Jupyter Notebook

A tool for well-documented, reproducible bioinformatics workflows

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March 24, 2016

Open Science

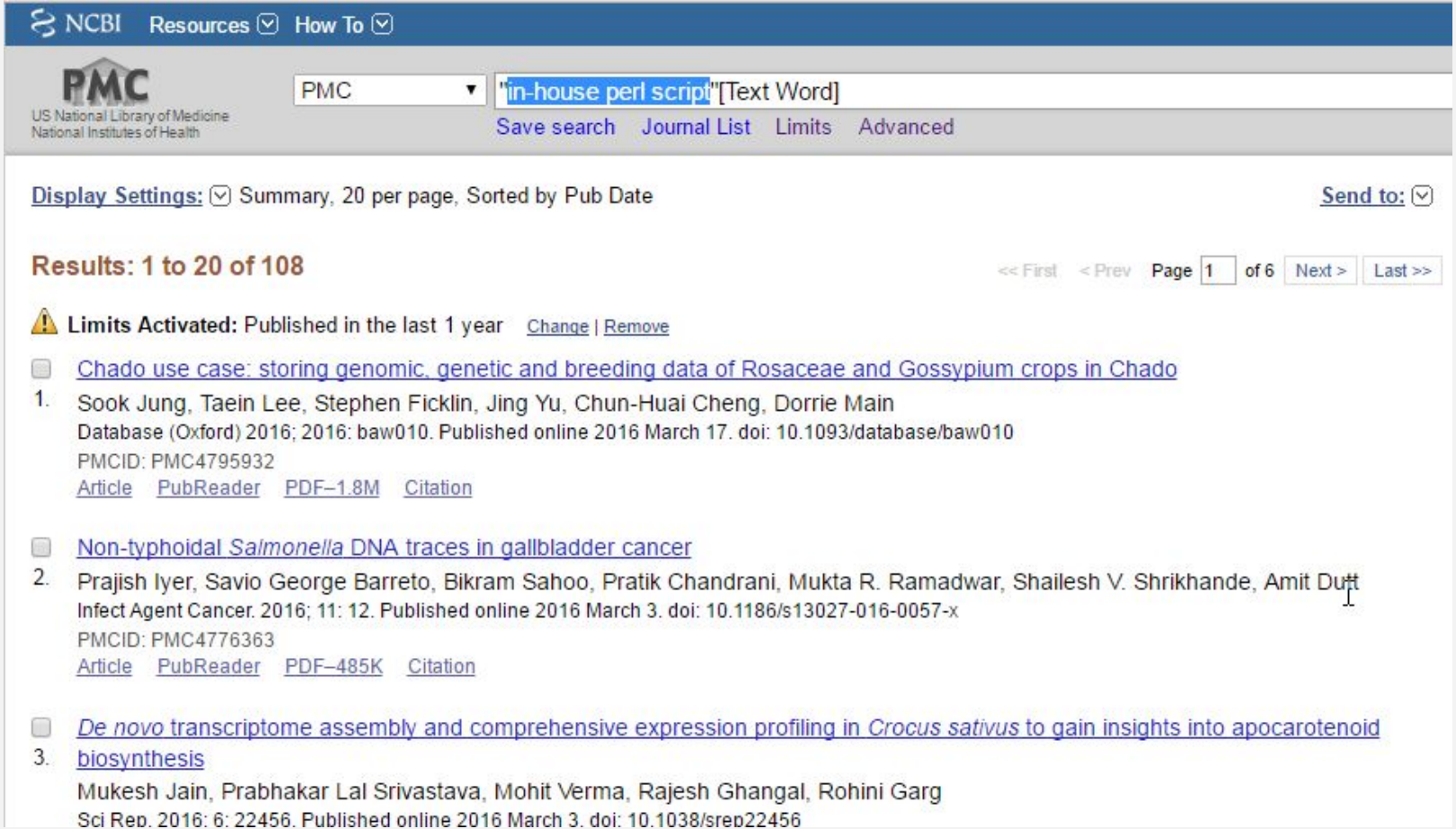
"Open science is the practice of making various elements of scientific research -- data & methods, code & software, and results & publications -- readily accessible to anyone."

--http://ropensci.org/about/

Open Science

How many times have you been reading a cool new publication, and then when you get to the Methods section, you see this term:

"In-house Perl scrips"



Source: http://www.ncbi.nlm.nih.gov/pmc/?term=%22in-house+perl+script%22[Text+Word]+AND+("2015/03/23"[PubDate]+:+"2016/03/23"[PubDate])

Source: https://twitter.com/philippbayer/status/288538682032545792

Jupyter Notebook

A web application that allows you to create and share documents that contain live code, equations, visualizations and explanatory text.

What is Jupyter?

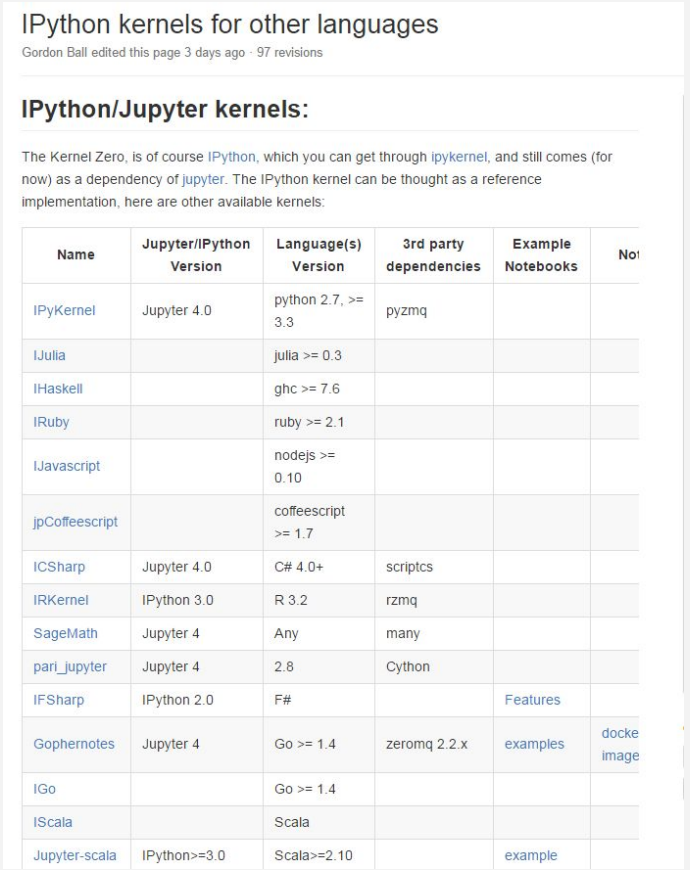
Started as IPython Notebook:

- Browser-based
- Organized by "cells", which could either be Python code or Markdown
- Has its own file format ".ipynb", which can be shared

What is Jupyter?

From beginning, IPython Notebook had ability to run Python code in code cells.

However, more and more support was added to run shell commands, and then ability to create "kernels" for other languages to build notebooks on.



IPython kernels for other languages

Gordon Ball edited this page 3 days ago · 97 revisions

IPython/Jupyter kernels:

The Kernel Zero, is of course IPython, which you can get through ipykernel, and still comes (for now) as a dependency of jupyter. The IPython kernel can be thought as a reference implementation, here are other available kernels:

Name	Jupyter/IPython Version	Language(s) Version	3rd party dependencies	Example Notebooks	No
IPyKernel	Jupyter 4.0	python 2.7, >= 3.3	pyzmq		
IJulia		julia >= 0.3			
IHaskell		ghc >= 7.6			
IRuby		ruby >= 2.1			
IJavascript		nodejs >= 0.10			
jpCoffeescript		coffeescript >= 1.7			
ICSharp	Jupyter 4.0	C# 4.0+	scriptcs		
IRKernel	IPython 3.0	R 3.2	rzmq		
SageMath	Jupyter 4	Any	many		
pari_jupyter	Jupyter 4	2.8	Cython		
IFSharp	IPython 2.0	F#		Features	
Gophernotes	Jupyter 4	Go >= 1.4	zeromq 2.2.x	examples	docke image
IGo		Go >= 1.4			
IScala		Scala			
Jupyter-scala	IPython>=3.0	Scala>=2.10		example	

Source: https://github.com/ipython/ipython/wiki/IPython%20kernels%20for%20other%20languages

What is Jupyter?

Support for other languages grew to the point that "IPython" notebook name was confusing, and project decided to re-brand as "Jupyter". This comes from the first main 3 data science languages that adopted the notebook format:

Julia, **Pyt**hon, and **R**

Source: http://blog.jupyter.org/2015/04/15/the-big-split/

The Big Split™

15 APRIL 2015

IPython has grown a great deal over the years. As of 3.0, IPython includes:

- an interactive shell
- a REPL protocol
- a notebook document fromat
- a notebook document conversion tool
- a web-based notebook authoring tool
- tools for building interactive UI (widgets)
- interactive parallel Python based on the above REPL protocol

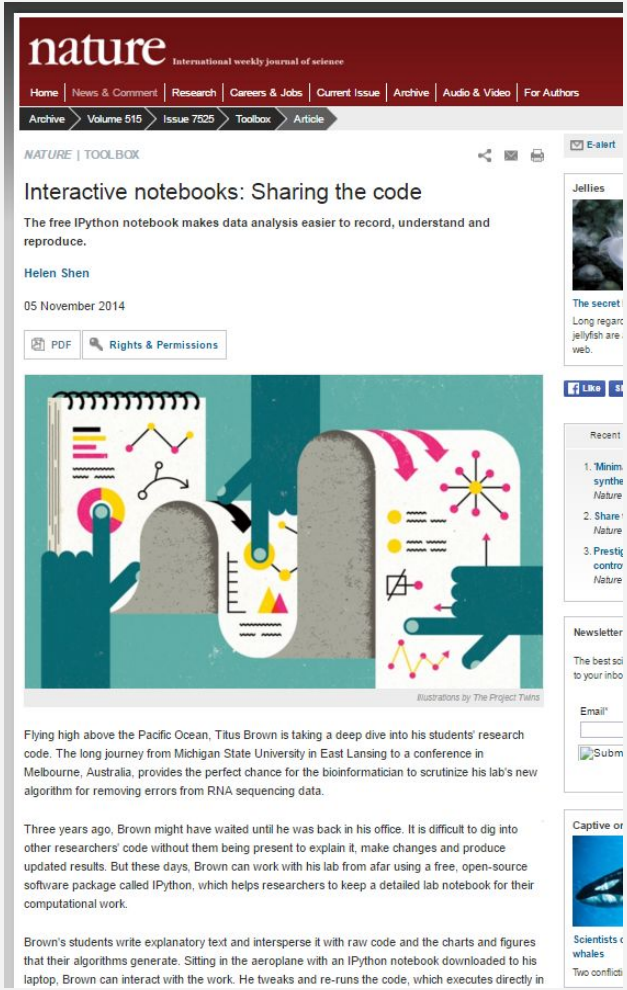
While all of these are part of the same story of tools for the lifecycle of a computational idea, they are increasingly becoming distinct projects that happen to live in a single repo. One significant part of the development is that pieces like the notebook and protocol are not even specific to Python, so it doesn't make sense anymore that they reside in a project called Interactive Python. This is the impetus for Project Jupyter, announced at SciPy 2014, which is the new home of language-agnostic projects that began as part of IPython, such as the notebook.

If anyone has been confused by what Jupyter is[1], it's the exact same code that lived in IPython, developed by the same people, just in a new home under a new name.

Some Examples

A 2014 article in Nature about IPython Notebook that also included a self-hosted notebook for demonstration purposes.

Source: http://www.nature.com/news/interactive-notebooks-sharing-the-code-1.16261



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Archive > Volume 515 > Issue 7525 > Toolbox > Article

NATURE | TOOLBOX

Interactive notebooks: Sharing the code

The free IPython notebook makes data analysis easier to record, understand and reproduce.

Helen Shen

05 November 2014

PDF | Rights & Permissions

Illustrations by The Project Twins

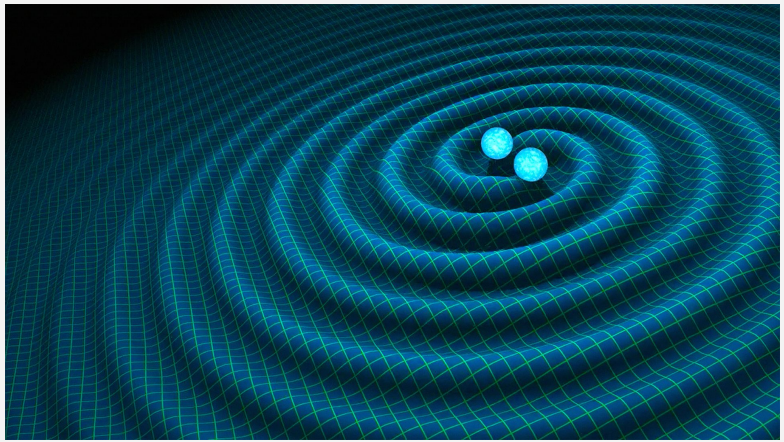
Flying high above the Pacific Ocean, Titus Brown is taking a deep dive into his students' research code. The long journey from Michigan State University in East Lansing to a conference in Melbourne, Australia, provides the perfect chance for the bioinformatician to scrutinize his lab's new algorithm for removing errors from RNA sequencing data.

Three years ago, Brown might have waited until he was back in his office. It is difficult to dig into other researchers' code without them being present to explain it, make changes and produce updated results. But these days, Brown can work with his lab from afar using a free, open-source software package called IPython, which helps researchers to keep a detailed lab notebook for their computational work.

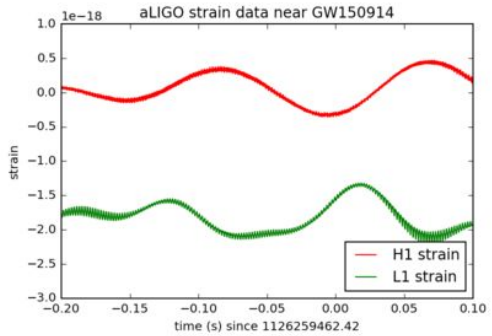
Brown's students write explanatory text and intersperse it with raw code and the charts and figures that their algorithms generate. Sitting in the aeroplane with an IPython notebook downloaded to his laptop, Brown can interact with the work. He tweaks and re-runs the code, which executes directly in

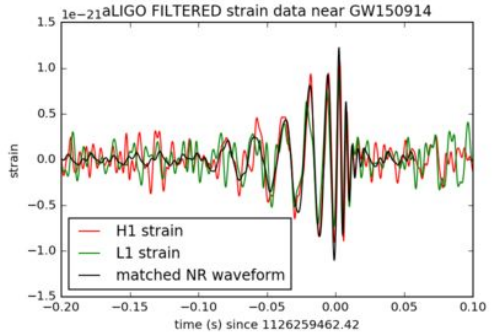
Some Examples

The February 2016 announcement by the Laser Interferometer Gravitational-Wave Observatory (LIGO) included a Jupyter notebook to show how their data was analyzed.



```
plt.plot(time-tevent,strain_L1_fils,'g',label='L1 strain')
plt.plot(NRtime+0.002,NR_H1_filt,'k',label='matched NR waveform')
plt.xlim([-0.2,0.1])
plt.ylim([-1.5e-21,1.5e-21])
plt.xlabel('time (s) since '+str(tevent))
plt.ylabel('strain')
plt.legend(loc='lower left')
plt.title('aLIGO FILTERED strain data near GW150914')
plt.savefig('GW150914_H1_strain_filtered.png')
```





Source: https://losc.ligo.org/s/events/GW150914/GW150914_tutorial.html

Some examples

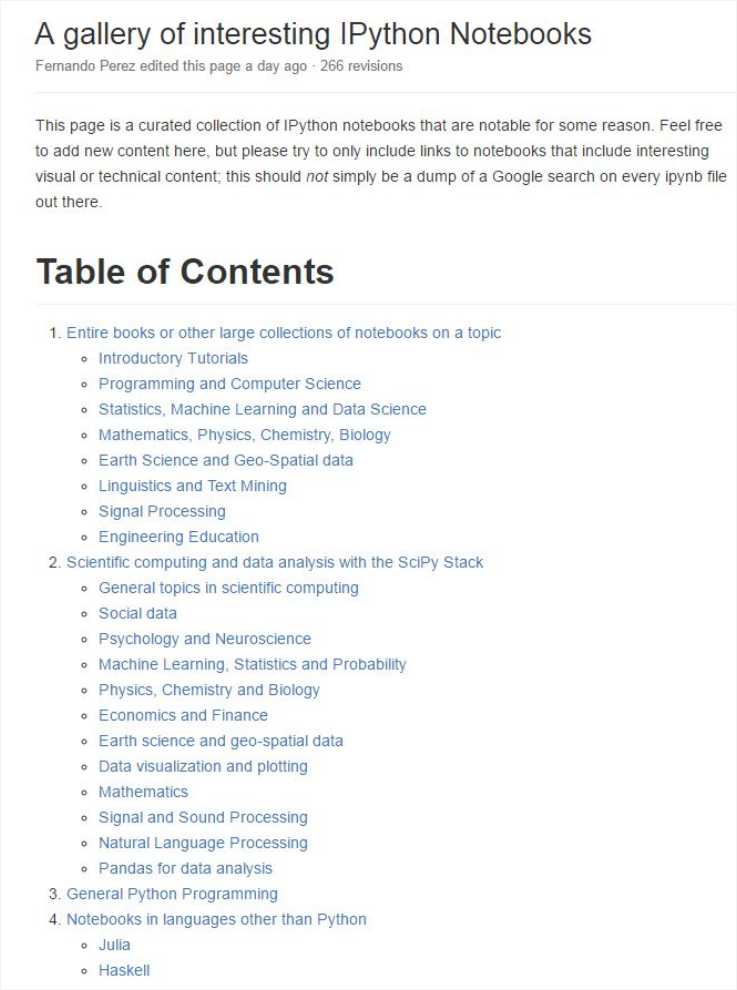
There are entire textbooks written as interactive Jupyter notebooks.

Two good examples are "An Introduction To Applied Bioinformatics" by Greg Caporaso, and "Probabilistic Programming & Bayesian Methods for Hackers" by Cam Davidson Pilon

Some examples

The IPython project maintains a curated "gallery" of interesting Jupyter notebooks, that includes examples from several different scientific fields and applications.

Source: https://github.com/ipython/ipython/wiki/A-gallery-of-interesting-IPython-Notebooks



A gallery of interesting IPython Notebooks

Fernando Perez edited this page a day ago · 266 revisions

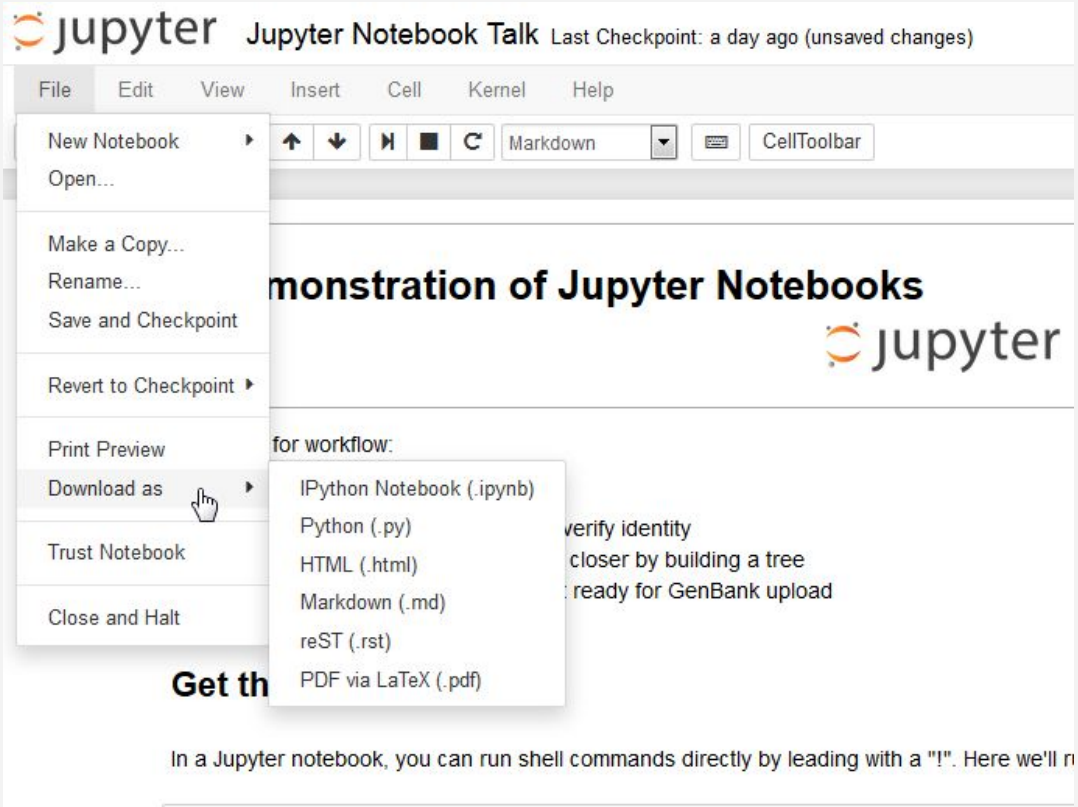
This page is a curated collection of IPython notebooks that are notable for some reason. Feel free to add new content here, but please try to only include links to notebooks that include interesting visual or technical content; this should *not* simply be a dump of a Google search on every ipynb file out there.

Table of Contents

How can I use Jupyter Notebooks?

How can I use Jupyter Notebooks?

If you have created a notebook, you can export it to a variety of different formats for people to view, such as HTML (as a webpage), Markdown or reST (which makes it easy to insert into blog posts), or PDF.



How can I use Jupyter Notebooks?

GitHub added native support for .ipynb files, which means that you can view Jupyter Notebooks posted to GitHub repositories and to Gists.

Source: http://blog.jupyter.org/2015/05/07/rendering-notebooks-on-github/

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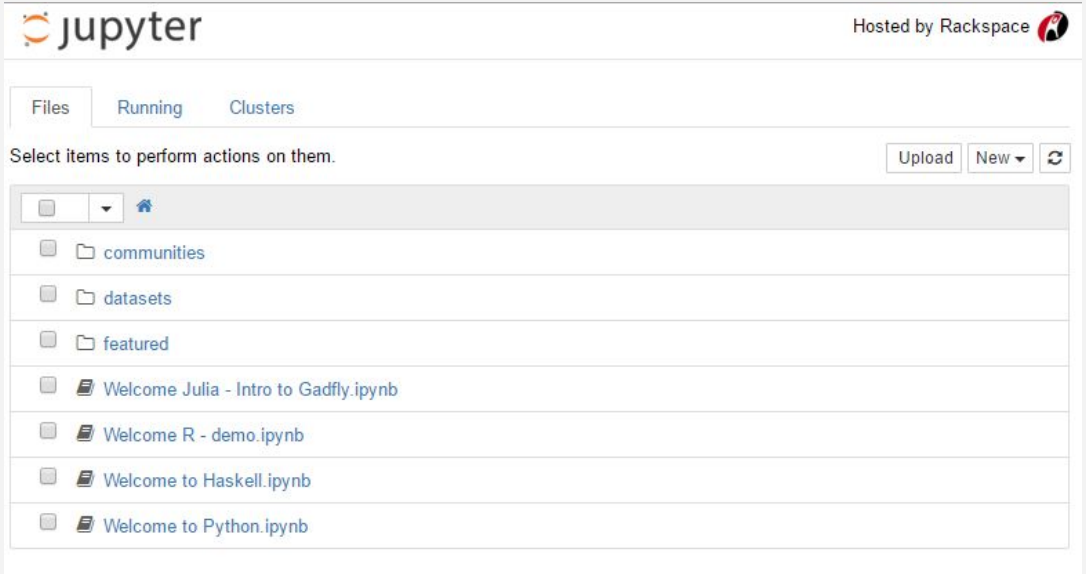
How can I create my own Jupyter Notebooks?

Jupyter.org has a Rackspace-hosted kernel where you can try out how Jupyter Notebooks work -- all without installing a single piece of software.

You can find this at: https://try.jupyter.org/



How can I create my own Jupyter Notebooks?

If you already have Python installed on your computer, installing Jupyter is as simple as:

"pip install jupyter notebook"

If you do not have Python installed, I recommend installing Miniconda from http://conda.pydata.org/miniconda.html, which is cross-platform. Then you can install Jupyter using:

"conda install jupyter notebook"

Ok, now onto the Demo…

Which you can find here:

https://github.com/MikeTrizna/jupyter_notebook_presentation/blob/master/Jupyter%20Notebook%20Talk.ipynb