



Jupyter for Everything Else

Michael Bright, EuroPython 2016 - Bilbao, 22 July.



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About Me

**Solution Architect working at Hewlett-Packard Enterprise,
Grenoble, France**

Working in the EMEA OpenNFV lab.

Interests:

- Docker, Docker, Docker, Jupyter, Python, OpenStack
- Run a local Python User Group in Grenoble
- From the UK, married to a Chilean, living in France for 24 years
- Argentinian Tango, Salsa, ...

TODO: add images ... Grenoble mountains, unicycle, Argentinian Tango, UK, NFV? SDN? Python UserGroup, Docker!!!, Jupyter, Linux, OStack





OUTLINE

- Introduction: From IPython to Jupyter
- The Jupyter Project & Ecosystem:
 - Kernels, Widgets, Extensions, Tools
 - Incubating projects
 - External: Thebe, Hosting, Binder ...
- Jupyter for Everything Else
 - Blog, Present, Web, Command-line, Status reports





IP[y]:

IPYTHON - THE CONSOLE

"*an afternoon hack*" (Nov 2001) by Fernando Perez

A tool to help in the exploration process

- Individual exploration
- Collaborative work
- Parallel Production Runs
- Publication of **reproducible** results
- Education
- Repeat





IP[y]: IPYTHON - THE CONSOLE

Initial 0.0.1 version [Gist](#)

- REPL in 259 lines
- Input / Output cells
- History
- Plotting

```
IPython 4.0.0 -- An enhanced Interactive Python.
?          -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help       -> Python's own help system.
object?    -> Details about 'object', use 'object??' for extended info.

In [1]: def myfunc(msg):
....:     ''' prints msg '''
....:     print(msg)
....:

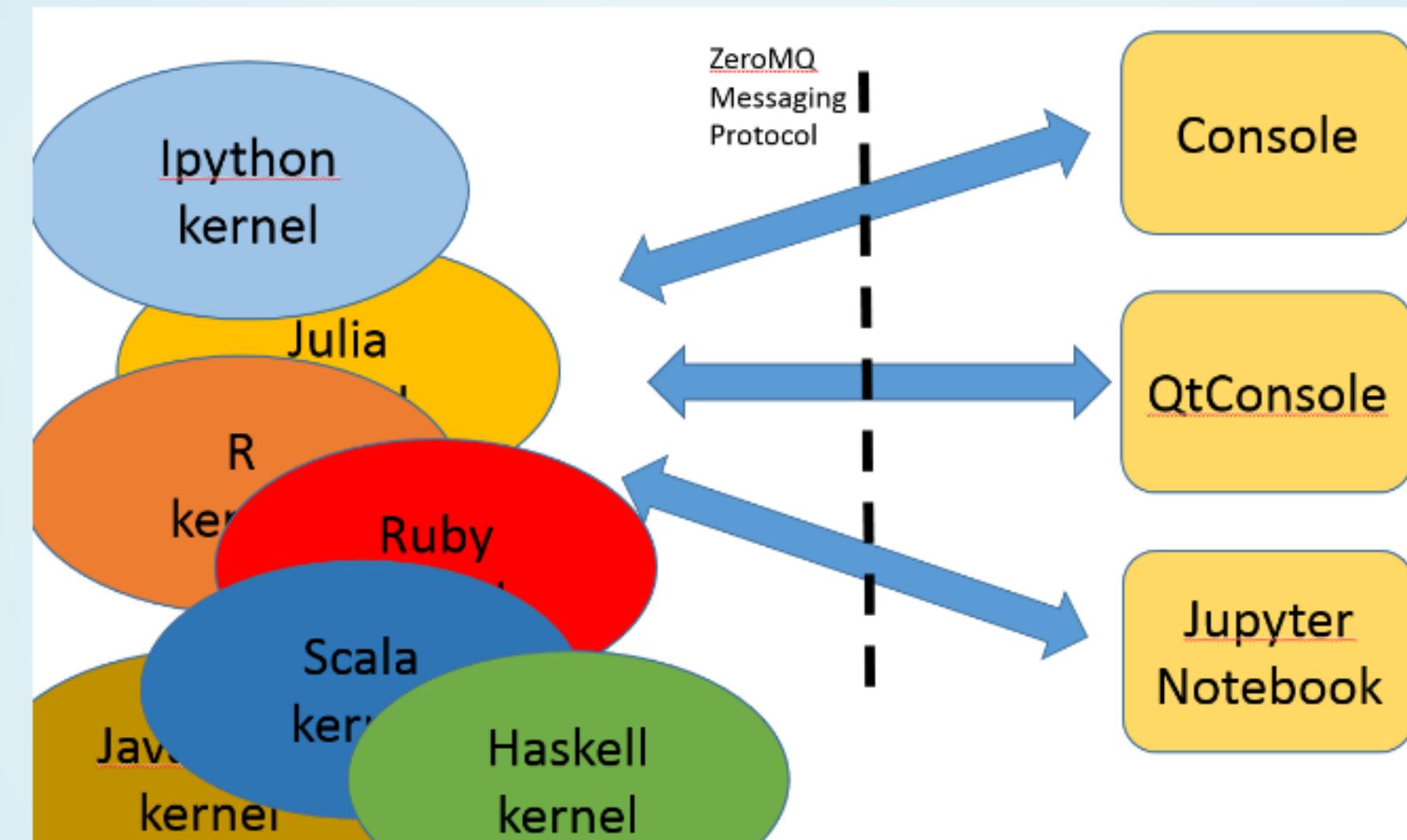
In [2]: myfunc("Hello World")
Hello World

In [3]: ?myfunc
Signature: myfunc(msg)
Docstring: prints msg
File:      d:\<ipython-input-1-e7b0ed71a6bd>
Type:      function
```





THE JUPYTER PROJECT



A notebook runs under one kernel





THE (JUPYTER) DASHBOARD & NOTEBOOK

Create & share documents of code, equations, visualizations and explanatory text as a **(reproducible) narrative**

The screenshot shows the Jupyter Notebook interface with several annotations:

- Toolbar:** An arrow points to the toolbar at the top.
- Menus:** An arrow points to the "Menus" button in the top bar.
- Running Kernel:** An arrow points to the "Running Kernel" status bar.
- Markdown:** An arrow points to the first two equations displayed in the notebook.
- Input Cell:** A large arrow points down to the input cell area.
- Audio:** An arrow points to the "Audio" section and its associated player.
- In [27]:** An arrow points to the code input cell:

```
In [27]: from IPython.display import Audio  
Audio(url="http://www.nch.com.au/acm/8k16bitpcm.wav")
```
- Out[27]:** An arrow points to the audio output cell, showing a play button and a progress bar.
- Output Cell:** An arrow points to the "Output Cell" text in the "Audio" section.
- In [28]:** An arrow points to the code input cell:

```
In [28]: import numpy as np  
max_time = 3  
f1 = 220.0  
f2 = 224.0  
rate = 8000.0
```



JUPYTER: PUBLIC NOTEBOOKS

Jupyter notebooks are used in many

- scientific (physics, chemistry, biology, genomics, data analysis)
- and non-scientific (finance) domains

Site	URL	Info
nbviewer	https://nbviewer.org]	submit your url, browse by theme
github	https://github.com	> 200k notebooks [<i>Announcement - May '15</i>]
IPython gallery	A-gallery-of-interesting-IPython-Notebooks	many notebooks organized by domain
Notebook Gallery	[nb.bianp.net [http://nb.bianp.net/]	view submitted notebooks by ' <i>most viewed</i> ' or ' <i>data</i> '





JUPYTER: RUNNING NOTEBOOKS

- Native OS Python distribution + Pip, or Anaconda
- JupyterHub, multi-user server
- Under Docker [e.g. *docker-stacks* images]
- Integrated into data science Cloud Hosting or plain IaaS:
 - Azure ML Studio
 - Google Cloud DataLab Beta
 - IBM Data Scientist Workbench
- Cloud hosted (ephemeral)
 - tryjupyter.org [uses *docker-demo* image]
 - **Binder** (<https://mybinder.org>), an example [github](#) repo





JUPYTER & AZURE ML STUDIO

Jupyter
Integration in
Azure ML Studio

- R
- Python

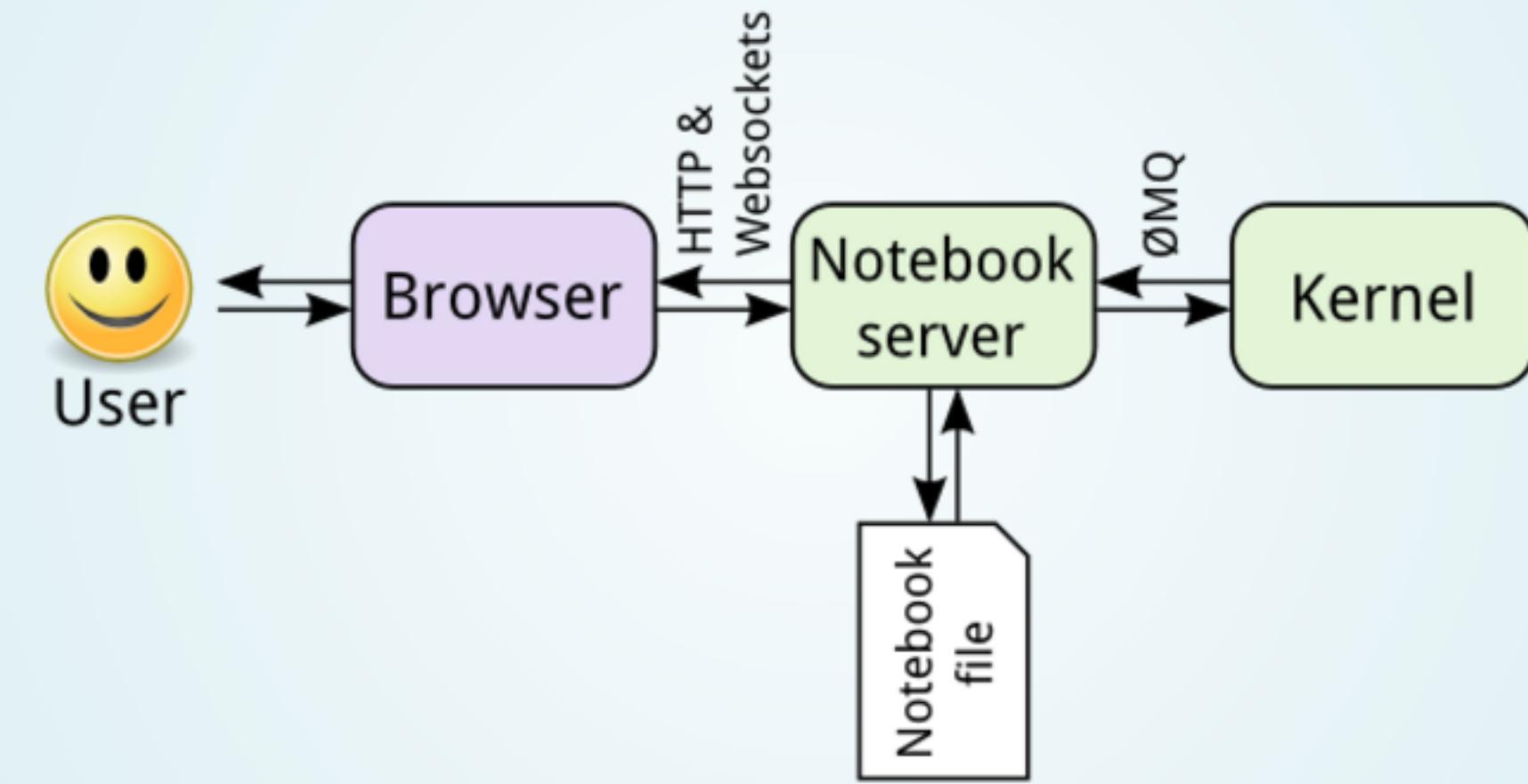
The screenshot shows the Microsoft Azure Machine Learning Studio interface. On the left, there is a sidebar with various icons and labels: EXPERIMENTS, WEB SERVICES, NOTEBOOKS (which is selected and highlighted in blue), DATASETS, TRAINED MODELS, and SETTINGS. The main area is titled "notebooks" and contains a table with two rows:

NAME	LANGUAGE	LAST MODIFIED
New R notebook	R	3/10/2016 4:24:18 PM
Welcome to Studio	Python 2	9/11/2015 1:44:35 AM

At the bottom of the main area, there are buttons for "+ NEW", "DELETE", and "RENAME".



KERNELS, WIDGETS & EXTENSIONS





~50 KERNELS

Kernels are execution environments - typically a language [Kernels Page]

IJulia

IScilab

Lua

IVisual VP

IScala

IForth

KDB+/Q Ker

cl-jupyter

Redis

IRKernel

IMatlab

Mochi

Brainfuck

IMathics

IPerl

ICryptol

IHaskell

jove

IPython

Hy

IErlang

Brython

IAldor

IPerl6

C++ (cling)

IElixir

Prolog

IRuby

Clojure

Spark

IOCaml

Calico

IPHP

Java 9

IFSharp

IGo

Bash

MetaKernel

MetaKernel_Bash

Calysto Pro

Calysto Prolog

IOctave

IJavascript

Calysto LC

Calysto Scheme





WIDGETS

Widgets are eventful python objects with a representation in the browser.
[\[documentation\]](#)

Provided widgets include:

- IntSlider, FloatSlider, FloatProgress
- Buttons, Checkboxes, Radio buttons
- Dropdown menus





EXTENSIONS

- Collection [github]: [ipython-contrib/IPython-notebook-extensions](https://github.com/ipython-contrib/IPython-notebook-extensions)
- Installed to <http://localhost:8888/nbextensions/>

Many extensions available, including:

- **RISE - these slides are running under Jupyter**
- [nbgrader](#) - creation/grading of classroom assignments

Generally installable via pip or from github repo





NBGRADER

jupyter Problem 1 Last Checkpoint: a few seconds ago (autosaved) Python 3

File Edit View Insert Cell Kernel Help

Cell Toolbar: Create Assignment Total points: 5

Part B (3 points)

Describe the difference between an *arithmetic mean*, a *harmonic mean*, and a *geometric mean*.

Points: 3 ID: describe_means Manually graded answer

Arithmetic mean:

$$\frac{1}{N} \sum_{i=1}^N x_i$$

Harmonic mean:

$$\left(\frac{1}{N} \sum_{i=1}^N \frac{1}{x_i} \right)^{-1}$$

Geometric mean:

$$\left(\prod_{i=1}^N x_i \right)^{\frac{1}{N}}$$




THE ECOSYSTEM & FUTURE PROJECTS





JUPYTER INCUBATOR PROJECTS

(<https://github.com/jupyter-incubator>) proposals

sparkmagic

Jupyter magics and kernels for working with remote
Spark clusters

declarativewidgets

Declare Widgets in HTML

dashboards

Create Dashboards from Notebooks

contentmanagement

Extensions for search, notebook
modules/[cookbooks](#), ToC, [bundlers](#) vid

kernel_gateway

Support different protocols to Jupyter server, e.g.
non-nb web clients, u-services, cluster





INCUBATOR: JUPYTER DASHBOARDS

(<https://github.com/jupyter-incubator/dashboards>) - alternative layouts

The screenshot shows a Jupyter Notebook interface with the title "meetup-streaming" and the URL "jupyter.cloudet.xyz/user/AnY1jQel3oyG/notebooks/dashboards/stream_demo/meetup-streaming.ipynb". The notebook is titled "jupyter meetup-streaming (autosaved)" and uses Python 3.

The dashboard layout includes:

- A header bar with "File", "Edit", "View", "Insert", "Cell", "Kernel", "Help" menus, and a "Python 3" kernel selector.
- A toolbar with various icons for cell operations like Run, Stop, Kernel, Cell, CellToolbar, and View.
- An instruction bar: "Arrange and size cells to create your dashboard." with a "MORE INFO" link, and a "Show code on hover" checkbox.
- A main section titled "Streaming Meetups Dashboard" containing:
 - A thumbnail image of a park scene.
 - The word "Park" below the thumbnail.
 - A link "Open gym volleyball for all levels of play."
 - The date "Wednesday, March 9, 2016, 8:30 PM"
- A "Stream" toggle switch.
- A text block explaining the purpose of the notebook: "The purpose of this notebook is to give an all-in-one demo of streaming data from the [meetup.com RSVP API](#), through a local [Spark Streaming job](#), and into [declarative widgets](#) in a dashboard layout."
- A "Filter" input field.
- A chart showing a distribution of data points (Grouped or Stacked) with a value of 1,138.0.
- A globe visualization at the bottom left.





JUPYTERLAB

(<https://github.com/jupyter/jupyterlab/>) - the future interface

The screenshot displays the JupyterLab interface. On the left is a file browser titled 'Files' showing a list of files and folders. In the center is a code editor window titled 'example.ipynb' with a Python 3 kernel selected. Below the code editor are several code cells:

- In [6]:**

```
import sys
print('hello world', flush=True)
for i in range(3):
    print(i, flush=True)
print('output to stderr', file=sys.stderr, flush=True)
print('some more stdout text', flush=True)
```

Output:
hello world
0
1
2

A portion of the output ('output to stderr') is highlighted with a pink background.

Output:
some more stdout text
- In [1]:**

```
from ipywidgets import IntSlider
IntSlider() # slider appears at the top of the notebook
```
- In []:**

```
# Markdown Cell
*It* **really** is!
```
- In [2]:**

```
this is a syntax error
```



EXTERNAL JUPYTER PROJECTS

There are many external projects such as *Beaker*, *Hydrogen (ATOM)*, *EIN (Emacs)*, *Rodeo*, *SageMathCloud* integrating Jupyter.

Publishers are also turning to Jupyter for books, blogs, reports, theses sometimes with live code examples.

- e.g. [Thebe](#) (O'Reilly)
- Nature, Scientific American Magazines is a simplified notebook interface

Educators

- tutorials, assignments, presentations, documenting
- MOOCs - online education:
 - notebook-based ([Edx](#)/[Apache Spark](#))





OREILLY BLOG ARTICLE - USING THEBE

This blog post contains modifiable, runnable code cells with a **RUN** button as shown below

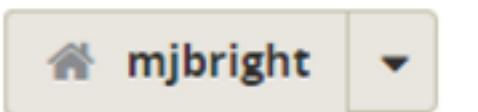
The screenshot shows a blog post from the O'Reilly website. The title is "Introducing Pandas Objects". The post discusses Pandas objects as enhanced versions of NumPy structured arrays. It includes a code cell with two lines of Python code:

```
1 import numpy as np
2 import pandas as pd
```

Below the code cell is a "Run" button.



MOOCs, E.G. F.U.N., GWU, EDX/SPARK...

 Inria: 41001S02 Python : des fondamentaux à l'utilisation du langage 

Courseware Info Cours Sommaire Discussion Progression

Semaine 1 : Introduction et prise en main

Présentation de la semaine et Evaluation du cours

1. Organisation du MOOC

2. Les outils de la distribution standard Python

3. Les notebooks

4. Pourquoi Python ?

Materiel du cours

Questionnaire

Semaine 2 : Types de base

Semaine 3 : Références

"Notebooks" IPython v2.0 File Insert Cell Kernel 

IPython ajoute également un nombre entre les crochets pour afficher, par exemple ci-dessus, In [1]: . Ce nombre vous permet de retrouver l'ordre dans lequel les cellules ont été évaluées.

Vous pouvez naturellement modifier ces cellules de code pour faire des essais; ainsi vous pouvez vous servir du modèle ci-dessous pour calculer la racine carrée de 3, ou essayer la fonction sur un nombre négatif et voir comment est signalée l'erreur:

```
In [1]: # math.sqrt (pour square root) calcule la racine carrée
import math
math.sqrt(2)
```

```
Out[1]: 1.4142135623730951
```

On peut également évaluer tout le notebook en une seule fois en utilisant le menu Cell -> Run All





JUPYTER FOR EVERYTHING ELSE

- Use of web technologies: mix-in HTML, CSS, js, SVG ...
- Use of bash kernel for command-line work
- Supplement command-line tools with graphics
- Create interactive presentations (thanks *RISE* extension !)
- Publish "live blog posts"
- Creating status reports from notebooks using nbconvert





EVERYTHING ELSE: WEB TECHNOLOGIES

- HTML/JavaScript/css experimentation
 - Many HTML, CSS, JS capabilities if you **proceed with care**
 - d3.js animations if
 - Need more interactivity
 - Prototyping a D3 project
 - Reusing existing D3 e.g. from <http://bl.ocks.org>
- SVG
- Example notebook

Select Theme: mysky





Everything Else: web technologies

- HTML/JavaScript/css experimentation
 - Many HTML, CSS, JS capabilities if you **proceed with care**
 - d3.js animations if
 - Need more interactivity
 - Prototyping a D3 project
 - Reusing existing D3 e.g. from <http://bl.ocks.org>
- SVG
- Example notebook

Select Theme: mybloodredsky



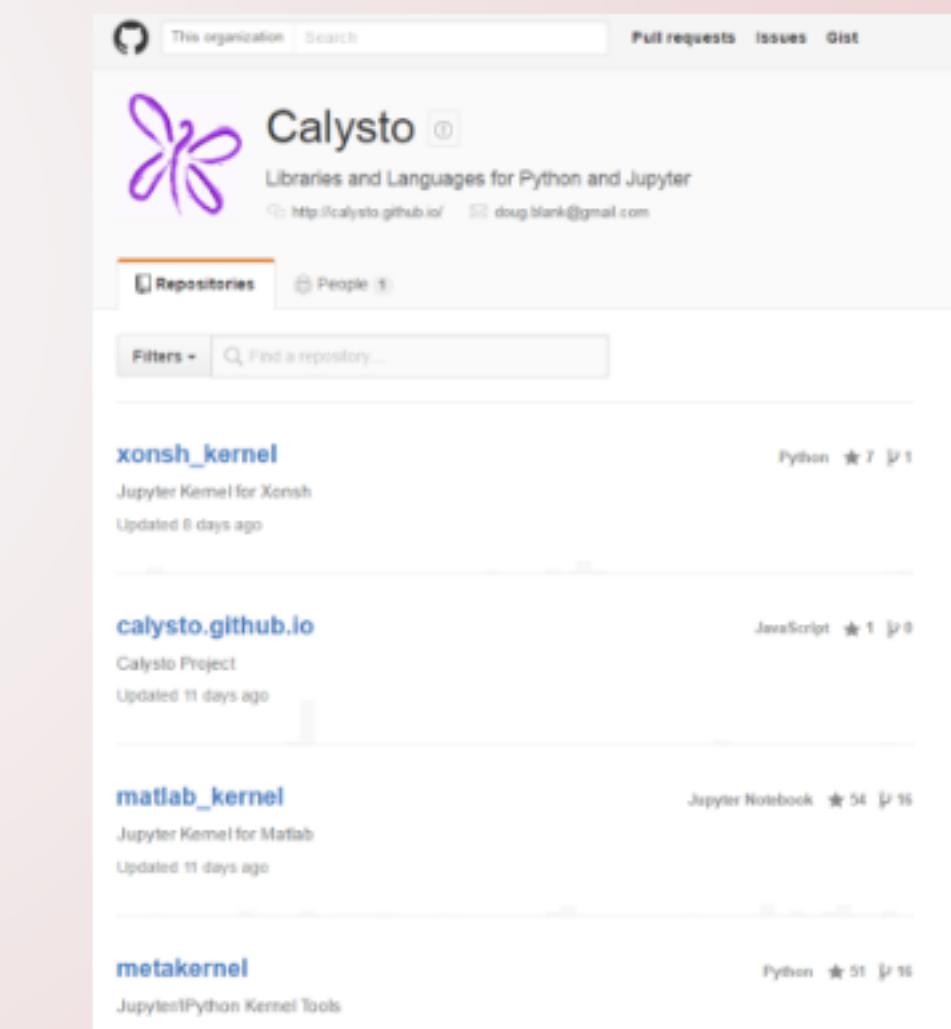


Everything Else: command-line

Two bash kernels are available for Jupyter bash_kernel and calysto/metakernel_bash

Calysto Metakernels

- easy to fix for Windows/Cygwin
- Provides magics
- Family of metakernels
- Under development





Everything Else: command-line

Why?

Inspired by the notebook as an educational tool
I wanted to use it for command-line tasks

- **Docker demos / labs in Jupyter**
- Why not Bash as 1st-class citizen with magics, graphics ?
- **Example notebook**
- Write command-line tutorials, cheat sheets
 - in an easy to maintain "live notebook" (runnable) format.

Adding HTML o/p capabilities to Bash in the Notebook

I've provided an 'html' function which enables display of html within the notebook

Below examples of pretty printing HTML from various sources

In [1]:

```
echo "<h1>An html header <!-- A comment --></h1>" | html
```

An html header

In [2]:

```
echo "<h1>A table <!-- A comment --></h1>
<table><tr><th>col1</th>
<th>col2</th>
<th>col3</th>
<th>col4</th>
</tr>
<tr><td>value1</td>
<td>value2</td>
<td>value3</td>
<td>value4</td>
</tr>
<tr><td>value1</td>
<td>value2</td>
<td>value3</td>
<td>value4</td>
</tr></table>" | html
```

A table

col1	col2	col3	col4
val1	val2	val3	val4
val1	val2	val3	val4





Everything Else: Binder 'live notebooks'



Turn a GitHub repo into a collection of interactive notebooks

Have a repository full of Jupyter notebooks? With Binder, you can add a badge that opens those notebooks in an executable environment, making your code immediately reproducible by anyone, anywhere.

100% free and open source. [Browse examples](#). [Read the FAQ](#).

Build a repository

[submit](#)

How it works

① In the field above, enter a GitHub repository that contains Jupyter notebooks, and click Submit to start the build. All files will be included, and if there's an index.ipynb notebook it will load first. Check out an [example](#).





Everything Else: "live notebooks" as runnable tutorials

We can create live tutorials online on Binder.

The notebook server can be launched by clicking on

the binder icon in a [github repo](#)

[launch binder](#)

I wrote a [Blog post](#) with link to "**live notebook**" of bash tutorials

The screenshot shows a web browser window displaying a blog post titled "The Art of the Command Line - ls (seen from Jupyter ... seen from MyBinder)". The post discusses the creation of executable cheat sheets for the art-of-the-command-line GitHub repository using a Jupyter notebook with a bash_kernel. It mentions that while Jupyter and MyBinder provide static versions, Docker and the Binder project allow for interactive execution. The blog post is dated Monday, May 16, 2016. On the right side of the screen, there is a sidebar with a "Pages" section containing a "Home" link and an "About Me" section featuring a small profile picture of a man.





Everything Else: Binder command-line "live notebooks"

In that [github repo](#) I created an **INDEX notebook**

other notebooks in the same repo

The screenshot shows a Jupyter notebook interface with the title bar "jupyter INDEX_Tutorials (autosaved)". The main content area displays a list of notebooks in the current directory:

```
In [8]: ls -altr *.ipynb
-rwxrwxr-x 1 main main 1152 Jul 9 05:29 Tutorial_Bash_Arrays.ipynb
-rw-r--r-- 1 main main 613 Jul 9 06:54 Perl6_timers_tutorial.ipynb
-rw-r--r-- 1 main main 27218 Jul 9 07:13 Networking_tcpdump_tutorial.ipynb
-rwxrwxr-x 1 main main 30582 Jul 9 07:16 Tutorial_ls.ipynb
-rwxrwxr-x 1 main main 25648 Jul 9 07:16 Example_bash_kernel.ipynb
-rw-r--r-- 1 main main 1773 Jul 9 07:19 INDEX_Tutorials.ipynb
```

Below this, there is a section titled "Using the Jupyter notebook" with links to "Go to TOP" and "Notebook%20Basics.ipynb".



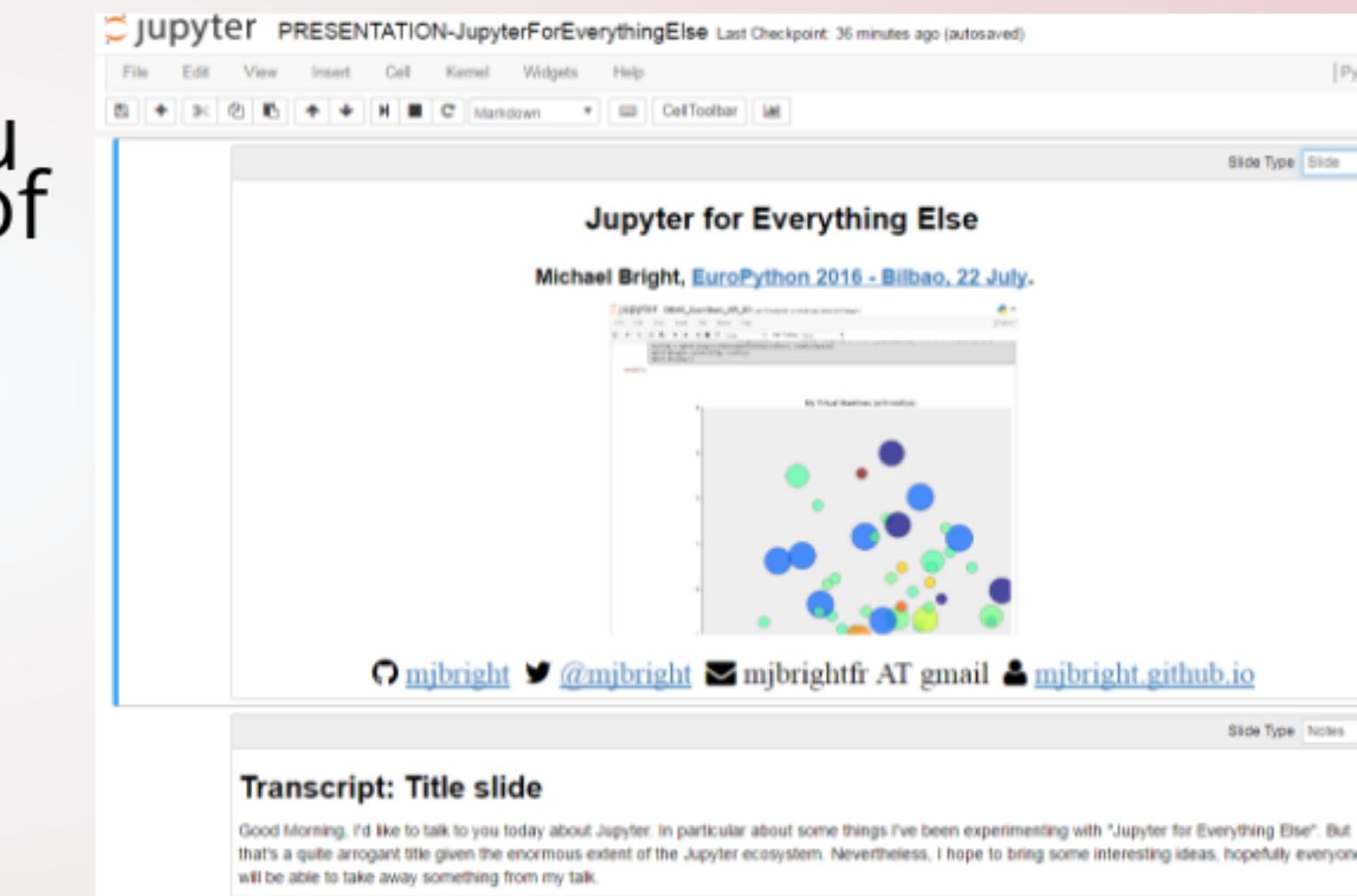


Everything Else: Slideshows

This **slideshow** is made using Jupyter with the RISE extensions

RISE adds special "Slide Type" menu options to each cell to specify one of

- Slide
- Sub-Slide
- Fragment
- Notes
- Skip





Everything Else: Automated e-mail status reports

Using nbconvert we can execute notebooks from the command-line

- Automatically run the notebook under cron
 - **nbconvert** notebook result to html
 - send html `report` as e-mail via cron
 - Capabilities created incrementally in notebook,
code migrated to modules to reduce
notebook (report) code

Platforms Status Summary				
Platform	Ping	Port status	Helpdesk available	Web ACTIVE
1.10.10.10	OK	OK	OK	OK
1.10.10.11	OK	OK	OK	OK
1.10.10.12	OK	OK	OK	OK
1.10.10.13	OK	OK	OK	OK

Platforms results

Platform: centos

Run at: 2018-01-16 20:08:04

[Return to Top](#) | [RESULTS](#) | [STATUS](#) | No ping_check entries in inventory

Name	Status	Reason	Image	Action
1.10.10.1	ok (live)	1.10.10.1:22: 2018-01-16 20:08:04	Ubuntu 14.04	Details
centos1	ok (live)	1.10.10.11:22: 2018-01-16 20:08:04	Ubuntu 14.04	Details
centos1-centos1-centos1	ok (live)	1.10.10.12:22: 2018-01-16 20:08:04	Ubuntu 14.04	Details
centos1-centos1-centos1-centos1	ok (live)	1.10.10.13:22: 2018-01-16 20:08:04	Ubuntu 14.04	Details
centos10	ok (live)	1.10.9.92:145:22	Ubuntu 14.04	Details
centos100	ok (live)	1.10.9.183:183:22	Ubuntu 14.04	Details
centos1000	ok (live)	1.10.9.192:145:22	Ubuntu 14.04	Details
centos10000	ok (live)	1.10.9.193:159:22	Ubuntu 14.04	Details
centos100000	ok (live)	1.10.9.192:134:22	Ubuntu 14.04	Details
centos1000000	ok (live)	1.10.9.192:149:22	Ubuntu 14.04	Details
centos10000000	ok (live)	1.10.9.192:183:22	Ubuntu 14.04	Details
centos100000000	ok (live)	1.10.9.192:141:22	Ubuntu 14.04	Details
centos1000000000	ok (live)	1.10.9.192:179:22	Ubuntu 14.04	Details
centos10000000000	ok (live)	1.10.9.192:142:22	Ubuntu 14.04	Details
centos100000000000	ok (live)	1.10.9.192:149:22	Ubuntu 14.04	Details
centos1000000000000	ok (live)	1.10.9.192:127:22	Ubuntu 14.04	Details
centos10000000000000	ok (live)	1.10.9.192:156:22	Ubuntu 14.04	Details

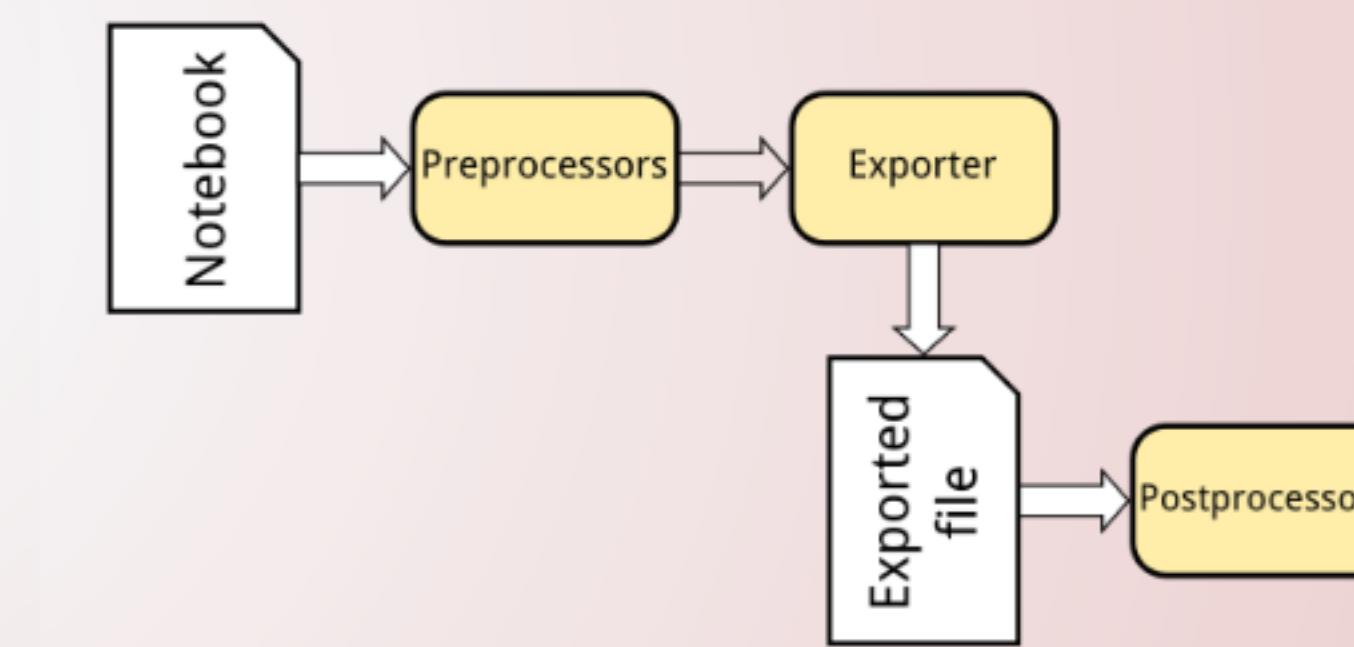


Everything Else: Automated e-mail status reports (nbconvert)

We can use nbconvert to automatically run the notebook under cron and send the results by e-mail

```
nbconvert --execute --template  
basic --to html Monitoring.ipynb
```

- --execute: execute the notebook
- --template: specify the o/p template
- --to: specify o/p format
- Input notebook





Everything Else: Coming up ...

- Experiment with JupyterHub, nbgrader, Binder
 - I'd like to reimplement some labs as a set of graded assignments
- More Metakernel_Bash experiments
- Make pull requests to Metakernel_bash
- Propose this stuff outside of the Python community
- Xonsh_kernel
 - Take advantage of new Python / unix-like shell
- CLing C++ interpreter kernel





Questions ?



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X

The End ...

?

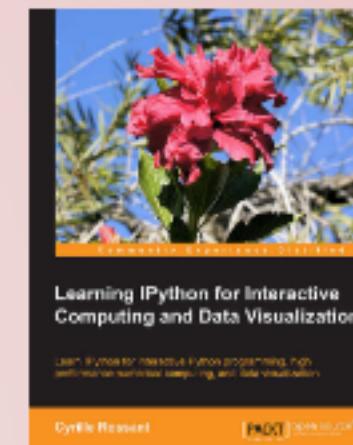


References: IPython / Jupyter Books

Learning IPython for Interactive Computing & Data Visualization

Cyrille Rossant

Introductory usage



IPython Interactive Computing & Visualization Cookbook

Cyrille Rossant

Advanced usage



The Jupyter GitBook

Extension writing



Documentation on ReadTheDocs

Extension writing