [Latest Python 3 Release - Python 3.5.1](#)
- [Python 3.4.4 - 2015-12-21](#)
 - Download [Windows x86 MSI installer](#)
 - Download [Windows x86-64 MSI installer](#)
 - Download [Windows help file](#)
 - Download [Windows debug information files for 64-bit binaries](#)
 - Download [Windows debug information files](#)
- [Python 3.5.1 - 2015-12-07](#)
 - Download [Windows x86 web-based installer](#)
 - Download [Windows x86 executable installer](#)
 - Download [Windows x86 embeddable zip file](#)
 - Download [Windows x86-64 web-based installer](#)
 - Download [Windows x86-64 executable installer](#)
 - Download [Windows x86-64 embeddable zip file](#)
 - Download [Windows help file](#)
- [Python 3.4.4rc1 - 2015-12-07](#)
 - Download [Windows x86 MSI installer](#)
 - Download [Windows x86-64 MSI installer](#)

Or from official site

Tips in python version

- Your system may have two different pythons:
 - python 2.x
 - python 3.x
- They may have different binary names:
 - python
 - python2
 - python3
- You can always check the python version by running its interpreter.
- We use python version 2 in this workshop.
- A common shebang line used for the Python interpreter is as follows:
 - `#!/usr/bin/env python`
- You must then make the script executable, using the following command:
 - `chmod +x xxxxxxxxxxx.py`

Configuring

How to add packages to python?

Install package (Anaconda build)

- To search/install packages, use “conda”
- Command:
 - `conda search xxxxxx`
 - `conda install xxxxxx`
- Other commands:

http://conda.pydata.org/docs/_downloads/conda-cheatsheet.pdf

Install package (Normal build)

- To search/install packages, use “pip”
- Python 3.4 (released March 2014) and Python 2.7.9 (released December 2014) ship with Pip.
- Package list: <https://pypi.python.org/pypi>
- Command:
 - `pip search xxxxxx`
 - `pip install xxxxxx`

Full Commands:

<code>install</code>	Install packages.
<code>uninstall</code>	Uninstall packages.
<code>freeze</code>	Output installed packages in requirements format.
<code>list</code>	List installed packages.
<code>show</code>	Show information about installed packages.
<code>search</code>	Search PyPI for packages.
<code>zip</code>	Zip individual packages.
<code>unzip</code>	Unzip individual packages.
<code>bundle</code>	Create pybundles.
<code>help</code>	Show help for commands.

Packages for Symbolic/numerical/statistic



NumPy



SciPy.org



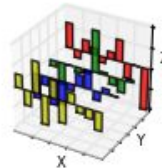
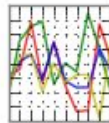
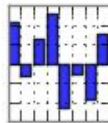
machine learning in Python



SymPy

pandas

$$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$$



- For symbolic
 - sympy
- For numerical
 - numpy
 - scipy
- For statistical and machine learning
 - scikit-learn
 - pandas

Python plotting / visualising packages



- **matplotlib**
 - all-round, major plotting in python
- **aplpy**
 - fits image plotting in high quality
- **yt**
 - large data / volumetric data visualising
- **bokeh**
 - interactive plots in html & javascript

Running python

How to run your scripts?

Python interpreter

- For Linux / OSX, type “python” in terminal.
- For windows, open “Anaconda” folder in Start menu.

```
python
# yanyan at vela in ~ [17:34:44]
$ python
Python 2.7.11 [Anaconda 2.3.0 (64-bit)] (default, Dec 6 2015, 18:08:32)
[GCC 4.4.7 20120313 (Red Hat 4.4.7-1)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
Anaconda is brought to you by Continuum Analytics.
Please check out: http://continuum.io/thanks and https://anaconda.org
>>> □
```

```
python
Deactivating environment "D:\Apps\Anaconda"...
Activating environment "D:\Apps\Anaconda"...

[Anaconda] C:\Users\yanyan>python
Python 2.7.11 [Anaconda 2.4.1 (32-bit)] (default, Dec 7 2015, 14:13:17) [MSC v.1500 32
Type "help", "copyright", "credits" or "license" for more information.
Anaconda is brought to you by Continuum Analytics.
Please check out: http://continuum.io/thanks and https://anaconda.org
>>>
```

Spyder IDE



Like Matlab

The screenshot displays the Spyder IDE (Python 3.4) interface. The main editor window shows a Python script named `interpolation.py` with the following code:

```
4 From the SciPy Cookbook
5 """
6
7 from numpy import arange, cos, linspace, pi, sin, random
8 from scipy.interpolate import splprep, splev
9
10 # make ascending spiral in 3-space
11 t=linspace(0,1.75*2*pi,100)
12
13 x = sin(t)
14 y = cos(t)
15 z = t
16
17 # %% add noise
18 x+= random.normal(scale=0.1, size=x.shape)
19 y+= random.normal(scale=0.1, size=y.shape)
20 z+= random.normal(scale=0.1, size=z.shape)
21
22 # %% spline parameters
23 s=3.0 # smoothness parameter
24 k=2 # spline order
25 nest=-1 # estimate of number of knots needed (-1 = maximal,
26
27 # %% find the knot points
28 tckp,u = splprep([x,y,z],s=s,k=k,nest=-1)
29
30 # %% evaluate spline, including interpolated points
31 xnew,ynew,znew = splev(linspace(0,1,400),tckp)
32
33 import pylab
```

The right-hand side of the interface contains three panels:

- Object inspector:** Shows the `mean` function from `numpy.core.fromnumeric`. It includes the definition: `mean(a, axis=None, dtype=None, out=None, keepdims=False)` and a description: "Compute the arithmetic mean along the specified axis. Returns the average of the array elements. The average is".
- Variable explorer:** Currently empty.
- File explorer:** Currently empty.
- Static code analysis:** Currently empty.
- IPython console:** Shows the command `runfile('/tmp/interpolation.py', wdir='/tmp')` and two plots. The first plot shows a 3D spiral of data points (blue dots) and a fitted spline (red line). The second plot shows a 2D projection of the same data and fit.

The bottom status bar indicates: Permissions: RW, End-of-lines: LF, Encoding: UTF-8, Line: 18, Column: 43, Memory: 86 %.

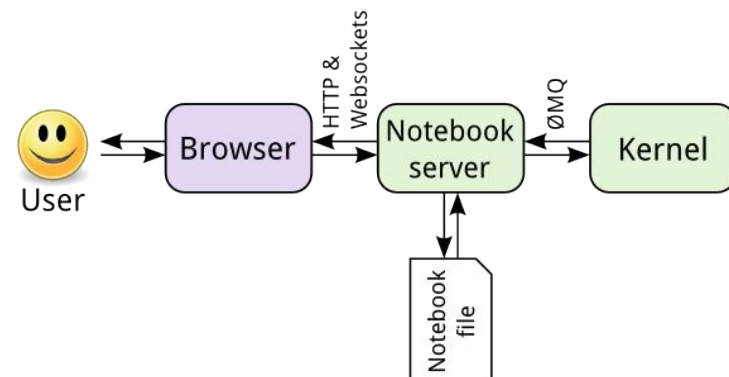
ipython / jupyter

Like Maple /
Mathematica!

For more interaction and fun, we use *ipython* to run our python code. *ipython* is old name, new name is call *jupyter*.



[INSTALL](#) [PROJECT](#) [COMMUNITY](#) [DOCUMENTATION](#) [NBVIEWER](#) [BLOG](#) [DONATE](#)

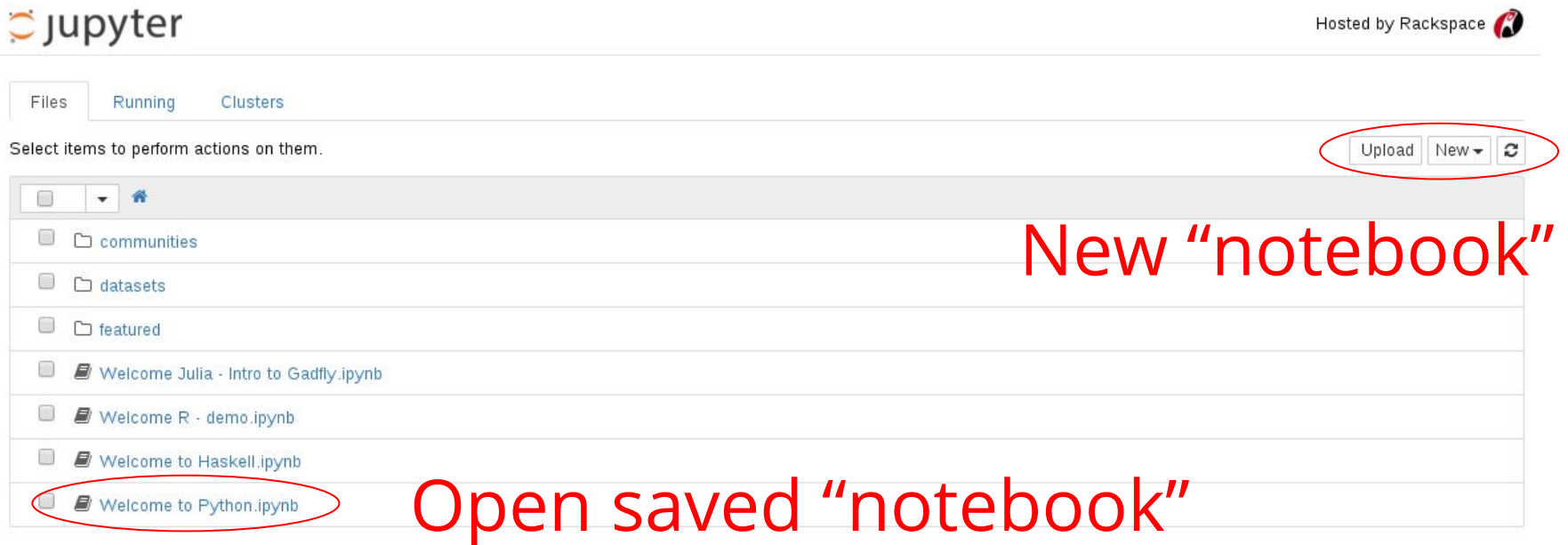


Open source, interactive data science and scientific computing across over 40 programming languages.

Launch ipython for testing purpose

Lazy? <https://try.jupyter.org/>

But missing some packages! Better run your program in your own computer



The screenshot shows the JupyterLab interface. At the top, the Jupyter logo is on the left and 'Hosted by Rackspace' is on the right. Below the logo, there are tabs for 'Files', 'Running', and 'Clusters'. The 'Files' tab is active, showing a file browser. The file browser has a search bar and a list of files and folders. The files listed are 'communities', 'datasets', 'featured', 'Welcome Julia - Intro to Gadfly.ipynb', 'Welcome R - demo.ipynb', 'Welcome to Haskell.ipynb', and 'Welcome to Python.ipynb'. The 'Welcome to Python.ipynb' file is circled in red. To the right of the file browser, there are buttons for 'Upload', 'New', and a refresh icon. The 'New' button is circled in red. The text 'New "notebook"' is written in red next to the 'New' button. The text 'Open saved "notebook"' is written in red next to the 'Welcome to Python.ipynb' file.

jupyter

Hosted by Rackspace

Files Running Clusters

Select items to perform actions on them.

Upload New ↕

communities

datasets

featured

Welcome Julia - Intro to Gadfly.ipynb

Welcome R - demo.ipynb

Welcome to Haskell.ipynb

Welcome to Python.ipynb

New "notebook"

Open saved "notebook"

Launch ipython in your computer

In command prompt/terminal, type
ipython notebook

Go to <http://localhost:8888/> in browser

jupyter

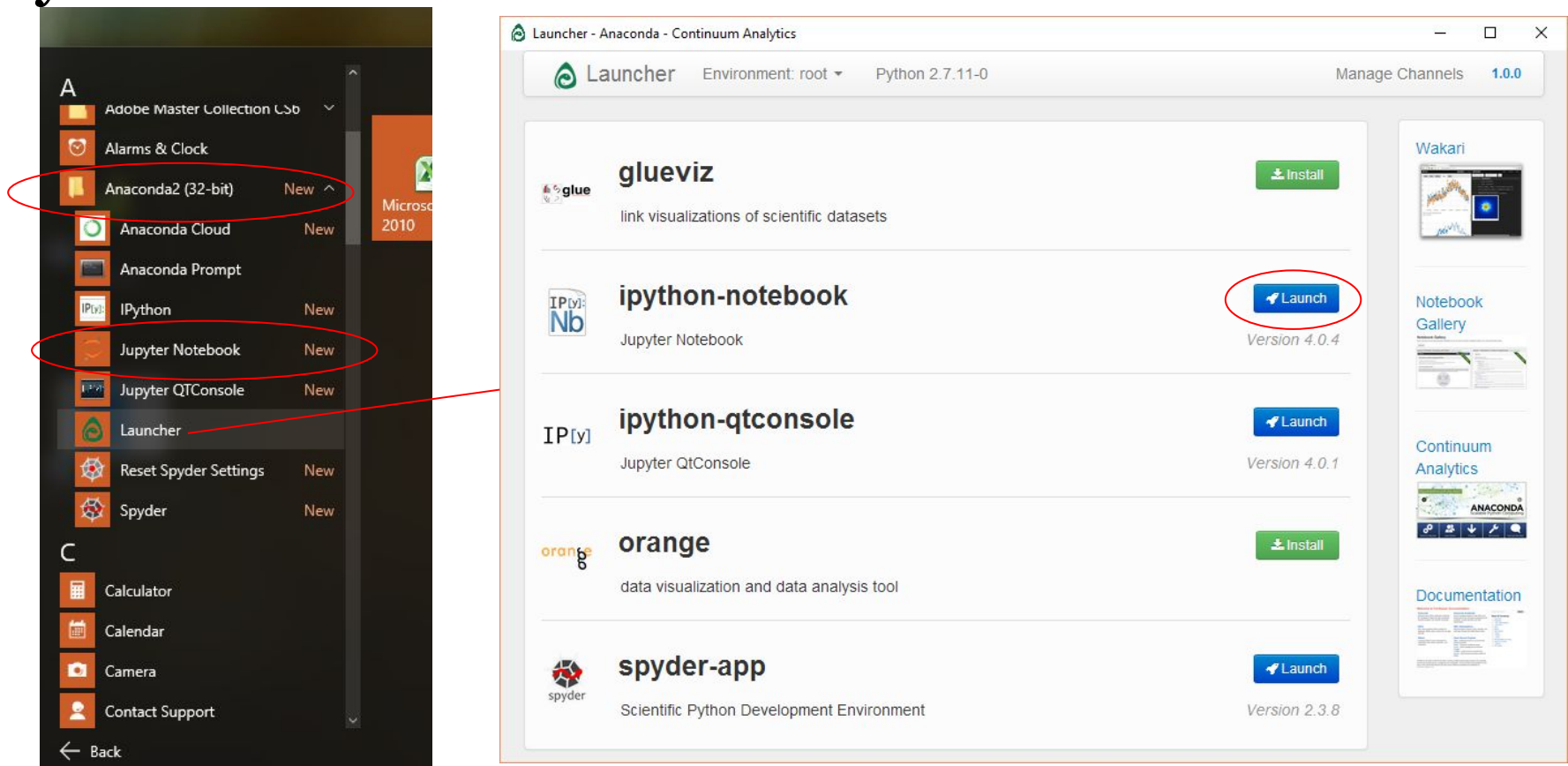
Files Running IPython Clusters

Select items to perform actions on them.

The screenshot shows the Jupyter Notebook web interface. At the top, there's a header with the Jupyter logo and the word "jupyter". Below it, there are tabs for "Files", "Running", and "IPython Clusters". The "Files" tab is active, showing a file browser. The breadcrumb path is "/ research / python / 2016-JAN_python_workshop". The file list includes: "..", "Data Structures and Loops.ipynb", "Files and Plot.ipynb", "Functions.ipynb", "Syntax.ipynb", "Basic python.pdf", "LICENSE.md", and "README.md". On the right side, a context menu is open, showing options: "Text File", "Folder", "Terminal", "Notebooks", "Julia 0.4.3", and "Python 2". The "Python 2" option is circled in red. Above the menu, there are buttons for "Upload", "New", and a refresh icon, with the "New" button also circled in red.

Launch ipython in your computer

If you have Anaconda GUI / using Windows, you can also launch here:




Welcome to the Temporary Notebook (tmpnb) service!

This Notebook Server was **launched just for you**. It's a temporary way for you to try out a recent development version of the IPython/Jupyter notebook.

WARNING

Don't rely on this server for anything you want to last - your server will be *deleted after 10 minutes of inactivity*.

Your server is hosted thanks to [Rackspace](#), on their on-demand bare metal servers, [OnMetal](#).

Hosted by Rackspace 

Files Running Clusters

Select items to perform actions on them.

Upload New ↕

<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>		communities
<input type="checkbox"/>		datasets
<input type="checkbox"/>		featured
<input type="checkbox"/>		Welcome Julia - Intro to Gadfly.ipynb
<input type="checkbox"/>		Welcome R - demo.ipynb
<input type="checkbox"/>		Welcome to Haskell.ipynb
<input type="checkbox"/>		Welcome to Python.ipynb
		Running

Opened/running
notebook

Hosted by Rackspace 

Files Running Clusters

Currently running Jupyter processes

Terminals ▾

There are no terminals running.

Notebooks ▾

	Welcome to Python.ipynb
	Welcome to Haskell.ipynb
	Welcome Julia - Intro to Gadfly.ipynb

All running
notebook

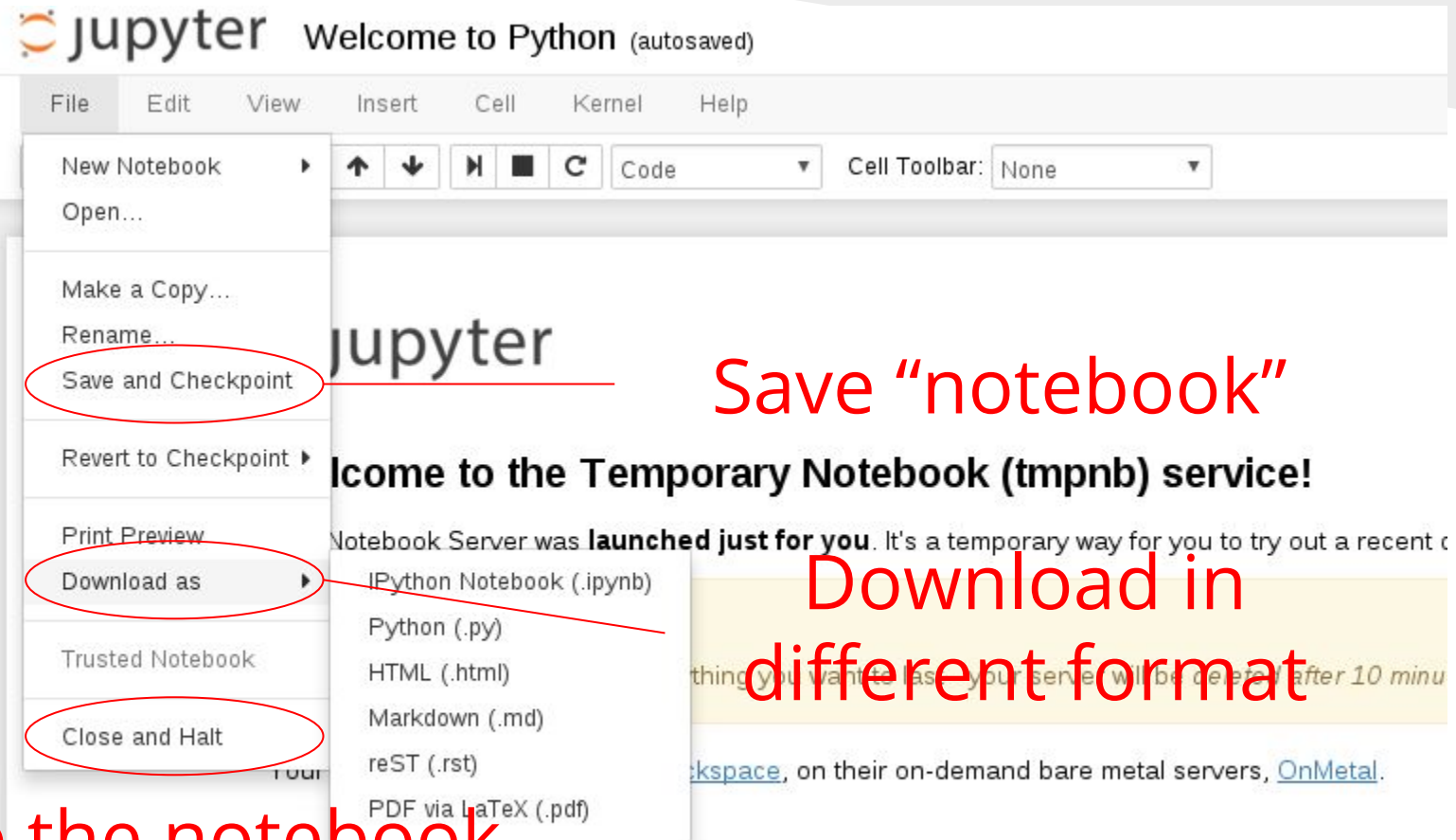
Shutdown
button

Shutdown

Shutdown

Shutdown

ipython (save/download notebook)



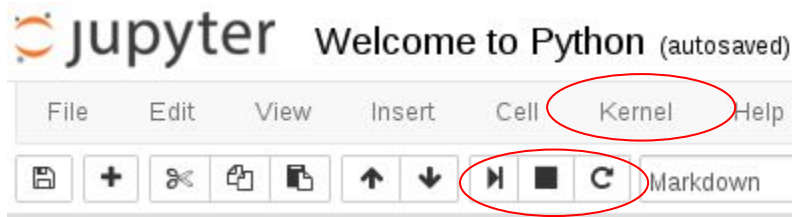
Save "notebook"

Download in
different format

Stop the notebook

Run some Python code!

Notes on using ipython/jupyter



Something goes wrong?
Stop the kernel

Stop the current
cell operation

- To be safe, make sure you open each notebook document in only one tab.
- Data will be lost if the kernel is stopped.
- You can close the browser tab safely after the notebook says “notebook saved”. It will run in background

Notes on using ipython/jupyter

3.1.1. Change Jupyter Notebook startup folder (Windows)

- Copy the *IPython Notebook* launcher from the menu to the desktop.
- Right click on the new launcher and change the “Start in” field by pasting the full path of the folder which will contain all the notebooks.
- Double-click on the *IPython Notebook* desktop launcher (icon shows [IPy]) to start the [Jupyter Notebook App](#), which will open in a new browser window (or tab). Note also that a secondary terminal window (used only for error logging and for shut down) will be also opened. If only the terminal starts, try opening this address with your browser: <http://localhost:8888/>.

3.1.2. Change Jupyter Notebook startup folder (OS X)

To launch [Jupyter Notebook App](#):

- Click on spotlight, type `terminal` to open a terminal window.
- Enter the startup folder by typing `cd /some_folder_name`.
- Type `ipython notebook` to launch the [Jupyter Notebook App](#) (it will appear in a new browser window or tab).

1. Syntax

Syntax.ipynb

2. Data Structures and Loops

Data Structures and Loops.ipynb

3. Functions

Functions.ipynb

4. Files operation

File operations.ipynb

5. Plots with matplotlib

Plots.ipynb

6. Plots continued

Advanced Plot.ipynb

Python in astronomy



Until ~2012 python astronomy modules were scattered.

Several core modules are now unified under astropy:

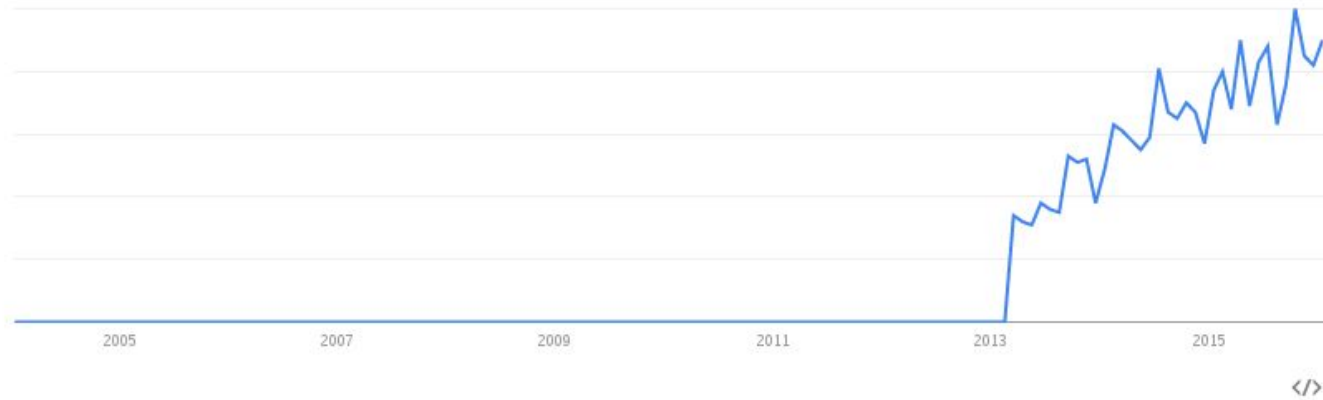
- **astropy.wcs** (World coordinate system (WCS) supported by PyWCS.)
- **astropy.io.fits** (FITS files support supported by PyFITS.)
- **astropy.coordinates** (Celestial coordinate and time transformations.)
- **astropy.units** (Unit and physical quantity conversions, physical constants specific to astronomy.)

astropy
Search term

+ Add term

Interest over time ?

☐ News headlines ? ☐ forecast ?



Regional interest ?



United States

Region | Town/City

100

7. Tools for astronomy

Astropy - Load fits.ipynb

APLpy - Fits image & colour map.ipynb

APLpy - Cass A in 3 colours.ipynb

Need more performance?

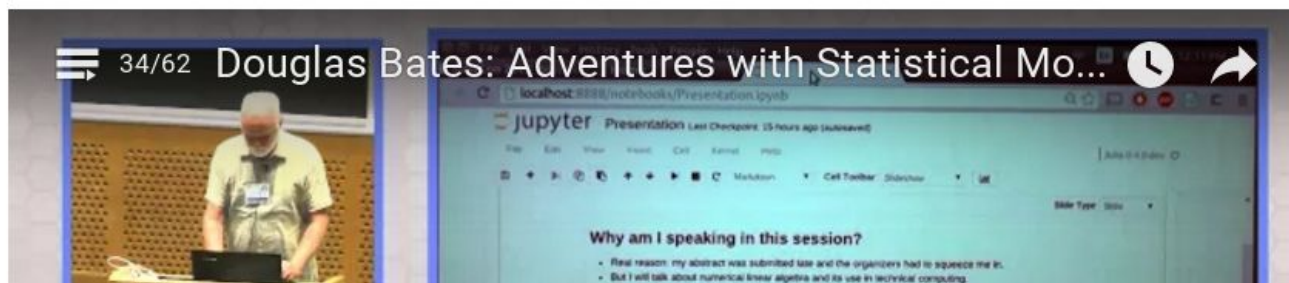
Any language apart from python and have a great performance?



[julia](#) | [source](#) | [downloads](#) | [docs](#) | [packages](#) | [blog](#) | [community](#) | [learning](#) | [teaching](#) | [publications](#) | [jsoc](#) | [juliacon](#)

Julia is a high-level, high-performance dynamic programming language for technical computing, with syntax that is familiar to users of other technical computing environments. It provides a sophisticated compiler, [distributed parallel execution](#), numerical accuracy, and an [extensive mathematical function library](#). Julia's Base library, largely written in Julia itself, also integrates mature, best-of-breed open source C and Fortran libraries for [linear algebra](#), [random number generation](#), [signal processing](#), and [string processing](#). In addition, the Julia developer community is contributing a number of [external packages](#) through Julia's built-in package manager at a rapid pace. [IJulia](#), a collaboration between the [IPython](#) and Julia communities, provides a powerful browser-based graphical notebook interface to Julia.

[JuliaCon 2015](#) at MIT was a huge success. The [videos](#) are now online, and a random video from JuliaCon 2015 is presented here.



Some basic features in julia

- Syntax similarities: python, MATLAB and C
- Utilize matplotlib for plotting, clever and sweet

	Fortran	Julia	Python	R	Matlab	Octave	Mathe- matica	JavaScript	Go	LuaJIT	Java
	gcc 4.8.2	0.3.7	2.7.9	3.1.3	R2014a	3.8.1	10.0	V8 3.14.5.9	go1.2.1	gsl- shell 2.3.1	1.7.0_75
fib	0.57	2.14	95.45	528.85	4258.12	9211.59	166.64	3.68	2.20	2.02	0.96
parse_int	4.67	1.57	20.48	54.30	1525.88	7568.38	17.70	2.29	3.78	6.09	5.43
quicksort	1.10	1.21	46.70	248.28	55.87	1532.54	48.47	2.91	1.09	2.00	1.65
mandel	0.87	0.87	18.83	58.97	60.09	393.91	6.12	1.86	1.17	0.71	0.68
pi_sum	0.83	1.00	21.07	14.45	1.28	260.28	1.27	2.15	1.23	1.00	1.00
rand_mat_stat	0.99	1.74	22.29	16.88	9.82	30.44	6.20	2.81	8.23	3.71	4.01
rand_mat_mul	4.05	1.09	1.08	1.63	1.12	1.06	1.13	14.58	8.45	1.23	2.35

- Ijulia and Jupyter

Home

Untitled1

localhost:8888/notebooks/Untitled1.ipynb?kernel_name=julia-0.4

John

Search

Star

Refresh

Home

Menu

jupyter

Untitled1 (unsaved changes)

Julia 0.4.2

File

Edit

View

Insert

Cell

Kernel

Help

Save

+

Undo

Redo

Copy

Paste

Up

Down

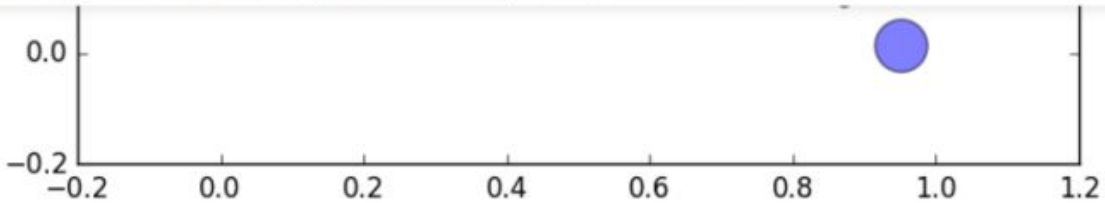
Run

Stop

Restart

Code

CellToolbar



Out[2]:

PyObject <matplotlib.collections.PathCollection object at 0x7f6e10c3e9b0>

In [4]:

?repmat

search:

Out[4]:

repmat(A, n, m)

Construct a matrix by repeating the given matrix n times in dimension 1 and m times in dimension 2.

repmat

In []:

If A_1, A_2, \dots are subsets of X , then $\cup_n A_n$ is the set
 $\{x \in X \mid x \in A_n \text{ for some } n \in \mathbb{N}\}$

In []:

That's all

You can stay here for practising, I have collected some programming tasks for you

Practise and hands-on session

Questions are obtained from <https://projecteuler.net/>

Q1 Factorial

Write a program which can compute the factorial of a given numbers.

Suppose the input is:

8

Then, the output should be:

40320

Q2 Even Fibonacci numbers

Each new term in the Fibonacci sequence is generated by adding the previous two terms. By starting with 1 and 2, the first 10 terms will be:

1, 2, 3, 5, 8, 13, 21, 34, 55, 89, ...

By considering the terms in the Fibonacci sequence whose values **do not exceed four million**, find the **sum of the even-valued terms**.

Q3 10001st prime

By listing the first six prime numbers: 2, 3, 5, 7, 11, and 13, we can see that the 6th prime is 13.

What is the 10 001st prime number?

Q4 Largest product in a series

The four adjacent digits in the 1000-digit number that have the greatest product are $9 \times 9 \times 8 \times 9 = 5832$.

7316717653133062491922511967442657474235534919493496983520312774506326239578318016984801869478851843
8586156078911294949545950173795833195285320880551112540698747158523863050715693290963295227443043557
6689664895044524452316173185640309871112172238311362229893423380308135336276614282806444486645238749
3035890729629049156044077239071381051585930796086670172427121883998797908792274921901699720888093776
6572733300105336788122023542180975125454059475224352584907711670556013604839586446706324415722155397
5369781797784617406495514929086256932197846862248283972241375657056057490261407972968652414535100474
8216637048440319989000889524345065854122758866688116427171479924442928230863465674813919123162824586
1786645835912456652947654568284891288314260769004224219022671055626321111109370544217506941658960408
0719840385096245544436298123098787992724428490918884580156166097919133875499200524063689912560717606
0588611646710940507754100225698315520005593572972571636269561882670428252483600823257530420752963450

Find the thirteen adjacent digits in the 1000-digit number that have the greatest product. What is the value of this product?

Q5 Find a data set and plot it out

There are many datasets under the “datasets” folder

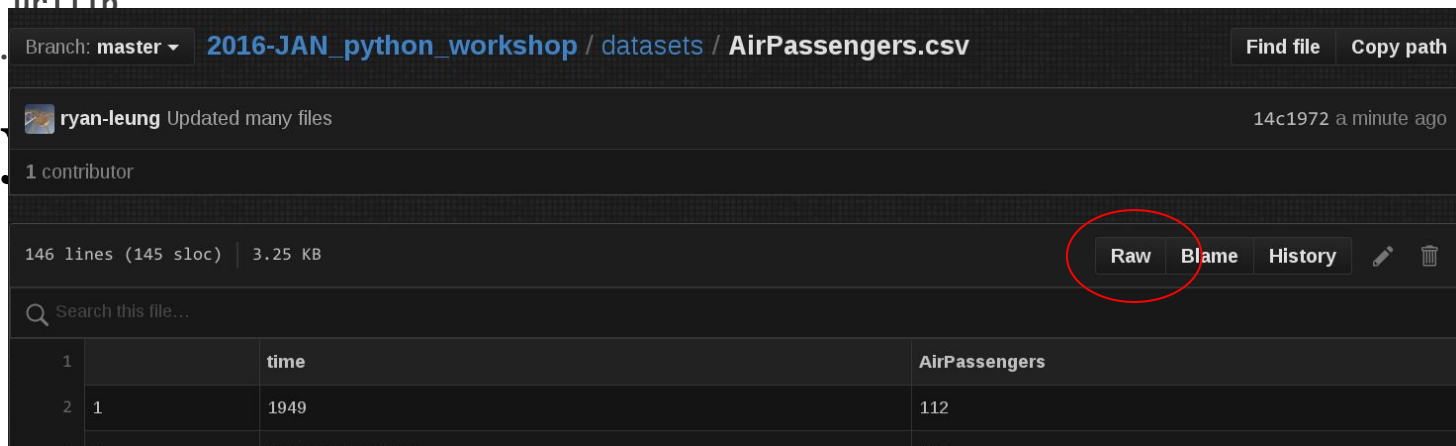
Load any one of them and try to plot them out :)

Remember you can download the file by:

```
import urllib
```

```
urllib.
```

Or
it.



The screenshot shows a GitHub file viewer interface for the file 'AirPassengers.csv' located in the 'datasets' folder of the '2016-JAN_python_workshop' repository. The file is 3.25 KB and has 146 lines (145 sloc). The 'Raw' button is circled in red. Below the file information, a search bar and a table of data are visible. The table has columns for line number, index, time, and file name.

1		time	AirPassengers
2	1	1949	112
3	2	1949-01-01	115