



# *Jupyter Notebooks for Teaching and Learning*

Thomas Kluyver



# It's not about me!

[groups.google.com/d/forum/jupyter-education](https://groups.google.com/d/forum/jupyter-education)



# Questions!

- Should I use notebooks?
- What can go wrong?
- What extra tools can I use?
- Hosted or local installs?

# Why not notebooks?

Notebooks &  
version control

Install  
problems

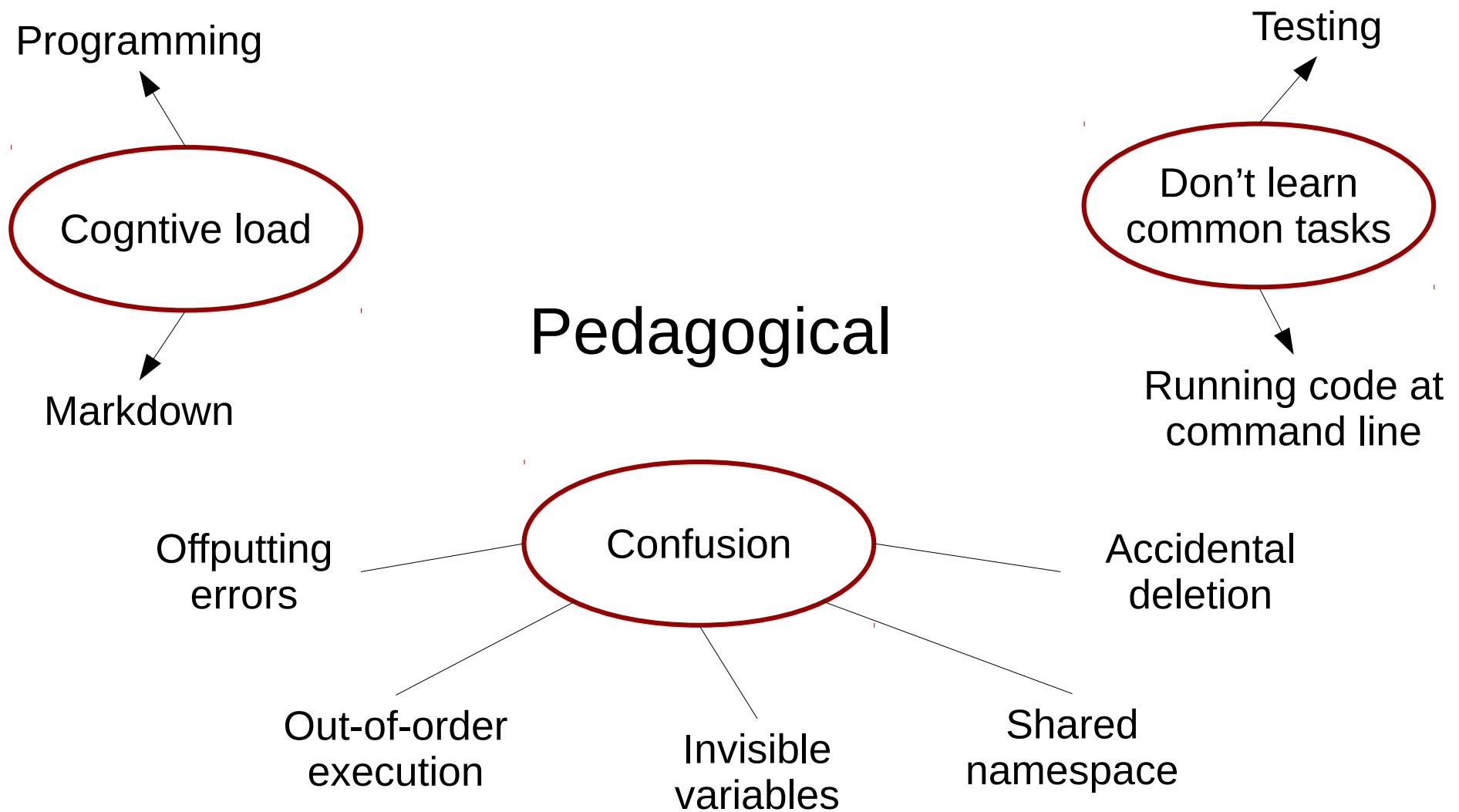
Low-res  
projectors

Technical

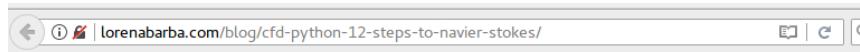
Large  
output

Awkward/  
limited undo

# Why not notebooks?

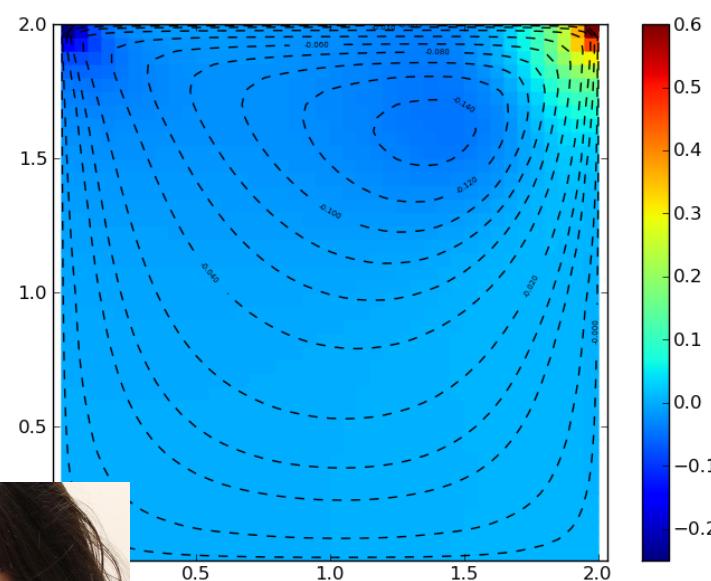


# And yet...



Lorena A. Barba group

## CFD Python: 12 steps to Navier-Stokes



A screenshot of a GitHub repository page for "barbagroup / CFDPython". The page shows a sequence of IPython notebooks featuring the "12 Steps to Navier-Stokes" series. Key statistics shown include 186 commits, 2 branches, and 0 releases. A list of recent commits is displayed, including: gforsyth committed on GitHub Merge pull request #35 from bryant1410/master, JSAnimation @ b14771b added JSAnimation as submodule, lessons Fixed boundary condition error, styles updated css with nicer fonts, .gitignore ignore autoenv, .gitmodules added JSAnimation as submodule, LICENSE Update LICENSE, and README.md Fix broken Markdown headings.

# Quantum Mechanics

This screenshot shows a GitHub repository page for 'QMlabs'. The repository has 0 issues, 0 pull requests, 0 projects, and a single contributor, amcdawes, who updated it on 3-15-2016. The notebook contains 851 lines of code and 21.9 KB. The content of the notebook is as follows:

## Two-particle systems

An introduction to multi-particle spaces, starting with photon polarization state

The state of two photons?

```
In [1]: import matplotlib.pyplot as plt
        from numpy import sqrt, pi, sin, cos, arange
        from qutip import *
```

The polarization states (in the HV-basis):

The QuTiP website homepage features a large 3D surface plot of a quantum state. The top navigation bar includes links for GitHub, Search, Pull requests, Issues, Marketplace, and Insights. The main menu includes QuTiP, News, Features, Download, Citing, and Documentation.

## QuTiP : Quantum Toolbox in Python

QuTiP is open-source software for simulating the dynamics of open quantum systems. It depends on the excellent [Numpy](#), [Scipy](#), and [Cython](#) numerical packages. In addition, it provides a convenient interface to [Matplotlib](#). QuTiP aims to provide user-friendly and efficient numerical simulations for a wide variety of Hamiltonians, including those with arbitrary time-dependence, commonly found in quantum optics, trapped ions, superconducting circuits, and nanomechanical resonators. QuTiP is freely available for use and/or modification on Unix platforms such as Linux, Mac OSX, and Windows\*. Being free of any licensing fees, QuTiP is ideal for teaching quantum mechanics and dynamics in the classroom.

\*QuTiP is developed on Unix platforms only, and some features may not be available under Windows.

# Data Science

data-8 / data8assets

Code Issues 1 Pull requests 0 Projects 0 Wiki Insights

Branch: gh-pages ➔ data8assets / materials / sp17 / hw / hw02 / hw02.ipynb

papajohn sp17/hw/hw02.push

1 contributor

941 lines (939 sloc) | 24.1 KB

## Homework 2: Arrays and Tables

Reading: Textbook chapters [4](#) and [5](#).

Please complete this notebook by filling in the cells provided. Before you begin, execute the first cell to set up the environment. Each time you start your server, you will need to execute this cell again to load the tests. Each time you start your server, you will need to execute this cell again to load the tests.

In [ ]: # Don't change this cell; just run it.

```
import numpy as np
from datascience import *

from client.api.notebook import Notebook
ok = Notebook('hw02.ok')
_ = ok.auth(inline=True)
```

**Important:** The ok tests don't always tell you that your answer is correct. More often than not, they only tell you that your answer is correct. It's up to you to ensure that your answer is correct. If you're not sure, ask someone (not your approach).

Once you're finished, select "Save and Checkpoint" in the File menu and then execute the first cell again. You will see a link that you can use to check that your assignment has been submitted.

OK

sumukh@berkeley.edu

ANNOUNCEMENTS

Welcome to Ok!  
Ok User Guide

ACTIONS

Choose Courses

Admin Dashboard

Logout

Courses » Sandbox (Summer 2016) » Ex » Submission b23G9W

Received on Fri 01/27 10:24 AM

Wk02-Common-ML-tasks.ipynb

## Machine Learning

Machine learning is increasingly in the news and pervades every aspect of our daily lives. Machine learning protects our inboxes from spam messages, recommends products we might like, and helps us to efficiently route our mail.

What is machine learning?

Teaching machines how to learn to carry out tasks without being explicitly programmed to do so.

Machine learning algorithms do not rely on static instructions pre-programmed into a computer. Instead, they learn from data and build a model from which they can make predictions or decisions.

Machine learning is now used in many fields and for many tasks:

- Detecting spam emails

# Python for biologists



https://flxlexblog.wordpress.com/2017/03/08/a-new-1/

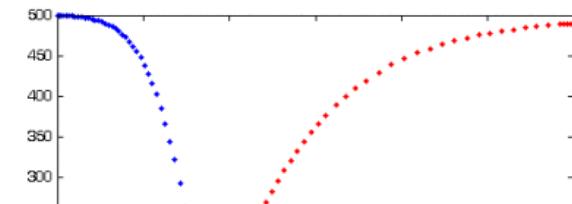
My Site Reader RSS - Posts Search ... Search Email Subscription

## A new 1st semester bachelor course “Introduction to Computational Modelling for the Biosciences”

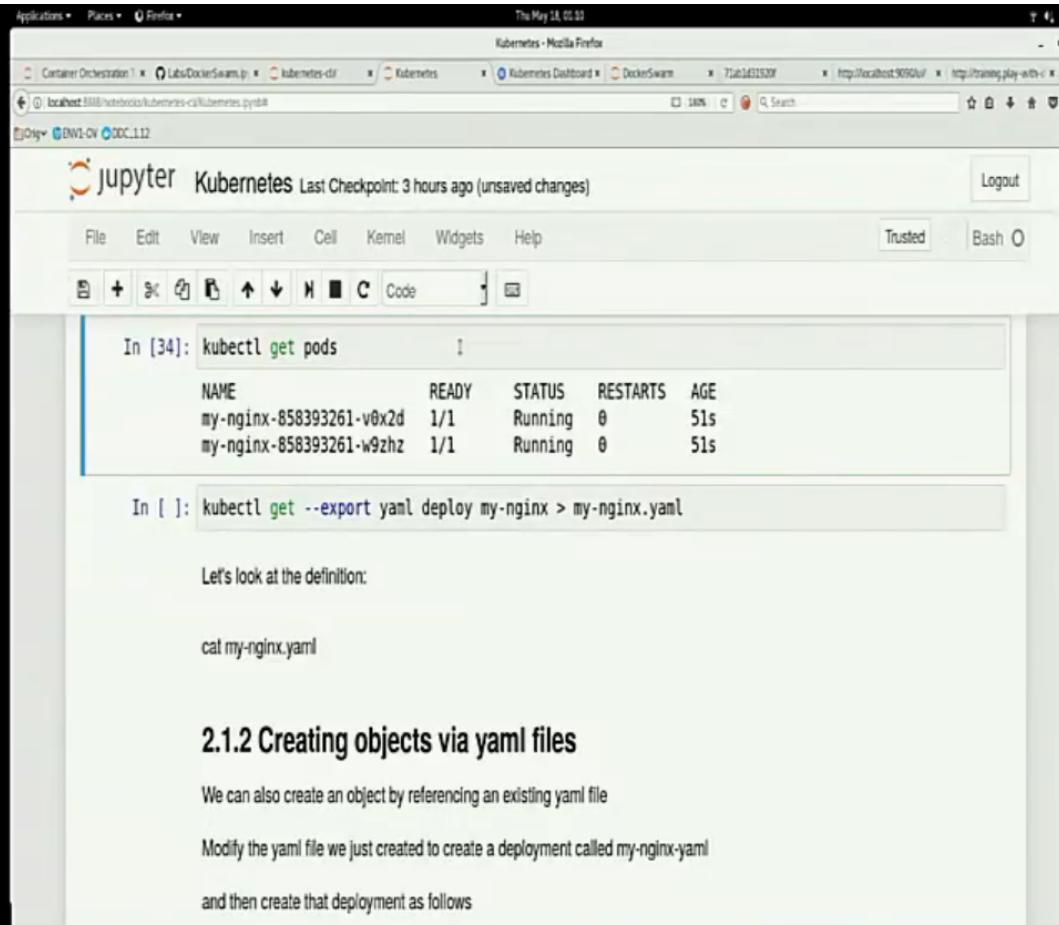
Posted on March 8, 2017 by lexnederbragt



The Institute of Biosciences, with the CSE project, set itself an ambitious goal: in the first semester for Biosciences students one of



# Container tutorials



The May 18, 05:00

Kubernetes - Mozilla Firefox

File Edit View Insert Cell Kernel Widgets Help Trusted Bash

In [34]: `kubectl get pods`

NAME	READY	STATUS	RESTARTS	AGE
my-nginx-858393261-v0x2d	1/1	Running	0	51s
my-nginx-858393261-w9hz	1/1	Running	0	51s

In [ ]: `kubectl get --export yaml deploy my-nginx > my-nginx.yaml`

Let's look at the definition:

`cat my-nginx.yaml`

### 2.1.2 Creating objects via yaml files

We can also create an object by referencing an existing yaml file

Modify the yaml file we just created to create a deployment called my-nginx-yaml

and then create that deployment as follows



# Why notebooks?

Students tackle harder problems

Follow lectures interactively

Open source

Engage with material

*Combine computation,  
writing, mathematics*

Get corrections on Github

Learn technical computing skills

NB exercises record thought process

Zero-install hosted service

More on this soon

# What can go wrong?



**Slow down!**  
& leave blanks?



# Nbgrader

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

File Edit View Insert Cell Kernel Help

Cell Toolbar: None

### Part A (2 points)

Write code to compute the mean of a list of numbers.

```
In [ ]: def mean(x):
    """Compute the mean of a list of numbers given in `x`."""
    ### BEGIN SOLUTION
    return sum(x) / len(x)
    ### END SOLUTION
```

```
In [ ]: """Check that the `mean` function is correct."""
assert mean([1]) == 1.0
assert mean([1, 2]) == 1.5
assert mean([5.5, 0, 2, 3.4]) == 2.725
assert mean(range(100)) == 49.5
assert mean(range(100, 0, -1)) == 50.5
```

### Part B (3 points)

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

Arithmetic mean:

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


# Nbgrader



Files

Running

Clusters

Assignments

Select items to perform actions on them.

Upload

New ▾



classes



cogphys



config



ipynb



misc



presentations



publications



research



teaching



tmp



tools



websites

# Nbgrader

Write a function that returns a list of numbers, such that  $x_i = i^2$ , for  $1 \leq i \leq n$ . Make sure it handles the case where  $n < 1$  by raising a `ValueError`.

In [3]:

Problem ID: squares Score: 1.6 / 2

```
def squares(n):
    """Compute the squares of numbers from 1 to n, such that the
    ith element of the returned list equals i^2.

    """
    return [i**2 for i in xrange(1, n + 1)]
```

Your function should print `[1, 4, 9, 16, 25, 36, 49, 64, 81, 100]` for  $n = 10$ . Check that it does:

In [4]:

```
squares(10)
```

Out[4]: `[1, 4, 9, 16, 25, 36, 49, 64, 81, 100]`

In [5]:

Score: 1.6 / 1.6

```
"""Check that squares returns the correct output for several inputs"""
from nbgrader.tests import assert_equal
assert_equal(squares(1), [1])
assert_equal(squares(2), [1, 4])
assert_equal(squares(10), [1, 4, 9, 16, 25, 36, 49, 64, 81, 100])
assert_equal(squares(11), [1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121])
```

In [6]:

Score: 0 / 0.4

```
"""Check that squares raises an error for invalid inputs"""
from nbgrader.tests import assert_raises
assert_raises(ValueError, squares, 0)
assert_raises(ValueError, squares, -4)
```

```
AssertionError Traceback (most recent call last)
```

# okpy.org



## Homework 9 Stats cal/cs61a/fa16

Home > cal/cs61a/fa16 > Assignments > Homework 9 > Stats

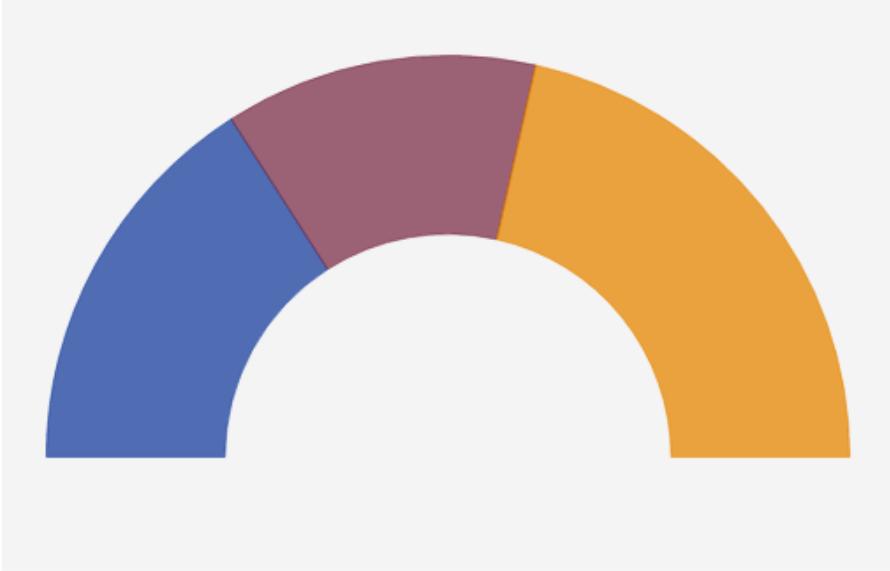
 SUBMITTED <b>594</b> 31.8% have submit...	 STARTED <b>1063</b> 57.0% have started	 UNIQUE SUBMISSIONS <b>1037</b> (Includes backups)	 ACTIVE GROUPS <b>27</b> 3 are still pending
-----------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------

### Stats

594 STUDENTS WITH SUBMISSIONS  
469 STUDENTS WITH ONLY BACKUPS  
802 STUDENTS WITHOUT SUBMISSIONS  
27 ACTIVE GROUPS  
1037 SUBMISSIONS TO GRADE  
61659 TOTAL BACKUPS  
1388 TOTAL SUBMISSIONS

### Homework 9 Charts

Students submission status



Legend: █ Students with Submissions   █ Students with Backups   █ Not Started

# Tools: hosted notebooks



DIY  
Login options



\$4 – \$20 per student  
Course tools



## **Convert to/from notebooks**

`nbconvert` · `nbsphinx` · `bookbook` · `ipymd` · `rst2ipynb`

## **Slideshows**

`nbconvert` · `RISE`

Programmatically generate notebooks

# Hosted or local install



Managed  
desktops



Students'  
computers



# Hosted or local install



COCALC

*Nothing to install!*

*Use your tablet!*

*Free!*

*No network issues!*



# Hosted or local install



*Auto-grading*

*Equity issues*

*Tools & materials  
for after course?*



# Acknowledgements

*jupyter-education mailing list*

[groups.google.com/d/forum/jupyter-education](https://groups.google.com/d/forum/jupyter-education)

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FOUNDATION

THE LEONA M. AND HARRY B.  
**HELMSLEY**  
CHARITABLE TRUST